



Booklet for the
International Conference on

Sustainable Sloping Lands and Watershed Management

Linking research to strengthen upland policies
and practices

December 12 - 15, 2006
Luang Prabang, Lao PDR





**Conference Booklet for the International Conference on
Sustainable Sloping Lands and Watershed
Management: Linking research to strengthen upland
policies and practices**

December 12 - 15, 2006

Held at the Provincial Meeting Hall

Luang Prabang, Lao PDR

Organized with support from



Information booklet produced by the NAFRI Information Service Unit

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Welcome Note

It is my pleasure to welcome you to Luang Prabang and the 2nd International Conference on “Sustainable Sloping Lands and Watershed Management: Linking research to strengthen upland policies and practices”.

The Government of Lao PDR is determined to eradicate extreme poverty and move beyond the category of Least Developed Country by the year 2020. The uplands and upper watershed catchments of Lao PDR are of high interest to government policy-makers and most international agencies. This is because these areas are at the interface where the highest incidence of poverty occurs and proper environmental management is most necessary.

The Ministry of Agriculture and Forestry has recently adopted a number of policies and support measures. These focus on four major targets that will have a direct bearing on the uplands of Lao PDR. These include:

1. Ensuring food security
2. Promotion of commodity and commercial production
3. Shifting cultivation stabilization for poverty alleviation
4. Sustainable forestry and natural resource management

The National Agriculture and Forestry Research Institute of Lao PDR (NAFRI) was established in 1999 and aims to contribute to the goals of the Government of Laos by focusing on adaptive research to overcome specific problems limiting production and causing degradation of natural resources. NAFRI seeks to do this by carrying out demand-driven research that supports local peoples' active involvement in their own development. NAFRI focuses on adaptive research in order to provide technical options, recommendations, and results to support agriculture, forestry, and fisheries development and strategic formulation of policies and programs in accordance with the government policy.

The problems facing development of the uplands are complex. The Government of Lao PDR recognizes that a “one solution fits all” approach to uplands development does not work under the diverse environmental, social, economic, and cultural conditions found in the uplands. In-line with this, NAFRI's current uplands research agenda goes beyond technology development to explore a number of other issues and areas such as: marketing and value chain analysis; understanding the environmental and social impacts of the rapid changes occurring in the uplands; and testing a range of land use planning approaches to assist district staff develop long-terms plans that are based on both geophysical and socio-economic criteria.

NAFRI decided to organize the 2nd international conference on Sustainable Sloping Land and Watershed Management for a couple of reasons. First, NAFRI has a mandate to carry out adaptive research that benefits the country as well as Lao farmers. Thus, NAFRI sees this conference as a good opportunity to exchange experiences and lessons with different countries around the region and the world in sloping land and watershed management. In addition, NAFRI would like to explore how research in the region is actually being applied and used

and the impacts it has had on improving upland livelihoods, and on maintaining the natural resource base for future generations.

Second, NAFRI sees this as an important opportunity to further develop the capacities and skills of Lao researchers (whether from NAFRI or other organizations). International conferences, such as this one, play an important role in updating and expanding the knowledge base within Laos, to ensure research efforts are not being duplicated, and to provide an opportunity for Lao researchers to share their results with other researchers.

The main purpose of the conference is to explore different strategies to promote environmental sustainability and enhance livelihoods of rural communities that inhabit upland areas. The main theme for this year's conference is to understand better the linkages between research and its application by policy-makers, development practitioners, and educators.

I would like to express my sincere thanks and appreciation to all donors and organizations that have supported the preparations for this conference. I would also like to thank the Provincial Government of Luang Prabang for hosting the conference.

Again, we hope you enjoy your time in Luang Prabang and you find the experiences and lessons gained at the conference useful in your own work.

A red circular official seal of NAFRI (National Agriculture Forestry Research Institute) is visible. The seal features a central emblem with a tree and a sun, surrounded by text in Lao and English. A black ink signature is written across the seal.

Dr. Bounthong Bouahom
Director General, NAFRI

Acknowledgements

The conference organizers would like to acknowledge the support and assistance of the following organizations and individuals:

- **Luang Prabang Provincial Authorities including:** The Provincial Governors Office, The Provincial Agriculture and Forestry Office, The Provincial Tourism Office, and the Provincial Finance Office for the use of their meeting room.
- **Financial contributions from:** the Asian Development Bank, Institut de Recherche pour le Developpement (IRD), International Water Management Institute (IWMI), the Swiss Agency for Development and Cooperation (SDC), and Swedish International Development Cooperation Agency (Sida) and The Swedish Environmental Secretariat for Asia (SENSA)
- **Technical and organizational support from** International Center for Tropical Agriculture (CIAT), the Lao-Swedish Upland Agriculture and Forestry Research Program (LSUAFRP), IRD, IWMI, and a number of key centers and divisions under NAFRI including: Soil Science and Land Classification Center, the Information Management and Strategic Planning Division, the Finance, Administration, Planning and Cooperation Division of NAFRI and The Northern Agriculture and Forestry Research Center of NAFRI
- **Field Trip organization from** CIAT, Center for Human Ecology Studies of the Highlands (CHESH), Japan International Cooperation Agency (JICA), IRD-IWMI and LSUAFRP. In addition, we would like to thank all the provincial and district authorities who allowed us to travel to these sites. Finally, we would like to thank the villagers for taking the time to allow us into their homes.

We would also like to thank all the participants who made a presentation or participated in the information market. Finally, we would like to thank all the projects, programs and organizations which have provided financial support for their staff to attend the conference.

Conference Organizing Committee

1. Dr. Bounthong Bouahom, Chairman
2. Mr. Soulivanthong Kingkeo, Vice Chairman
3. Mr. Oloth Sengtaheunghoung, Vice Chairmen
4. Mr. Sisongkham Mahathilath, Administrative and Finance Coordinator
5. Mr. Houmchitsavath Sodarak, Luang Prabang Coordinator
6. Mr. Bandith Ramangkoun, Conference Coordinator
7. Dr. Thiphavong Boupha, Conference Secretariat
8. Dr. Olivier Ribolzi, Representative of IRD, IWMI
9. Dr. Christian Valentin, Representative of IRD, IWMI
10. Dr. Rod Lefroy, Representative of CIAT
11. Mr. Carl Mossberg, Representative of LSUAFRP
12. Mr. Michael Victor, Coordination Support

In and around Luang Prabang

The ancient town of Luang Prabang in the heart of northern Laos has been described as one of the most charming and best preserved towns in Southeast Asia. Luang Prabang was listed as a UNESCO World Heritage Site in 1995. It is also the ‘gateway’ to the Uplands of Laos. Luang Prabang has been chosen as the conference site because it is close to interesting field sites and provides a good way for participants to see the Lao uplands.



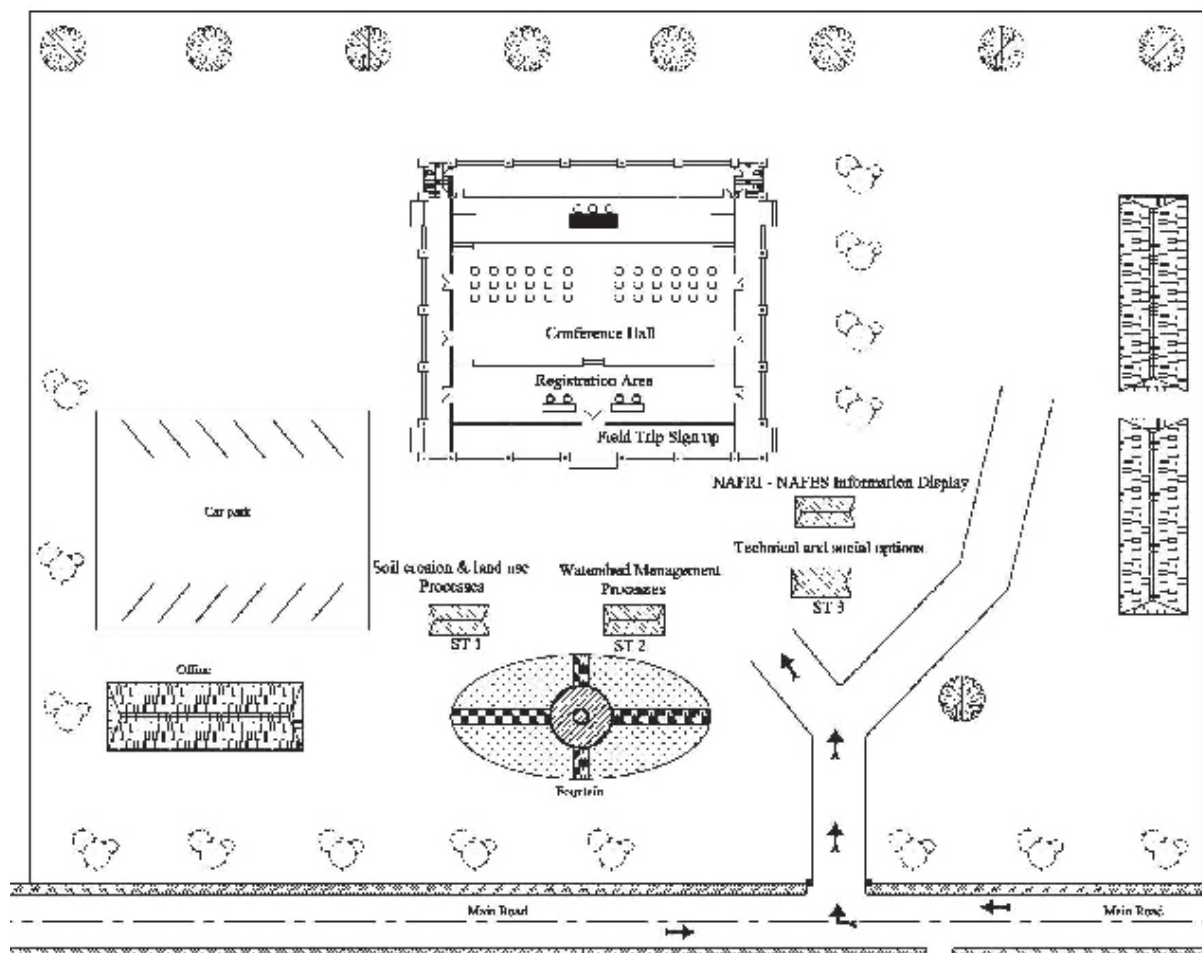
Key Meeting Areas

Many of the key meeting areas are highlighted on the map itself. Two important areas will be:

- 1) **The Provincial Meeting Hall:** Most of the conference activities will take place at the conference meeting hall which is conveniently located in the heart of Luang Prabang. See Map on following page for more information
- 2) **Provincial Finance Meeting Hall:** On Day 2 and the morning of Day 4, parallel session B will take place here. The provincial finance meeting hall is about 500 meters from the main conference venue and transportation will be available to and from both venues.

In terms of site seeing some important places of note include:

- **Night Market:** The main road in town is closed down every night for the famous night market which features soft lights and a lot of good hearted bargaining
- **Ethnic Music Festival:** From December 14-16, the first Lao ethnic music festival will take place at the sports field across from the provincial meeting room.
- **Temples:** There are a number of important Buddhist temples in Luang Prabang such as Wat That Phousi and Wat Xiengthong.
- **Kings' Palace:** In the center of town is the ancient palace of the Lang Xang Kings.
- **Morning Offerings to monks:** If you wake up early enough you can participate in the daily ritual of giving monks their daily food.



Overview of the conference

The main purpose of this conference is to explore different strategies to promote environmental sustainability and enhance livelihoods of rural communities that inhabit upland areas.

SSLWM 2006 will highlight emerging planning and management strategies for the sustainable management of upper catchments. A particular focus of the conference will be on strategies that both promote environmental sustainability and address the socio-economic circumstances of marginalized rural communities that inhabit these areas.

SSLWM 2006 encourages debate on the current status of sloping land management in upper catchments in developing countries through the presentation of case studies, and will highlight existing strategies and incentives to promote and up-scale the adoption of sustainable management practices. The conference will identify management and governance strategies that could support more effective management action and direct future applied research.

The objectives of the workshop are to:

- Encourage sharing of recent research findings regarding sustainable management of upland farming system to enhance local livelihoods and environmental sustainability
- Better understand the range of policy support interventions to promote the adoption of sustainable practices in upper catchments
- Improve networking and learning between researchers, development practitioners and policy-makers in the region.

The outputs of the workshop include:

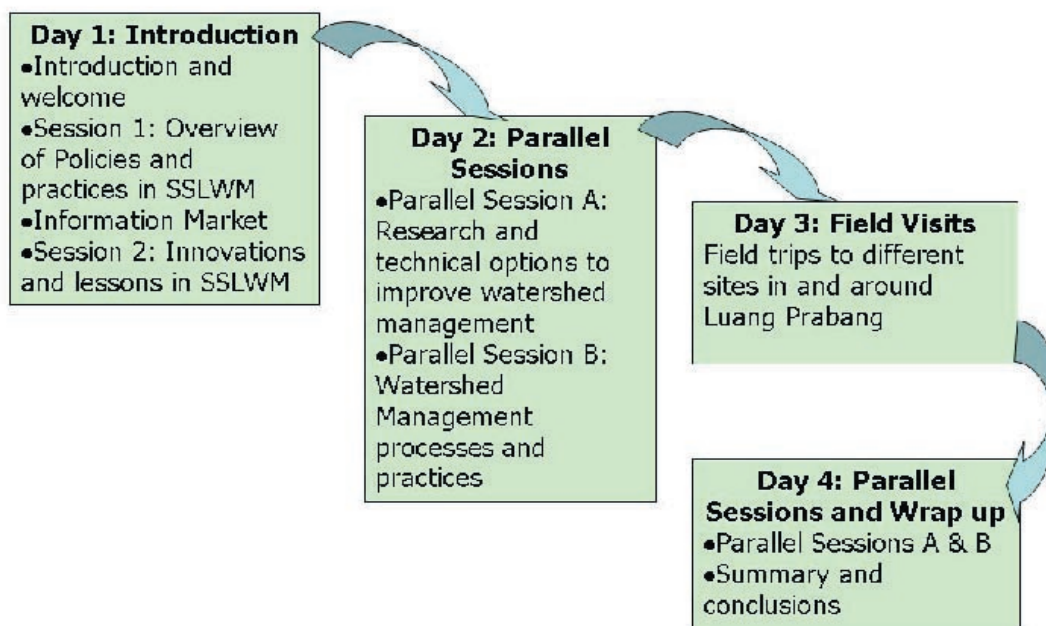
- Improved understanding on different planning and management strategies for sustainable management of upper catchments
- Improved networking between and among researchers, development practitioners and academics in the region
- High quality proceedings that will be disseminated widely
- Recommendations for different stakeholders (from policy-makers, regional bodies to research and development professionals)

Conference Process and Main Conference Elements

As shown in the diagram, the conference has been designed to maximize learning through presentations in plenary and parallel sessions, posters and through the field trips. While there will be no structured working groups at this conference, we hope to ensure an opportunity for everyone to contribute to the conference summary and recommendations which will be read out at the end of the conference.

Day 1 has been structured to provide everyone with an opportunity to understand the key issues in sustainable sloping land watershed management. In addition, the Information Market will primarily be held on Day 1 and offers a less formal setting in which to share results. Day 2 is focused on the parallel sessions which will run concurrently. On Day 3 participants will have an opportunity to visit a number of different field projects in and around Luang Prabang. On the final day, the morning will be spent in the same parallel sessions of Day 2 and in the afternoon time will be spent summarizing the key issues and lessons generated from the conference.

Conference Process



Paper Presentations

The main method for sharing lessons and experiences will be through paper presentations (on Days 1, 2 and the morning of Day 4). Presentations focus on key issues that have arisen, technologies being used or tested, and/or approaches and methods being used, rather than the activities of a project or program itself. Since the focus of the conference is to understand how research results can be applied or used by policy makers or practitioners, we are particularly interested to see how research results can be used, or can facilitate, better decision-making at various levels.

Due to the high number of abstracts submitted, presentations on Days 2 and 4 have been grouped into two overall parallel sessions. These sessions will be held at different locations in Luang Prabang and include:

- **Parallel Session A: Research and technical options to improve watershed management** to be held at the Provincial meeting hall
- **Parallel B: Watershed management policy, processes and practices** to be held at the Provincial Finance Meeting Room

Do I have to choose one parallel session and stay there all day? How can I move from one parallel session to another?

You are welcome to choose the presentations that you would like to listen to and move from one room to another. While the parallel session rooms are not too far apart, you will most likely require transport from one parallel session to the next. We have arranged for a number of vehicles to drive from one parallel session room to another and expect that they will be stopping by each parallel session every 20 minutes or so. Please wait right outside of the parallel session room and a vehicle should be around soon.

Information Market

On the morning of Day 1, the information market will be held. In general the purpose of the information market is to provide an alternative and less structured space for participants to share and exchange experiences.

There will be four stations at the information market:

1. Soil Erosion and land management focused research
2. Watershed management policy, planning and implementation processes
3. Social and technical options and results to improve upland livelihoods
4. NAFRI and NAFES information display and dissemination area

When will the information market be open?

The information market will be open throughout the conference but primarily on Day 1 in the morning and most of Day 2. Since students from Luang Prabang Agriculture College and Supanouvong College have expressed interest to explore the information market and we have set aside this time for them on Day 3 of the conference during the field visits. Thus, if you would not like to go on the field trips you can visit and further explore the information market.

Poster Presentations grouped by themes

Station 1: Soil Erosion and land management focused research

No.	Name of Presenter	Title
1.	Rudolf Van der Helm, IRD/IWMI, Laos	The use of erosion modelling to discuss watershed management options with stakeholders
2.	Alain Pierret, IRD/IWMI, Laos	Interactions between fine root growth, slope conditions and soil detachment under different land uses in a small mountain catchment of Northern Lao PDR
3.	Kasdi Subagyono, IAHRI, Indonesia	Integrated Grass Planting and Cattle Fattening for Sustainable Erosion Control in Babon Subcatchment, Central Java, Indonesia
4.	Mattiga Panomtaranichagul, Chiang Mai University, Thailand	Improvement of sustainable rainfed multiple cropping system on sloping land in Northern Thailand
5.	Didier Orange, IRD/ IWMI, Vietnam	Sustainable watershed management in cultivated sloping lands of SEA
6.	Koji Watabe, Hokaido University, Japan	Soil fertility in slash-and-burn systems in the hills of northern Laos
7.	Ulrich Schuler, the Uplands Program, Chiang Mai University, Thailand	Elicitation of local soil knowledge in northern Thailand and consequences for land use decision-making
8.	Kanjana Chuenpichai, Office of Land Development, Thailand	"Din Thai" Thai Soil Databased management and application for geographic soil and agricultural information systems
9.	Benedict Kayombo, Botswana	Socio-economic characterization of indigenous soil and water conservation
10.	Dr.V.M.Chowdary, Kyoto University, Japan	Spatial and Temporal changes in swiddening cultivation areas in part of Oudomxay province, Laos using remote sensing

Station 2: Watershed management policy, planning and implementation processes

No.	Name of Presenter	Title
1.	FAO	The new generation of watershed management programmes and projects
2.	Paulo Pasicolan, LSUAFRP, Laos	Formation of Broad-Based Partnership in Watershed Management: Philippines Experience
3.	Land Management and Forestry Research Components, LSUAFRP, Laos	Village Cluster Development Planning Approach to Watershed Management: Some Initial Thoughts from the Lao Swedish Upland Agriculture and Forestry Research Project
4.	Patrick Lucas, CUSO, STEA, Oudomxay, Laos	Water for Life: A project to empower upland ethnic communities in the upper Ko River watershed of Oudomxay Province
5.	MRC-GTZ Cooperation Program	Watershed management processes, experiences and information
6.	Florian Rock, GTZ, Laos	Land Policy Development in Lao PDR
7.	Saipim Channuan, ICRAF, Thailand	Farmers' Adaptation to Rural Development Policy Under Theun-Hinboun Hydropower Project: A Case Study of Sobngouang Village, Khamkeuth District, Bolikhamxay Province, Lao PDR
8.	Ronnakorn Triganon, RECOFTC	Overview of RECOFTC Information and Experiences
9.	Vilaphorn Visounnarath, Electricity Department of Lao PDR	External Push and Internal Pull of Sustainable Upland Rice Production And Its Interrelationship With The Ecology Of Theun-Hinboun Hydropower Project
10.	Samlan Phothien, GTZ/RDMA, Laos	Experiences on Participatory Land Use Planning from Luang Namtha, Laos

Station 3: Social and technical options and results to improve upland livelihoods

No.	Name of Presenter	Title
1.	Tran Duc Toan, NISF, Vietnam	From the watershed research to the agricultural strategies in a Commune of Northern Vietnam: local knowledge for Natural Resources Management
2	Degi Harja, ICRAF, Indonesia	SEI-FS - a tree growth simulation model to explore mixed tree designs and their production potential
3	Yuji Niino, FAO	Conservation Agriculture for Sustainable Land and Water Management
4.	GTZ/RDMA, Laos	Sustainable small household rubber extension
5.	GTZ/RDMA, Laos	Sedentary Upland Farming by Hedgerow and Value Added Fallow
7.	Kukiat Soitong, Department of Agriculture Extension, Thailand	Thailand Farmer to Farmer Extension Approach : The Study on the Competency of Smart Farmers as the Technology Transferring agents
8.	Laxman Joshi, ICRAF, Indonesia	Predicting economic benefits from farming practices using the Olympe Approach: A case from rubber agroforestry systems in West Kalimantan, Indonesia
9.	Holger Grages, GAA Laos	Sustainable Use of Sloping Lands: Experiences of the GAA Poverty Reduction Project in Mueang Mai, Phongsaly
10.	Christopher Le-page, Chulalongkorn University, Thailand	Ecole-ComMod project - participatory simulations with local stakeholders
11.		
12.		
13.	Shicai Shen, CBIK, China	Impacts of Sloping Farmland Conversion Policy on Biocultural Heritage in the Dulong River Watershed, Yunnan, China
14.	Ben Samson, Lao-IRRI	Sustainable Rice-Based Cropping Systems in the Uplands of Laos – Enhanced Fallows and the Restoration of Soil Fertility
15.	Damien Jourdain et al., IRRI, Vietnam	Sustainable management of rice landscapes in uplands of Vietnam: a framework and technological opportunities
16.	Bounthene Phasiboriboun, Faculty of Forestry, NUOL, Lao PDR	Agroforestry extension on Sloping Lands for improving land use and sustainable development, the case of Sangthong District

Station 4: NAFRI and NAFES information display and dissemination area

No.	Name of Presenter	Title
1.	Martin Grijmans, SNV	NFTP Handbook for Lao PDR
2.	CIAT in Asia	Posters and information from CIAT
3.	PRONAE/CIRAD	Information and Materials from the CIRAD program
4.	LSUAFRP	Information and Materials from the Lao-Swedish Upland Agriculture and Forestry Research Program
5.	IRD/IWMI	Information and materials from IRD/IWMI program
6.	NAFRI	Information and display of NAFRI materials and activities
7.	LEAP/NAFES	Lao Extension Approach Roles of NAFES
8.	Seng Hkum Nhkum, Nam Ngum River Basin Development Sector Project ADB	Experiences from the Nam Ngum River Basin Development Sector Project ADB
9.	Horticulture Research Center	Genebank for Local Vegetable in Lao PDR

Field trips

Day 3 has been set aside for visiting field projects near Luang Prabang. This will also allow participants an opportunity to interact in a less formal and more open environment. It will also allow participants an opportunity to discuss directly with farmers their own lessons and experiences. The objectives of the field visit are to:

- Enable participants to visit some interesting sites where they can see examples of different upland research & development initiatives;
- Provide an opportunity for participants to get to know each other and interact outside the conference hall

There are 5 field trips planned:

Field site	Project	Focus
Ban Lak Sip	MSEC-Lao, NAFRI-IRD-IWMI	Riparian zone management for water quality, and Land use, land degradation and soil erosion processes
Xieng ngun district	NAFRI-CIAT	Forage production for improve management of ruminants, reducing shifting agriculture through improved livestock systems, and linkages to markets for livestock and <i>Porsaa</i> (paper mulberry)
Phonsay district	NAFRI-LSUAFRP	Upland farming and forestry technologies and Agro-ecological analysis and zoning
Ban Long Lan	CHESH-PAFO Luang Prabang	Different approaches to forest and land use planning, community forestry management, indigenous knowledge
Ban Hat Houay, Pakseng District	FORCOM/JICA	Integrated livelihood development, capacity building and community organization

How do I sign up for the field trips?

You can sign up for the field trips during the information market in the afternoon on day 1. Each field trip is limited to 35-40 participants in order to maximize interaction and ensure optimum exposure to lessons in the field.

Conference Agenda

Monday, December 11, 2006

11:00 – 16:00	Preparation for Information Market and Posters (those wishing to display or present information at the market should prepare display at this time)
13:00 - 18:00	Pre-registration

Tuesday, December 12, 2006

Time	Presentation/Activity
7:45 – 8:30	Registration
8:30 – 9:00	Welcome Ceremony <ul style="list-style-type: none"> • Welcome Address by Provincial Government of Luang Prabang • Opening Address by Ministry of Agriculture and Forestry
9:00 – 9:10	Introduction to conference purpose, objectives and expected outcomes Dr. Bounthong Bouahom, Director General, NAFRI
9:10 – 10:30	Session 1: Overview of policies, practices and key issues in sustainable sloping lands and watershed management
9:10 - 9:50	1. Impact of innovative land management practices on annual runoff and soil losses from 27 catchments of South-East Asia Christian Valentin, IRD/IWMI
9:50 – 10:30	2. Where central policies meet local initiatives: Exploring sub-basin-level participatory watershed management in northern Thailand David Thomas, ICRAF
10:30 – 11:30	Opening of Information Market and Coffee Break
11:30 – 12:20	3. Shifting Cultivation in the Eastern Himalayas: Farmers Innovations as Lessons for Policy Elisabeth Kerkhoff, ICIMOD
12:20 – 13:30	Lunch
13:30 – 15:00	Session 2: Innovations and lessons in sustainable sloping lands and watershed management
13:30 – 14:00	4. Enhancing Water Quality through the Better Land Management of Degraded Highland Regions in Northern Lao PDR Oloth Sengtaheunghong, NAFRI/SSLCC
14:00 – 14:30	5. A Systemic Approach Based on Direct-seeding, Mulch-Based Cropping Systems to Promote Sustainable Agriculture Khamkeo Panyasiri, NAFRI, CIRAD, PRONAE
14:30 – 15:00	6. Improving information access for innovation of the Jhum farming system in the Chittagong Hill Tracts of Bangladesh Stephan Mantel, ISRIC Netherlands
15:00 – 15:30	Coffee Break

Time	Presentation/Activity
15:30 – 16:00	7. Environmental impact of a hydropower dam in Fincha'a watershed, Ethiopia: Land use changes, erosion problems, and soil and water conservation adoption Bezuayehu Tefera and Geert Sterk, Erosion and Soil & Water Conservation Group, Wageningen University
16:00 – 16:30	8. Payment for Watershed Services in China: Role of Government and Market, A Diagnostic Study Li Xiaoyun, Jin Leshan and Zuo Ting, College of Humanities and Development, China Agricultural University
16:30 – 17:30	Poster session and information market
18:30 -	Welcome Dinner at the Villa Ban Lao

Day 2: Wednesday, December 13, 2006

This day will be split into 2 parallel sessions

- 1) Research and technical options to improve watershed management** to be held at the Provincial Meeting hall
- 2) Watershed management policy, processes and practices** to be held at the Provincial Finance Meeting Hall

Presentations will be for 30 minutes (20 minutes presentation and 10 minutes discussion)

Time	Session/Activity	
	Parallel Session A: Research and technical options to improve watershed management	Parallel Session B: Watershed management: policy, processes and practices
8:30 – 10:00	Session 1: Research and monitoring of Land use change	Session 2: Watershed Management tools and processes
10:00 – 10:30	Coffee Break	
10:30 – 12:00	Session 3: Research and monitoring of Land use change (Continued)	Session 4: Payment for Environmental Services
12:00 – 13:30	Lunch	
13:30 – 15:00	Session 5: Using spatial analysis to better understand land use changes	Session 6: Experiences in Community based natural resource management
15:00 – 15:30	Coffee Break	
15:30 – 17:00	Session 7: Spatial analysis and land use changes (Continued)	Session 8: Incentives and institutional support to enhance upland livelihoods

Day 3: Thursday, December 14, 2006

Field trips will be offered to a number of locations dealing with social, technical and institutional issues related to sustainable sloping land and watershed management

Day 4: Friday December 15, 2006

Time	Session/Activity	
	Parallel Session A: Research and technical options to improve watershed management	Parallel Session B: Watershed management: policy, processes and practices
8:30 -- 10:00	Session 9: Technical options for improving upland farming systems	Session 10: Social and economic considerations for SSLWM
10:00 – 10:30	Coffee Break	
10:30 – 12:00	Session 11: Technical options for improving upland farming systems (Continued)	Session 12: Social and economic considerations for SSLWM (Continued)
12:00 – 13:30	Lunch	
13:30 – 14:45	Summary and discussion of key issues and considerations	
	<ul style="list-style-type: none"> • Reflection by different participants on key issues and lessons • Facilitated Discussion 	
14:45 - 15:15	Coffee break	
15:15 - 16:00	Closing Ceremony	
	<ul style="list-style-type: none"> • Summary and recommendations of the workshop • Closing ceremony 	

Parallel Session A: Research and technical options to improve watershed management		Parallel Session B: Watershed planning and management: processes, policies and practices	
Session 1: Research and monitoring of Land use change		Session 2: Watershed Management tools and processes	
8:30 - 9:00	1. Hillslope sediment trapping of natural or cultivated riparian vegetation of Northern Laos O. Vigiak, O. Ribolzi, N. van Breusegem, I. Duang Vong, C. Valentin, IRD/IWMI	8:30 - 9:00	1. Natural Resources and Governance – An Analytical Framework Christoph Feldkötter, MRC/GTZ
9:00 - 9:30	2. Impact of land-use change on earthworm diversity and activity: consequence for soil erosion Pascal Jouquet, Nicolas Bottinelli, Didier Orange, Pascal Podwojewski, Tran Duc Toan, IRD, NISF/Vietnam	9:30 - 10:00	2. Multiple stakeholders' perceptions of upper watershed management : Agrarian & institutional analyses in two Mien villages of Northern Thailand. Barnaud Cécile, Dumrongrojwattana Pongchai, Marie Jérôme and Guy Trébuil, Paris X University and Chulalongkorn University
9:30 - 10:00	3. Challenges for sustainable litchi production systems in northern Thailand: an ecological perspective Dirk Euler, Konrad Martin and Joachim Sauerborn, University of Hohenheim	10:00 - 10:30	3. Learning devices and mediation tools for collective management of natural resources: experiences from northern Vietnam uplands Jean-Christophe Castella, IRD
10:00 - 10:30	Coffee Break	10:00 - 10:30	Coffee Break
Session 3: Research and monitoring of Land use change (Continued)		Session 4: Payment for Environmental Services	
10:30 - 11:00	4. How erosion of upland fields contributes to the dispersal of weed seeds Anneke De Rouw, et al, IWMI, IRD, NAFRI	10:30 - 11:00	4. The Impact of Development Disparities on Natural Resources in the Lower Mekong Basin: Understanding Environmental Services in a Meso-scale Perspective Peter Messerli and A. Heinemann, Swiss National Centre of Competence (NCCR) North-South
11:00 - 11:30	5. Impact of upstream soil nutrient losses on soil fertility in paddy fields Nguyen Van Dung and Tran Duc Vien, CARES/Hanoi Agriculture University, Vietnam	11:00 - 11:30	5. Payment for Environmental Services: An Approach to Sustainable Watershed Management Xing Lu, Hetong Li, Regional Development Research Center, Yunnan University
11:30 - 12:00	6. National Land Management Authority (NLMA): Policy and research needs Ms. Soulianh Bouakham, Department of Land Development, Prime Minister's Office	11:30 - 12:00	6. Criteria and indicators for ecosystem service reward and compensation mechanisms: realistic, voluntary, conditional and pro-poor Meine van Noordwijk and Minh-Ha Fagerstrom, ICRAF

Session 5: Spatial analysis and land use change		Session 6: Experiences in Community based natural resource management	
1:30 - 2:00	7. Capability of satellite imagery for land use analysis Y. Yamamoto (JIRCAS), T. Oberthür (CIAT), R. Lefroy (CIAT), J. Kashiwagi (Hokkaido Univ) and S. Sukchan (MOAC, Thailand)	1:30 - 2:00	7. Economic Growth and Watershed Management: Drivers of Research and Development Innovations DC Catacutan, CE Duque, R Margate, and LJ Arbes, ICRAF Philippines
2:00 - 2:30	8. Agrarian land use transformation in Northern Laos S. Thongmanivong, K. Phanvilay and Y. Fujita, National University, Faculty of Forestry	2:00 - 2:30	8. Problems and prospects of the hilly watersheds in Bangladesh, Priorities for their conservation Dr. Khaled Misbahuzzaman, Institute of Forestry and Environmental Sciences, Chittagong University
2:30 - 3:00	9. Estimation of erosion and erodibility of soil in a slash-and-burn cultivation area of northern Laos J.KASHIWAGI, T. KOTERA, K. WATABE, Hokkaido University, Japan	2:30 - 3:00	9. People and Resource Dynamic Project (PARDYP) – participatory options for sustainable sloping land management promoted in 5 watersheds in the Himalayas Isabelle Providoli, Sanjeev Bhuchar, Roger White, Keshar Man Sthapit, ICIMOD
3:00 - 3:30	Coffee Break	3:00 - 3:30	
Session 7: Using spatial analysis to better understand land use changes		Session 8: Incentives and institutional support to enhance upland livelihoods	
3:30 - 4:00	10. Applying GIS-assisted modeling to predict soil erosion for a small agricultural watershed within sloping lands in Northern Vietnam Do Duy Phai (NISF, Vietnam), Didier Orange (IRD)	3:30 - 4:00	10. Improving management of natural resources in sloping land for sustainable agricultural production and poor's income in northern Vietnam Nguyen Van Thang, S. Wani, Tran Dinh Long and Nguyen Thi Chinh, Legume Research and Development Center, Vietnam Academy of Agricultural Sciences (VAAS)
4:00 - 4:30	11. How do farmers make decisions in a land degradation context? Floriane Clement, IRD, IWMI, NISF	4:00 - 4:30	11. Economic analysis of improved smallholder rubber agroforestry systems in West Kalimantan, Indonesia - implications for rubber development Dr. Laxman Joshi, ICRAF, Indonesia
4:30 - 5:00	12. Lessons and experiences from the Integrated Upland Agriculture Research Project in Luang Prabang, Laos Mr. Phouthone Sophathilath, NAFRI	4:30 - 5:00	12. Incentives in Enhancing Sustainable Land Management
			S. Chandrapatya, IWMI

Day 4, December 15, 2006

Parallel Session A: Research and technical options to improve watershed management		Parallel Session B: Watershed planning and management processes, policies and practices	
Session 9: Technical options for improving upland farming systems		Session 10: Social and economic considerations for sustainable sloping land and watershed management	
8:30 - 9:00	13. Root Crops for People and Pigs: Food security and income generation aimed at supporting transition from upland rice cropping in northern Laos Keith Fahrney, et al. CIAT	8:30 - 9:00	13. Palong and Black Lahu Local Ecological Knowledge about the Sustainability of Forest Watershed Management and Agroforestry Ecosystems Chalathon Choocharoen, Pornchai Preechapanaya and Andreas Neef, The Uplands Program, Chiang Mai University
9:00 - 9:30	14. Sustainable agricultural productivity through farm pond option in the integrated watershed management of Northeast Thailand Thawilkal Wangkahart, Bonyong Toomsan, ICRISAT, Faculty of Agriculture, Khon Kaen University	9:30 - 10:00	14. Women role in use and management of Rangeland resources in Semi arid-mountains of Pakistan A Case Study of Karak District Iffat Tabbassum, Department of Geography, University of Peshwar, Pakistan
9:30 - 10:00	15. Germplasm-Collection of Local Vegetable Varieties – Treasure for Income Generation and Food Diversification in the Northern Uplands of Lao PDR Mathias Plewa and K. Keovichit, NAFRI/HRC	10:00 - 10:30	15. Farming Systems Options for Poverty Alleviation in Northern Lao Sloping Lands: How Pro-Poor Are They? Blesilda Calub, University of Philippines Los Banos
	Coffee Break		Coffee Break
Session 11: Technical options for improving upland farming systems (Continued)		Session 12: Social and economic considerations for sustainable sloping land and watershed management (Continued)	
10:30 - 11:00	16. Local knowledge and land degradation: a participatory case study in the uplands of Laos Lestrelin, G., Pelletreau, A., Moizo, B., Valentin, C., IRD	10:30 - 11:00	16. Agro-Enterprise Strategies for Linking Upland Farmers to Markets John Connell and Ounkeo Phattammavong, CIAT
11:00 - 11:30	17. How can research and development help shifting cultivators to improve their farming system? Experiences of LI-BIRD in PTD K. P. Aryal and B. R. Regmi, Swedish Biodiversity Centre (CBM), ICIMOD, Nepal	11:00 - 11:30	17. Watershed Conflict: Competition over Natural Resources in Northern Thailand Nathan Badenoch and Apai Wanitpradit, M-POWER, SEA-USER
11:30 - 12:00	18. Farm forestry and buffer zone enhancement in montane southwest China: A Way to Enhance Rural Economies and the Environment Horst Weyerhaeuser, ICRAF	11:30 - 12:00	18. Land degradation in the sloping uplands: economic drivers and strategies for promoting sustainable land use Sushil Pandey, IRRI

Overview of Issues Concerning Upland Resource Management in the Lao PDR

The two articles presented here are taken from:

- ***Improving Livelihoods in the Uplands of the Lao PDR, a Sourcebook (Volumes 1 & 2)***. 2005.
NAFRI, NAFES, NUOL, Vientiane, Lao PDR

Evolving Operational Upland Policies



The National Growth and Poverty Eradication Strategy (NGPES) coordinates agriculture, integrated watershed management and forestry sectors to facilitate the transformation of upland livelihoods with the aim of reducing rural poverty and conserving natural resources. There are five major policy themes relevant to upland development.

It is claimed that for shifting cultivation to be sustainable, a cycle of 20 to 25 years is needed to give forests a chance to recover before being 'slash-and-burned' again. The government sees shifting cultivation as unsustainable and intends to stop it by:

- Making agriculture sedentary through diversification and agro-forestry.
- Opening market access through feeder roads and market information.
- Land allocation and land use entitlements (MAF 1999).
- Land-use zoning based on slope and land capability.
- Rural savings and credit.

1. Shifting cultivation

Estimates in 2000 indicated that 39% of the Lao PDR's population, covering 13% of the total land area, depended on shifting cultivation (JICA 2001). Concern about the negative impacts of shifting cultivation has been a consistent theme of government policy since the founding of Lao PDR. Although implementation of early decrees prohibiting shifting cultivation was limited, the 1989 National Forestry Conference proposed forest land allocation to villagers as a policy to rationalise forest use and introduce alternatives to shifting cultivation (MAF 2003b). Subsequent land-related policies have had 'stabilisation' of shifting cultivation as a central objective, and by 1998 the government acknowledged that rural development priorities had been aimed mainly at national rice self-sufficiency and restricting shifting cultivation (SPC 1998).

2. Opium eradication

Opium provided income to compensate villagers for poor rice productivity at high elevations. Because highland paddy sites are scarce, opium is viewed as a special case of the 'shifting cultivation problem'. In neighbouring Thailand, opium income earned by mountain villagers was low enough that crop substitution programmes (combined with enforcement once viable alternatives are in place) were successful. Experience has evolved into what is now called 'alternative development' for drug control.

Efforts to control opium production in Laos began in the 1990s with a central commission, provincial committees and a Comprehensive Drug Control Programme. The 1999 Opium Elimination Strategy aims to eliminate production by 2006. A review during 1999-2001 indicated that progress and constraints (except for special issues like drug addiction) are similar to those encountered by development projects in mountainous areas of Laos. Most effort focuses on sub-tropical and temperate tree crops, as well as on alternative income sources to replace that obtained from opium.

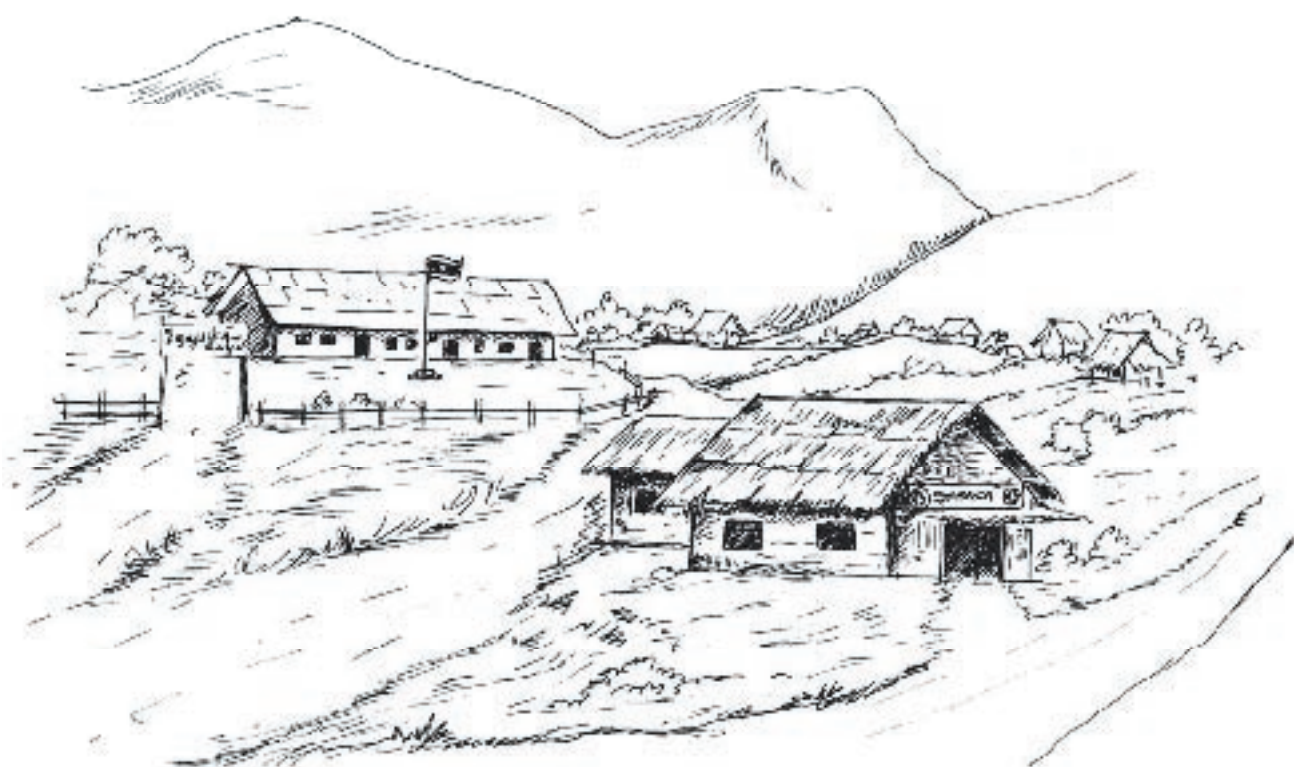


3. Land and forest allocation

Along with eliminating shifting cultivation and opium production, the government wants 'settled' upland communities practicing permanent agriculture on defined land parcels, with access to infrastructure and social services linking them to wider economic and social systems. To achieve this, tools developed during 1989-95 included land use planning and land and forest allocation.

Under MAF guidelines, the Land-Use Planning and Land Allocation (LUP/LA) process takes local communities through an eight-step Participatory Land-Use Planning exercise. A Central Committee for Land and Forest Allocation set and review annual targets, and from 1996 to 2002 land allocation was carried out in some 6,200 villages (>50% of the

national total) and more than 379,000 households (>60% of all agricultural households), covering more than eight million hectares. LUP/LA has been characterised as one of the few forest related programmes with clearly defined policy objectives, detailed instructions for field implementation and nationwide implementation (MAF 2003b).



4. Focal site strategy and village relocation and consolidation

The focal site strategy has been a central feature of rural development strategies in Laos for almost ten years. This area-based approach begins with selected locations where policies and activities are implemented. In principle, the approach is a pilot project to test systematic and coordinated implementation under a range of conditions and a demonstration area to show the process and its results, facilitating further implementation and adoption.

Progress of the focal site approach was assessed a number of times and lessons learned implemented. Village participation was not convincing and sites were biased toward poor and politically important areas, with few areas having high potential for development. Roles were unclear, monitoring and evaluation systems were absent, operational targets were not clear, and staff capacity at provincial levels was weak. However, the focal site approach is seen as warranting further effort because:

- It has the potential to encourage integrated planning and implementation that is difficult for line agencies.
- It has potential for bottom-up participatory planning and implementation essential for rural development.
- It is an effective way to use a limited budget and scarce local human resources.

Adjustments under the policy included rationales for both village consolidation and relocation. These centred on perceived needs for efficient extension services and community development structures to bring local people into development planning and implementation. In this way, 'unsettled families' living in 'scattered, remote communities' whose

'traditional methods of slash-and-burn cultivation are no longer sustainable' are to be attracted to sites with improved access to services. Pull-effects can already be seen as a number of villagers are voluntarily establishing new settlements along road corridors.

Development is concentrated in zones where activities in agriculture, social sectors, institutional capacity building and physical access to villages and markets are conducted in a synergistic manner to boost household income and eradicate poverty (CPC 2003). Since most poor districts are in upland areas, the focal site strategy is important for upland development.

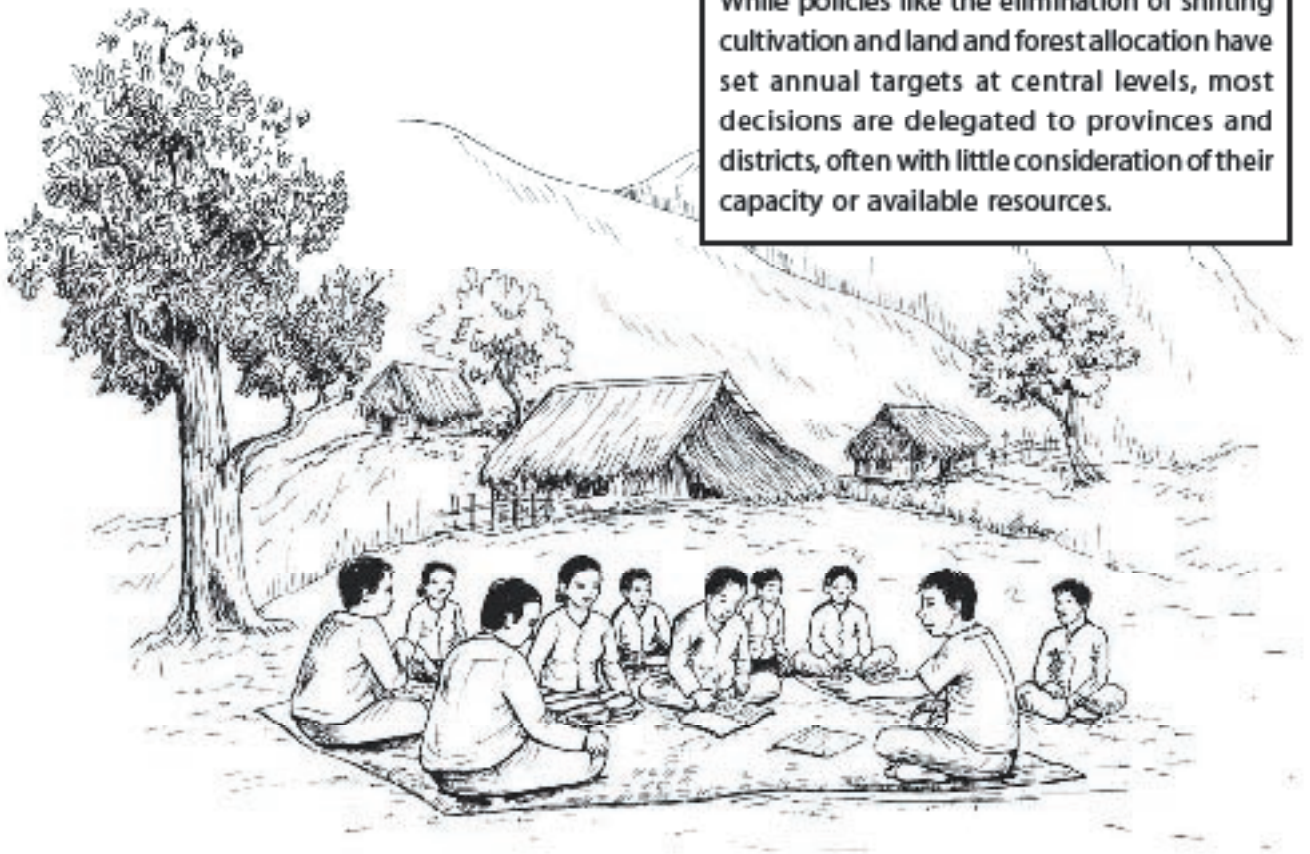
The NGPES seeks to expand core elements of the focal site approach to the poorest districts of the country. In recognition of the close links between rural poverty and agriculture, responsibility for planning and coordinating rural development was shifted back to MAF in 1999. The strategy uses the 'focal area approach' to target poor remote areas and areas with growth potential. The focal site development approach aims to:

- Stabilise shifting cultivation.
- Improve access to social services.
- Facilitate market-oriented economic activities.
- Allow integrated development by access to remote areas.
- Integrate all regions into a dynamic national economy.

5. Decentralisation

All the above policies place strong emphasis on decentralised approaches, reflecting natural resource governance trends across the region (Duper and Badenoch 2002). Decentralisation

While policies like the elimination of shifting cultivation and land and forest allocation have set annual targets at central levels, most decisions are delegated to provinces and districts, often with little consideration of their capacity or available resources.



In Laos is aligned with a 2000 directive that redefined central-local relations with provinces as strategic planning units, districts as planning and budgeting units, and villages as implementation units (CPC 2003). For example, after the government recognised problems with village resettlement and consolidation, the focal site programme saw its 'cornerstones' as consultation, coordination and strengthening provincial and district institutions, with village level focus on volunteers and committees (SPC 1998). Human resource development is key to local implementation of the strategy.

While policies like the elimination of shifting cultivation and land and forest allocation have set annual targets at central levels, most decisions are delegated to provinces and districts, often with little consideration of their capacity or available resources.

Given its agriculture, forestry and rural development mandates, MAF was reorganised to better meet decentralisation objectives. This 'demand-driven' approach sees villagers interacting directly with district staff, under guidance and support from provincial offices. Central support services are channelled through NAFRI and NAFES. Consolidated central research services were launched under NAFRI through reorganisation and elaboration of the existing research units within various departments of the old structure. However, since the consolidated extension agency needed to be created, its establishment could not be so rapidly accomplished. Development of staff capacity at provincial and district agriculture and forestry offices has been more problematic because of constraints on human and financial resources.

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Author:

David Thomas, D.Thomas@cgiar.org

This paper is adapted from "Review of Policies and Practices in the Uplands of the Lao PDR" in *Poverty Reduction and Shifting Cultivation Stabilisation in the Uplands of Lao PDR: Technologies, approaches and methods for improving upland livelihoods*. NAFRI 2005.

Improving Livelihoods in the Uplands of the Lao PDR was produced in 2005 by NAFRI, NAFES and NUOL.

Upland Poor in the Lao PDR: A Profile



People

Among the 4.2 million rural people of the Lao PDR (2000), representing 80% of the total population of 5.2 million, about 40% (approximately 2 million people) are estimated to live in poverty. Comprising some 300,000 households in more than 6,300 villages, they are largely upland farmers who depend on insecure livelihoods and live in remote and diverse environments. The majority of these rural poor belong to the country's many ethnic

minorities. The breakdown by ethno-linguistic grouping is 56% Mon-Khmer, 15% Hmong-Mien, 13% Tai-Thai, 9% Tibeto-Burmese and 7% Lao.

Livelihoods

Most live in upland forested areas and practice slash-and-burn shifting cultivation to produce upland rice and other crops. They also raise

livestock. Some lowland poor have moved from upland areas where they were better-off. To compensate for rice shortages, they generate income by selling NTFPs, wildlife, small livestock, vegetables and handcraft products, and by hiring out family labour to wealthier farmers in their own or different villages.



Local perspectives

The agro-ecosystems of the poor are low-input rice-based agricultural systems already stressed by external factors. Family labour is the main input. They see their major poverty indicators as being a lack of rice and livestock but do not consider their lack of integration into the market economy as a sign of poverty. Poverty in the Lao PDR does not necessarily mean hunger: there are various coping mechanisms in a

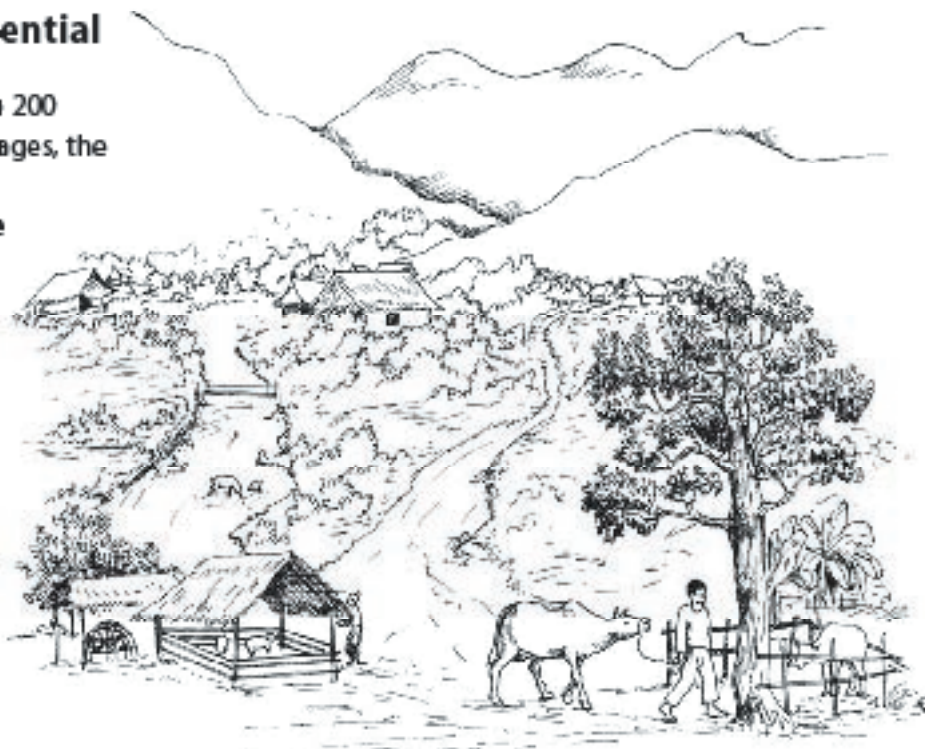
country with low population density and relatively abundant natural resources. Rather, a spiritual interpretation of poverty and other disruptive life events matter to the poor, who try to correct these disruptions through specific ethnic rituals.



Constraints and potential

Poor rural villages have 50 to 200 inhabitants. Within these villages, the poorest are never found on village committees and have less contact with the local administration than the better-off. A lack of assets, including labour, prevents them from contributing actively to development initiatives. However, they usually have a wealth of traditional knowledge about their environment. Poor rural women and children are often severely malnourished and the poorest rural women are normally overburdened by household and farming tasks. Because most rural poor do not have access to safe drinking water, they regularly suffer from diarrhoea, malaria and respiratory infections. Lack of access to appropriate medical services is common in most poor villages. Infant mortality is high, while education and literacy levels in the Lao language are low.

Improving Livelihoods in the Uplands of the Lao PDR was produced in 2005 by NAFRI, NAFES and NUOL.



Poverty dynamics

Rural poverty in Laos is a recent phenomenon and not endemic. Several poor people said they became poor because of land access restrictions or resettlement. Some suffered from pest infestations, natural disasters and war-related stress. Most upland villages practice shifting cultivation and have been forced to reduce fallow periods. With the relocation of several ethnic minority villages, substantial numbers of rural poor have been resettled in the lowlands or near main roads where they are encouraged to produce wetland rice along with permanent upland agriculture. Data from the National Statistical Centre in 2004 shows that poverty is decreasing in Laos.

Source: UNDP, 2001. National Human Development Report for Lao PDR, Vientiane.

Compiled by: Dirk Van Gansberghe, dirkvangansberghe@yahoo.com

ABSTRACTS

**Session 1 and 2: Overview of policies, practices, innovations,
lessons and key issues in sustainable sloping land and
watershed management**

Impact of Innovative Land Management Practices on Annual Runoff and Soil Losses from 27 Catchments in Southeast Asia

C. Valentin¹, E. Agus², R. Alamban³, A. Boosaner⁴, J.P. Bricquet⁵, V. Chaplot¹, T. de Guzman⁶, A. de Rouw⁷, J.L. Janeau¹, A. Maglinao⁶, D. Orange⁷, K. Phachomphonh⁸, Phai Do⁷, P. Podwojewski¹, O. Ribolzi⁸, N. Silvera⁹, K. Subagyo², J. Thiébaux⁸, T. Toan⁷ and T. Vadari²

1. IRD, Centre de Recherche de l'Ile de France, 32, av. H. Varagnat, 93143 Bondy cedex, France, valentin@bondy.ird.fr
2. Indonesian Agroclimate and Hydrology Research Institute, Jl. Tentara Pelajar No. 1A, Bogor 16111, Indonesia
3. Agricultural Engineering Programme, School of Mechanical Engineering, Fiji Institute of Technology, P.O. Box 3722, Samabula, Suva, Fiji
4. National Park, Wildlife and Plant Conservation Department, Ladyao, Jatujak, Bangkok 10900 Thailand
5. IRD, Maison des Sciences de l'Eau, CC 57, 34095 Montpellier Cedex 5 - France
6. PCARRD, Los Baños, Laguna 4030, Philippines
7. National Institute for Soils and Fertilizers, TuLiem, Hanoi, Vietnam
8. Soil Survey and Land Classification Center, NAFRI, Vientiane, Lao PDR
9. IRD, Po Box 102, Kasetsart University, Bangkok 10903, Thailand

In Southeast Asia, the declining productivity of lowlands is leading to continued expansion of cultivated land on slopes, often involving the clearance of native upland vegetation. Being an open access resource, upland soils have been subjected to misuse and unsustainable farming practices, resulting in degradation. Land degradation is often associated with poverty especially in the mountainous regions inhabited by people who are often politically disempowered and economically marginalized.

Public interest in these communities has emerged mainly from a realization that environmental degradation of uplands affects richer communities: run-off and soil loss resulting from the changes in land use and/or climatic conditions concerns not only the upland farmers but also the users of water resources downstream. Peculiar attention has thus to be paid to upper catchments. It is generally hypothesized that increased exploitation of land resources in small headwater catchment areas, with associated fragmentation of native forest vegetation, results in increased sediment discharge and elevated nutrient loads that reduce water quality and availability for downstream users. As the land resource base becomes less productive, food security is compromised and competition for dwindling resources increases. A downward eco-social spiral is created when uplands are eroded and their nutrients depleted by unsustainable land management practices that result in lost soil stability and permanent damage.

Southeast Asia is the most populated area of the world and has a very fast rate of economic growth. Invariably the entire region will be impacted by the insatiable consumptive footprint of the emerging economies of China and India. As the pace of economic and social change in this

region accelerates, the possibilities of discontinuous and accelerated change cannot be ignored. Such change may convert large tracts of rainforest into agricultural land - with potentially critical environmental implications such as natural disasters (e.g. floods) and crop failure (e.g. due to drought), especially in the context of climatic change. Bruijnzeel, (2004) reported that rainfall in the whole of Thailand shows a remarkable decreasing trend since the 1950s during the month of September, i.e. when the southwest monsoon current is weakening. In July and August, when the monsoon is still strong, no such decrease is noted. In East China, the aridity index tends also to increase as a result of changes in surface roughness, leaf area index and reflection coefficient. Thus, observational evidence concurs with model predictions in suggesting that large-scale land-cover change in East Asia is indeed capable of producing changes in the regional surface climate. Where annual rainfall is known to have decreased significantly over the last decades (Sahel, Western Australia), no concurrent decrease has been observed in the frequency of extreme events. Under these conditions, no decrease in the frequency of flooding is to be expected from a reduction of mean annual rainfall. IPCC (2001) has predicted increased runoff of 50%-150% in Southeast Asia. Public concern is growing, as illustrated in the growing frequency of newspaper articles on increased flood frequency and the impact of drought. Studies of erosion under climate change have not taken into account farmer choices on crop rotations or planting dates, which will adjust to compensate for climate change. Adaptation of the upper catchments in Southeast Asia to climate and land use changes is dependent on their current and predictable adaptive capacity. The assessment of their vulnerability to these changes and their adaptation should be a priority, especially in developing countries where investments are usually more focused on recovery from a disaster than on the creation of adaptive capacity.

The interactions between climatic and anthropic changes remain much less studied in this region than in areas of mean latitude, although their effects are likely to have impacts at the global level. Integrated and cross-scale knowledge is therefore essential to understanding current processes and predicting future trends. A key element in achieving these goals is the ability to operate at multi-scales within a catchment where the integration of attributes will enable integrated approaches. Also essential is the need to quantify the sensitivity and resilience of fragmented landscapes in upper catchments.

Much research into soil erosion on sloping land has harvested considerable results, but almost all research has been carried out on plots. Only a few studies have been conducted in Asia on catchment scales, mainly in the Himalayan region, and these remain limited in space and time. Only a few tropical watershed studies have lasted long enough to facilitate a credible analysis of the long-term effects of land use change on the environmental services provided by catchments.

In order to provide sound data on the extent of accelerated soil erosion resulting from rapid land use changes, it was decided by the end of the 1990s to launch a regional network, the Management of Soil Erosion Consortium. This association of five countries (Indonesia, Laos, Philippines, Thailand and Vietnam), an international (IWMI) and a French (IRD) institute, is implementing a long term research programme to monitor at the catchment scale changes in farming systems, runoff and sediment yields, and to test various improved practices to reduce

soil losses and enhance livelihoods. This paper summarizes the main results obtained by this consortium over the last six years and assesses the impacts of i) rapid land use changes and possible climatic changes on annual run-off ratio and sediment yield, including bed load and suspended sediments loads from 27 catchments and sub-catchments in the five countries; ii) various soil conservation practices tested in these catchments. These objectives meet the two technology transfer needs related to catchment processes recently identified for the tropics of Southeast Asia: i) 'how to incorporate the appropriate level of 'good science' with socio-economic issues and constraints; and ii) develop appropriate management perspectives.

27 catchments and sub-catchments have been selected and monitored since 2000. Their size varies between 0.6 ha and 285 ha, their mean slope steepness between 8% and 48%, and their annual rainfall between 1028 mm and 3840 mm. Contrasting socio-economic conditions favour the intensive use of industrial agricultural inputs in Thailand, and organic inputs in Indonesia, Laos, Vietnam and Philippines. Descriptive statistics for the runoff coefficient and sediments yields were computed from the 116 catchment-years available from the five countries.

The observed current shifts from upland rice to maize in Southeast Asia, as a response to shorter summer monsoons, show that future crop management changes due to climate and economics can affect the magnitude of erosional impacts beyond that which would be predicted from direct climate change alone. Current observations also suggest that the conversion of upland rice to maize is associated with similar changes in weeds, the native forest vegetation tending to be replaced by a savannah-type vegetation. The main drivers of land use changes differ greatly among countries, depending on population density, economic conditions, and so on.

Measured runoff coefficient ranged from 0.1% to 75%, suspended sediments loads from 0 to 26.4 tonnes ha⁻¹ yr⁻¹ and bed load from 0.01 to 51.6 Mg ha⁻¹ yr⁻¹. Conversion of upland rice or fruit tree crops to maize invariably induced dramatic increase in sediment yields. By contrast, conversion of cassava to fodder crops, improved fallows, or planting grass on bench terrace risers and in the lower areas of catchments reduced soil losses to nearly nought within one or two years. The proportion of forest or tree plantations did not appear as a key factor for soil conservation. The advantages of the mostly spontaneously adopted agro-forestry systems are best illustrated in Indonesia - these systems are not well accepted by farmers in other countries. Tree plantations on hill-slopes greatly limit soil erosion, but are thought by farmers in Vietnam to deplete water availability for downstream irrigated rice. Despite their effectiveness in combating erosion, natural vegetative strips introduced in the Philippines were not adopted by tenant farmers, due to cost of establishment.

The negative impact of land use change - and to a lesser extent, climatic change - can be corrected by including innovative conservation measures in the catchment management to control runoff and soil losses. If they are to be adopted by farmers, conservation strategies need to be tailored to the local demographic, economic and cultural conditions. This diversity needs to be more acknowledged by international agencies and donors, some of which are too specialized in a single strategy.

Where Central Policies Meet Local Objectives: Exploring Sub-Basin-Level Participatory Watershed Management in Northern Thailand

David Thomas, ICRAF Chiang Mai

Global efforts to improve the sustainability of natural resource management are finding that watersheds and river basins are appropriate units for integrated management of many types of natural resources. However, most current management and organizational practices center on hierarchies of social and administrative units, with boundaries that often do not correspond to watersheds or river basins. General trends toward increased decentralization are occurring in both natural resource and administrative hierarchies.

Most national natural resource policies tend to emphasize uniform sets of structures, roles and programs that are formulated at high levels and extend downward in a top-down manner. At the same time, day-to-day decisions by local households, groups and communities are based on the realities of very localized conditions. Many innovations in livelihoods and natural resource management emphasize these local realities and seek to build bottom-up initiatives through collaboration with local communities and local governments. The strength and potential of these approaches are recognized by many decentralization programs.

There are multiple levels of watershed and river basin ‘catchments’, just as there are multiple levels of government administration. Central governments tend to focus on higher levels of organization and the needs of broader populations, while local communities tend to focus on the most local levels. One of the greatest challenges lies in trying to build a common framework where both top-down and bottom-up directions of development can interact in constructive and mutually-reinforcing ways. The sub-basin level has considerable potential as a level of management organization that can help fill in this ‘missing middle’ and serve as a venue for interfacing and integration levels above and below.

In order to help further explore the potential of the sub-basin level in northern Thailand, the Office of Natural Resources and Environmental Policy and Planning has recently concluded a pilot project entitled the *Participatory Watershed Management for the Ping River Basin Project*. Efforts to build river basin organizations in the Ping River Basin have been active since 1999. While they have been making substantial efforts to move in more decentralized and participatory directions, they have been doing so from a basically top-down perspective.

This project has sought to explore and test more participatory approaches for sub-basin level management of natural resources and environment in three pilot sub-basins of the Ping River Basin, with particular focus on organizations and planning:

- The organizational component focused on organizational structures and roles at the sub-basin level. These efforts sought to build on reviews of experience with river basin management organizations in many parts of the world, as well as existing organizations within pilot sub-basins, and on their previous experience with river basin programs;
- The planning component focused on the logical structure and content of action plans formulated at sub-basin level. These efforts sought to coordinate with other existing plans at multiple levels, within the context of a fairly broad integrated river basin approach and providing opportunities for emergence of local ideas and approaches.

This was accomplished by a two-phase approach that emerged during project implementation:

- The first phase used a fairly conventional participatory approach facilitated by outside consultants. This centered on finding a single approach to coordinate with existing organizations and plans;
- The second phase built on results of the first phase, but provided opportunities for local sub-basin leaders and networks to organize broader groups of stakeholder representatives to review and modify initial draft organizational arrangements and action plans.

A number of interesting lessons have emerged from this experience:

- **Diversity.** There is very substantial diversity among sub-basins in the Ping River Basin. While technical assessments had already identified substantial variation in biophysical conditions, ethnic composition, infrastructure and economic activity, during this project diversity of additional types of social characteristic also emerged. One important example is the differences in approaches to social organization, and especially the relative importance of central government agencies, provincial administrations and local governments. These findings helped clarify why efforts to impose uniform approaches and arrangements in all sub-basins are inappropriate, and what kinds of differences are likely to emerge if more flexibility and local initiative are allowed;
- **Roles.** There is considerable agreement among sub-basins about the basic types of roles for sub-basin management organizations. Basic roles include: (1) problem analysis, negotiation and conflict management; (2) sub-basin level planning, coordination, monitoring and evaluation; (3) higher-level relations with other sub-basins and river basins (upstream-downstream) and larger society (biodiversity, economic development policy, etc.). There was also basic agreement that implementation of activities under management plans should be mainly through existing local organizations and local governments – implementation by sub-basin management organizations should be limited to new or additional types of activities not under the jurisdiction of others. Most of the differences among sub-basins were reflected in their approaches to organizing and implementing some of these roles.

While the project helped confirm the potential importance of the sub-basin level of river basin management organization, it also helped reveal major challenges that it will face:

- Clear high-level policy commitment will be necessary (1) to convince people in the sub-basin that the time and effort they invest will be important; (2) to motivate stakeholders to participate actively in the process; (3) to help local and provincial government see the importance of this work and not see it as a threat; (4) so that central government agencies will participate with sincerity and consistency;
- Fully participatory processes are needed that (1) are not dominated by a few stakeholder groups, and (2) balanced local interests and legitimate national level concerns;
- Cooperation is needed among agencies and stakeholders to provide information and to operate with transparency and accountability;
- There is need for all parties to recognize that this will be a long-term process with support and capacity building needs that will change over time. The aim is to create a learning process based on participatory monitoring of actual results and their effects on livelihoods and natural resource sustainability.

<i>Day 1, Session 1, Paper 3</i>

Shifting Cultivation in the Eastern Himalayas: Farmer Innovations as Lessons for Policy

Elisabeth Kerkhoff, International Centre for Integrated Mountain Development, Nepal

Despite intensive and lengthy government efforts throughout the eastern Himalayan region to stop shifting cultivation, the practice has remained entrenched over large areas. Recognising this, the International Centre for Integrated Mountain Development (ICIMOD), with support from the International Fund for Agricultural Development and joined by partners in five eastern Himalayan countries (Bangladesh, Bhutan, India, Myanmar and Nepal), designed a new initiative based on the idea that shifting cultivation must make some sense if hundreds of millions of farmers continue to practise it despite all incentives to stop.

The study was designed to take a fresh and unbiased look at the practice, and especially at innovations introduced by farmers in response to modern pressures and restraints. The hope was to find new methods that would help resolve the current situation in which outside development and policy interventions are not taking effect, while the practice of shifting cultivation is deteriorating as a result of the limitations imposed on it. The aim was to raise awareness about issues related to shifting cultivation, to establish a platform for exchange of ideas, and to develop detailed policy recommendations to support the work of governments. 20 case studies on farmer innovations in shifting cultivation were completed in the five countries,

and analysed for policy lessons. The findings were discussed at the 'Shifting Cultivation Regional Policy Dialogue Workshop for the eastern Himalayas' in 2004, and concrete policy recommendations were formulated. This work was published in a document addressed to policy makers, titled "Debating Shifting in the Eastern Himalayas: Farmer innovations as Lessons for Policy," and summarised below.

In the eastern Himalayas shifting cultivation is the most prominent farming system, providing a way of life for a large number of ethnic minorities and other poor and marginalised upland communities. Many see it as unproductive and damaging to the environment, but they fail to see that farmers have for centuries been able to sustain their livelihoods on those lands where farming conditions are most challenging and slopes are steepest. A common policy approach to shifting cultivation can be found across the countries in this study: Bangladesh, Bhutan, India, Nepal and Myanmar aim to replace it with permanent forms of land use. However, the current problems related to shifting cultivation are often found to be as much a result of counterproductive policies as of inappropriate land-use practices. Across the region there is therefore a need for new, more effective and socially more acceptable policy options that help to improve shifting cultivation, rather than replace it.

At stake in this debate are on the one hand some of the most diverse and unique biodiversity resources in the world. The Eastern Himalayas are one of the world's 34 biodiversity hotspots, the 'Indo-Burman hotspot', and accommodate important watershed functions. In north east India, as much as 65% of the land is covered by forest, extending to 80% or more in hilly areas. On the other hand there are the lives of millions of farmers, whose livelihood and cultural identity depends fully or partly on shifting cultivation on steep slopes. Most of them belong to the poorest and most marginalised in their respective countries and subsist on less than 1US\$ a day.

The research presented here identifies farmers' traditional practices and more recent indigenous innovations that contribute to the benefits this farming system has to offer. These benefits accrue both to the practitioners and to other stakeholders, including national governments. Shifting cultivation, and the farmers' innovations in particular, were found to contribute to forest cover and biodiversity conservation, while at the same time maintaining agricultural and forest productivity. Commercial niche products and organic farming contribute to economic development that is adjusted to mountain circumstances and builds on existing potential. The local institutions developed by shifting cultivation communities were found to be relatively strong, and they enhance social security and cultural integrity. Development approaches that build on this existing potential and capacity are likely to be more achievable and acceptable to the farmers concerned.

Realising this potential and the need for policy change across region, the 'Shifting Cultivation Regional Policy Dialogue Workshop for the Eastern Himalayas' was held in October 2004 in Shillong, India, to discuss the research findings and formulate concrete policy recommendations. These recommendations were endorsed through the Shillong Declaration, which was adopted

by all the participants, including representatives of government agencies, farmers, international bodies, non-governmental organisations, academia, science and research institutions, local institutions, international donors and development assistance agencies, the private sector, and other professionals.

The Declaration recommends that policy makers:

- Re-examine the policies in place, removing explicit policies and instruments that discourage shifting cultivation;
- Strengthen the implementation of existing beneficial policies.
- Address issues of land tenure security, research, and extension, and their impact on traditional shifting cultivation practices;
- Explore market development and commercialisation of shifting cultivation niche products;
- Strengthen the capacity of customary institutions;
- Adopt credit policies in situations where common property regimes apply;
- Build coordination among the different government agencies that have responsibilities for aspects of shifting cultivation.

Since the adoption of the Shillong Declaration, and advocacy for the recommendations, the issues related to shifting cultivation have gained renewed interest in policy debate as well as in research and development. The new perspective has been appreciated well beyond the initial countries of the study, including in Southeast Asia. It has been welcomed by policy makers who realise that many of their efforts to replace shifting cultivation have not had the expected results, while the challenges remain as pressing as ever. In certain areas shifting cultivation is no longer banned. The National Forest Commission in India has applied for four of the policy recommendations to be adopted by the Ministry of Environment and Forests. In Nepal, policy makers have become more aware of the specific issues that shifting cultivators deal with, and in Bhutan the ban on shifting cultivation is again in discussion.

For many development workers, researchers and government extension officers who have been working in the field trying to 'wean' farmers away from shifting cultivation, the new perspective makes sense, and the identified technical innovations are useful. Many government programmes that were appreciated elsewhere would previously not work in shifting cultivation areas because of the constant struggle. The more appreciative and participatory approach promoted in this publication has provided them with new options.

Enhancing Water Quality through Better Land Management of Degraded Highland Regions in Northern Laos

Oloth Sengtaheuanghoung¹, Christian Valentin², Olivier Ribolzi², Anneke de Rouw² and Jean-Pierre Thiébaux²

1 National Agricultural and Forestry Research Institute, Vientiane, Laos, oloth.s@nafri.org.la

2 NAFRI-IRD-IWMI, Vientiane, Laos

Rural water supply and human health are primary development focal areas for many countries in Southeast Asia. In many water supply systems based on open water bodies, increased turbidity during periods of high rainfall is commonplace and reduces the quality of water for human consumption. The cause of this increased turbidity is invariably rapid land conversion that induces a change in the path through which water moves within the landscape. In this respect the ratio of surface (turbid) / sub-surface flow (clean) increases, resulting in a significant increase in sediment loads. Limited attention has been given to the downstream impacts of elevated sediment and nutrient loads associated with waters emanating from these upper basins, and to their potential impact on water quality and the livelihoods of rural communities. The off-site impact of inappropriate land management in upland agricultural production systems can have negative effects on the life span of reservoirs and other structures through sedimentation, water quality deterioration, degradation of downstream aquatic ecosystems, and a decline in fisheries production. All these contribute to deterioration in the livelihoods of downstream communities. Sedimentation and eutrophication of aquatic ecosystems leads to declining fish catches, which in turn threatens the nutrition and health of downstream communities.

To provide data lacking at the catchment scale, outflow and sediment yield have been monitored at eight small (0.5 ha-64 ha) rural catchments since 2001 in northern Laos. Soil conservation strategies have been developed and tested on three of these catchments. Results clearly show that sediment yields can be reduced from 5-11 Mg ha⁻¹ yr⁻¹ under the current slash-and-burn system, to nearly nil when appropriate practices are selected. Such practices include improved fallow systems based on legumes. These innovative methods rehabilitate degraded land and enhance water quality, and are currently disseminated by several organizations in the region.

Improving Smallholder Livelihood, Watershed and Soil Management through Conservation Agriculture in Laos

P. Lienhard^{1,4}, H. Tran Quoc^{1,4}, C. Khamxaykhay^{2,4}, T. Sosomphou^{2,4}, F. Tivet^{1,4}, G. Lestrelín³, K. Panyasiri^{2,4} and L. Séguy⁵

1. CIRAD, PO Box 2991, Vientiane, Lao PDR. E-mail: florent.tivet@cirad.fr

2. NAFRI, PO Box 7170, Vientiane, Lao PDR. E-mail: contact@nafri.org.la

3. IRD, PO Box 06, Vientiane, Lao PDR. E-mail: lestrird@laopdr.com

4. PRONAE-PCADR, Lao PDR. E-mail: pronae.pcadr@nafri.org.la

5. CIRAD, Goiânia, Brazil. E-mail: lucien.seguy@cirad.fr

Main author: K_panyasiri@yahoo.com

Over the past fifteen years, farming systems have changed drastically in Laos, with swidden systems giving way to more modern agricultural technologies in many areas. In southern Xayabury traditional systems have collapsed, with a transition from subsistence agriculture to intensive cultivation of cash crops, led by the demands of the Thai market. Notable changes in agricultural practices have included the adoption of heavy mechanisation and use of pesticides. With the support of local traders, maize is now widely sown throughout the region and is spreading to more areas every year. With agricultural intensification, rotational cultivation systems and fallow periods are disappearing, being progressively replaced by a 'resource-mining' agriculture that has serious social and environmental costs, including increased soil erosion (leading to destruction of roads and paddy fields), loss of soil fertility, and chemical pollution of the environment. On high-altitude plains, in the upper part of the Nam Ngum river basin (Xieng Khouang province), large areas of savannah grasslands are under-utilized by smallholders with main farming systems based on lowland paddy fields, livestock production with extensive grazing on savannah grasslands, and off-farm activities. Regarding these situations, the Lao National Agro-Ecology Programme (PRONAE) is implementing an iterative research-development approach based on conservation agriculture. The aim is to find innovative systems that will reverse the present resource-mining practices used in southern Xayabury, and to develop alternatives systems for higher plains and remote areas like those in Xieng Khouang province. This holistic approach emphasises the process of adaptation and validation by farmer groups, meaning that priorities are defined by smallholders in light of the constraints of their farming systems and the overall environmental conditions.

Since 2002 in Xayabury and early 2003 in Xieng Khouang, the programme has developed and adapted diversified systems that, as much as possible, integrate annual cropping and livestock production. These innovative alternatives are based on no-till systems, with use of multipurpose species (*Brachiaria* sp., finger millet, pigeon pea, *Crotalaria* sp., and *S. guianensis*), through a participatory approach involving village communities and groups of farmers. The two main systems currently in use in both provinces are presented in this paper.

The first system described is the extension, in southern Xayabury, of no-tillage systems with residue management. Farmer groups from different villages were consulted to gauge the biophysical diversity and farming strategies of the region. In 2006, a survey was carried out in four villages to estimate the current level of dissemination of DMC systems at village level. The agro- and socio-economic results of this work are presented and discussed in this paper. Results show that the level of DMC dissemination differs greatly among the villages surveyed depending on their environmental and socio-economic conditions. Farmers adopt DMC systems primarily because of the socio-economic advantages they bring (e.g. low production costs), and also when intensive cropping systems have become unproductive and/or unprofitable owing to soil depletion. The introduction of mechanisation into DMC systems appears to be a key factor encouraging fast adoption and wide dissemination of these innovations. Lack of both credit systems and access to agricultural inputs present significant limitations to dissemination of the DMC systems. While positive results (increases in net income and labour productivity) have clearly been displayed, and growing interest in widespread adoption has been observed, realising all the biophysical and economic advantages of DMC is a long process. No-tillage systems have to be progressively improved through the use of rational crop rotations, relay crops and cover crops to reduce herbicide and input costs.

The second system under extension and described in this paper is generation of efficient and economically viable livestock production on high plains. This system is a first step towards the regeneration of savannah grassland for annual cropping. Cattle were fattened on improved pastureland (*Brachiaria ruziziensis*) and all agronomic and economic data recorded to analyze the viability of this system. In 2005, weight gain and seed production obtained during this experiment produced a gross income of \$879 over 1.5 ha, enough to covers the cost of all fencing, fertiliser, seed, and animal management in the first year. Barbed wire fencing and fertiliser formed the main expenses. In the medium term, the cost of fencing could be reduced by growing living fences (hedges) using species such as *Acacia mangium*, *A. auriculiformis*, *Calliandra calothyrsus*, and *Jatropha* sp. Development of specific market channels for seeds could indirectly improve pasture management, avoid high stocking rates and generate new income that could be invested in fertiliser and animal care. If converted into rice the income generated in 2006 by this cattle fattening represents 1.8 tonnes of rice, a very high yield on the high plains.

The PRONAE approach emphasises the progressive development of teamwork with all stakeholders: smallholders, agronomists, DAFEO staff, development projects, policy-makers and the private sector. One of the main challenge of this approach is to transfer systems and technologies to extension agencies and the private sector through a medium-term research and development programme. Independent management of research and development programmes still seems some way off at PAFO and DAFEO, since authorities and extension workers are still to understand the benefits and advantages of these activities.

Improving Information Access for Innovation of the *Jhum* Farming System in the Chittagong Hill Tracts of Bangladesh

Stephan Mantel¹, Mozaharul Alam², José Ramon Olarieta Alberdi³, Fida Malik A. Khan⁴

1 ISRIC – World Soil Information

2 Bangladesh Centre for Advances Studies

3 University of Lleida

4 Center for Environmental and Geographic Information Services

In almost all aspects the Chittagong Hill Tracts (CHT) are different to the rest of Bangladesh. Geographically the area is part of the Hindu-Kush-Himalaya region. The traditional rotational slash-and-burn farming system, known locally as *jhum*, is sustainable if practiced with long enough fallows, but due to increased population and scarcity of suitable land, fallow periods have shortened from 15-20 to 2-5 years. The *jhum* system is commonly blamed for land and forest degradation. Development in the CHT has lagged because of sustained conflict while local institutions lack the capacity to support sustainable development.

Proper planning and land management support are vital to post-conflict sustainable development. The exchange of information between generations within farmer communities and families has been an important mechanism in the development of sustainable land management systems adapted to the local environment. With the rapid increase in population pressure over past decades and the resulting scarcity of new suitable land, knowledge systems are only partially appropriate and new methods have to be tried. Conventional technical options for soil and water management often prove unsuitable in the complex environment of farm households that have to satisfy multiple goals and are often driven by short-term survival. Even proven soil and water conservation techniques are not widely adopted, most often because they are not known. Indigenous knowledge is still barely exploited in the development and dissemination of technology. Often there is little or no local involvement of women or policy makers, so initiatives often run into policy-related constraints.

This research is part of a project aimed at institutional capacity building and provision of an improved information basis for decision making in natural resources management.

The research and implementation has five main activities:

1) Environmental diagnostic survey of the CHT; 2) Inventory of stakeholder requirements for improved planning; 3) Inventory of land management practices and sustainable alternatives; 4) Development of data documentation and dissemination tools; 5) Pilot study on improved land use and management planning.

- 1) An environmental diagnostic survey was performed to quantify the status of the CHT environment. The pressures on the environment and the underlying causative factors and processes are assessed. Biomass change has been studied through analysis of remotely-sensed information, supported by field verification of hotspots of biomass change. Compiled spatial data covering the whole CHT region includes biophysical information such as climate, soils, landforms, lithology, rivers, settlements, and land cover.
- 2) A review was made of stakeholders' roles in natural resource management planning, and of the environmental regulations and controls and the planning process in land management. An inventory was made of decision making in land management, and of the need for information. Field surveys included: 450 household questionnaire surveys, 38 focus group discussions, six sub-district level (*upazilla*) meetings and three district level consultation meetings.
- 3) A field survey was made of natural resource management methods, their social and economic prerequisites, and the biophysical environments under which each method has been successful or unsuccessful. Forty randomly chosen farmers were surveyed in villages with traditional land uses (*jhum*, plain-land and fringe-land agriculture) across the three CHT districts. Innovative farmers trying new crops and methods were specifically targeted.
- 4) Information from various sources, including the spatial information from the environmental diagnostic survey and land management technologies and approaches, will be linked. An information system will be tested by stakeholders and adapted based on their feedback. The information system links scientific information to people in networks and documents local knowledge. In this way the experience of others in the same or similar environments and conditions can be used to support farmer innovation in coping with new conditions.
- 5) A methodology is tested in a pilot area for designing a natural resource management or land-use plan in a participatory way. The main sub-district of Bandarban, Bandarban Sadar, was selected for the pilot study after comprehensive discussion with various agencies and institutions. The sequence of actions is: a) data collection and survey, b) organization workshop at union level (clustered villages, the lowest administrative unit in Bangladesh); c) sub-district workshop, d) preparation of draft land-use plan of the pilot study area.

Farms that obtain most of their income from farm produce own and use less land than those that obtain a higher proportion of their income from outside the farm. The land-use types recorded have been grouped in four major types: ploughland, fringeland, *jhum*, horticulture (fruit garden), and wood plantation. Ploughland (land in valley bottoms, seasonally flooded) is used mostly for paddy, vegetables and sugarcane. Ploughland is managed with external inputs such as fertilizers and pesticides. *Jhum* is practiced on a mean cycle of one year cropping and four to five years of fallow. The longest fallow recorded is seven years, while in cases of ginger production there is no fallow period. Here, use of external inputs is less frequent than in ploughland. Horticulture does not appear to be a widely accepted land use alternative. Soil erosion is extreme in some of the monospecific plantations of teak and *gamari*, and the

literature shows rates of erosion even higher than in *jhum* plots. These monospecific plantations are therefore not a sustainable ‘alternative fallow’.

From research that includes the questionnaires and workshops, the following information needs have been identified for improved natural resource management by different stakeholder groups: Environmental information such as land types, soil quality, and (ground) water; Methods and knowledge of traditional cultivation systems; New management technologies and approaches for agriculture, forestry, and fisheries; Cadastral information such as land ownership, land use, and land size; Sources of financial support; Improved seeds/fertilizer/seed preservation/storing; Crop productivity by land categories.

Stakeholders have expressed a need for practical information at both local and policy level. It was recommended that local institutional capacity for natural resource management, including the compilation and maintenance of data, be improved. The Chittagong Hill Tracts lack regional cross-sectoral planning that stimulates sustainable development and proper resource utilization by local land-user groups. Strengthening of customary laws and integration with the formal decision-making process could improve land resource management planning. A natural resource management plan will be developed in a pilot area with relevant stakeholders. The participatory pilot study provides a basis for a regional learning network that will use the knowledge base and methodology, and support its continuing development. A regional implementation strategy will be written based on the pilot study experiences and results.

Day 1, Session 2, Paper 7

Environmental Impact of a Hydropower Dam in Fincha’a Watershed, Ethiopia: Land Use Changes, Erosion Problems, and Soil and Water Conservation Adoption

Bezuayehu Tefera¹ and Geert Sterk²

1 SWC Department, Oromiya Agriculture and Rural Lands Administration Bureau, Addis Ababa, Ethiopia.

2 Erosion and Soil & Water Conservation group, Wageningen University, P.O. Box 47,6700 AA, Wageningen, The Netherlands. geert.sterk@wur.nl

In Ethiopia, the construction of dams has caused social, environmental, and economic problems by increasing the relocation of communities against their will and inducing watershed land degradation. The failure to recognise people as partners in the planning and implementation processes is a major characteristic of watershed-based development projects. Soil erosion is a serious problem in the Ethiopian highland areas, threatening the agricultural sector and causing increased sedimentation of reservoirs and lakes. Unfortunately, there is very little reliable

information on the spatial dynamics of the land use types, the factors driving the changes, and the implications of these changes in watersheds where a reservoir has been created. Such information is, however, very important for planning watershed-based development projects such as soil and water conservation (SWC). Studies have shown that despite some achievements, SWC programmes in Ethiopia have not triggered the voluntary adoption of conservation practices outside the project areas.

Fincha'a watershed is a representative watershed for the western highlands of Ethiopia, with a mixed crop and livestock agricultural system. Fincha'a is a special watershed because of a hydropower dam and reservoir that was constructed in 1973. This reservoir has caused several effects on the local community, giving rise to a different situation than in other watersheds in western Ethiopia. The watershed covers 1,318 km², while the hydropower reservoir covers approximately one-third of the watershed area.

Elevation in the watershed ranges from 2,200 m to 3,100 m. Most of the area (80%) is an extensive rolling plateau, ranging in altitude between 2,200 m and 2,400 m. About 51% of the watershed is flat (0% to 3% slope) and mainly under the reservoir and swamp. The gently sloping (3% to 8% slope) to sloping (8% to 15% slope) areas cover about 34% of the watershed. Steep (15% to 30%) to very steep (> 30%) slopes account for about 15% of the watershed area. The dominant soils in the watershed have a texture of clay-loam, clay, or loam. The long-term average annual rainfall is 1,823 mm. About 80% of the annual rain falls between May to September. The monthly mean temperature varies from 14.9°C to 17.5°C. The average annual reference evapotranspiration (based on Penman–Monteith) is 1,320 mm, with small monthly variations.

Fincha'a watershed was selected for a four-year research project to study the impact of the hydropower reservoir on the environment and the people living in the watershed. Options for improvements were also explored. In the presentation, the following research objectives are addressed:

- 1) Analysis of the impact of the dam on land use and soil erosion in Fincha'a watershed;
- 2) Determination of the factors affecting the adoption of SWC.

Sets of aerial photos from 1957 and 1980, and an ASTER satellite image from 2001 were used to make three land-use maps of the watershed by means of GIS. Before the dam was built there was no water body in this watershed. Interpretations of the 1980 aerial photos, however, revealed a water body, of 151 km², which had increased to 239.3 km² by 2001. The lake has inundated a total of 100 km² of grazing land, 120 km² of swamp, 18 km² of cropland and 1.2 km² of forest. Cropland has been expanded to steep and fragile parts of the watershed and now occupies 77% of the land potentially available for community use, indicating that there is hardly any possibility for further expansion to accommodate new families. The expansion of the cropland area that has occurred in Fincha'a watershed is much greater than the changes found in the many studies conducted elsewhere in Ethiopia. The enormous expansion of cropland, especially on the steeper parts of the watershed has made the land more vulnerable to soil erosion. Erosion features are

visible throughout the watershed area, and also thick layers of sediment have been deposited along the boundary of the lake. Hence, the land-use changes that occurred in the watershed following the construction of the hydropower reservoir could affect the livelihoods of the community and will affect the ability of the dam to deliver the planned economic benefits.

To better understand the erosion and sedimentation dynamics in the watershed, the Morgan, Morgan and Finney (MMF) model was used to predict the spatial soil erosion and sedimentation rates and the subsequent on-site and off-site effects. Erosion data collected from crop fields was used to calibrate and validate the model. This resulted in a coefficient of efficiency of 0.86 for calibration, and 0.79 for validation. After being calibrated and validated, the model was run for two sub-watersheds (Hadocha and Qoricha) using land-use data from 1957, 1980, and 2001. It was found that soil erosion rates have increased to the extent that erosion could potentially undermine crop production in both sub-watersheds. Sediment delivery ratios have increased by 120% in Hadocha and 140% in Qoricha. The major drivers of the erosion and sedimentation problems are the land-use changes that have been induced by Fincha'a dam, coupled with population growth. On most steep parts of the sub-watersheds as well as in Fincha'a watershed, the soil has become shallow, which means that any further soil loss might lead to reduced soil productivity, threaten farmers' food security, and increase offsite reservoir sedimentation. The removal of vegetation cover on steep slopes will have reduced rainfall infiltration and probably also groundwater recharge. Some of the major consequences of soil degradation in Fincha'a watershed are crop failure (due to reduced moisture storage capacities of the soil), inundation from overflowing rivers and streams, and the drying up of most perennial springs. Despite these problems, SWC measures have not been applied to the entire watershed. Neither are any meaningful policies in place to prevent the unwise use of land resources in the watershed.

Knowledge of soil erosion processes, attitudes towards rational use of resources and institutional support affect the capability of farmers to implement SWC measures. A study was conducted to determine the factors that affect adoption of SWC measures in Fincha'a watershed. A total of 50 farmers were interviewed using a semi-structured questionnaire, and two group discussions were held with 20 farmers. Moreover, transects were walked to classify erosion features, and a quantitative erosion survey was made on 19 farm plots during the rainy season of 2004. The results showed that crop fields are affected by annual soil losses ranging from 24 to 160 t ha⁻¹. Farmers are well aware of these erosion problems, and related the soil loss to steep slopes and a decline in soil fertility. However, they do not invest much in SWC measures, but rather apply soil management practices to sustain crop yields. The major factors affecting SWC adoption are the wealth status of farmers, land tenure arrangements, and degree of access the farmers have to information. The high labour demand of SWC measures, and a lack of short-term benefits and free grazing has negatively affected SWC adoption. Relatively poor farmers show more interest in adoption of SWC measures because they generally lack the means to sustain soil fertility on their fields. They however are also reluctant to invest in SWC because of a lack of confidence in the positive effects of SWC on crop yields.

Soil erosion problems in Fincha'a watershed have both on-site and off-site effects that require integrated SWC adoption at watershed scale. For effective implementation of soil conservation and sediment control measures, it is necessary to have sound knowledge of the spatial variability in soil erosion and sediment production within the watershed. Such information, however, should be complemented by other socio-economic information derived from analysing the agricultural problems of the community at watershed-scale. During this analysis, emphasis needs to be given to land tenure, wealth status, gender, age, education, and institutional supports. To avoid further watershed degradation and reservoir siltation problems, a watershed-based SWC programme is required in which incentives are used to stimulate SWC adoption by farmers. Part of the money needed for the programme could come from the revenues of the hydropower scheme, as the power company will benefit from the programme as well.

An important lesson can be learned from the Fincha'a case study. The construction of new dams should proceed only after satisfactory recognition and compensation of the affected population and completion of environmental protection measures. In the process of forging a partnership between the government, civil society, and community in order to use water resources, the prerequisite should be to bring all stakeholders to a common platform. This multi-stakeholder platform can address the social, environmental, and economic problems of new dams, and seek solutions that are acceptable to all stakeholders. In order to reduce funding problems, the concept of payment for ecological services generated by specific land uses within watersheds should be introduced as a key element of watershed intervention.

Day 1, Session 2, Paper 8

Payment for Watershed Services in China: Role of Government and Market, a Diagnostic Study

Li Xiaoyun, Jin Leshan, and Zuo Ting

College of Humanities and Development, China Agricultural University, Beijing

jinls@cau.edu.cn

In the past 20 years, the Chinese economy has sustained an average annual growth rate of 9.5%. Two consequences of the fast growing Chinese economy are: 1) a decreasing supply of watershed services as more and more watersheds are claimed or polluted by economic development; 2) increasing demand for watershed services: public demand for watershed services grows fast alongside increasing income. To address this demand, the central government has launched several large scale payment for environmental services (PES) programs, such as the Sloping Land Conversion Program (SLCP). Local initiatives have also emerged. This research identifies PES schemes in China and explores the institutional context governing whether these schemes can work or not.

The paper address the following research questions:

- How do agricultural policies and environmental policies conflict with each other with regards to land use in watersheds, most of which are sloping uplands?
- What is the potential for economic instruments such as payment for watershed services (PWS) to address the problem of insufficient supply of watershed services?
- What is the nature of large national public payment schemes such as the SLCP and are they financially sustainable?
- What is the role of government in establishing the market infrastructure for PWS?
- What is the niche for PWS among a variety of policy instruments in watershed management?

The authors reviewed the impacts of three major policies on PWS in China: agricultural policy, forest policy, and WTO accession. Five case studies were made across four provinces of China (Jiangxi, Zhejiang, Hunan, and Yunnan), dealing with PWS in different scales of watershed, four of which are host to upland livelihoods.

The major findings and conclusions of the study are:

- There are two major drivers that move PWS or eco-compensation in China. One is the supply-side upstream government and communities. The other is the higher level of government. This contrasts with PWS schemes in the rest of the world, where demand-side is the main driver.
- Most eco-compensation programs in China have no livelihood impacts at the household level but might have welfare impact at the regional level. A few large public programs do have livelihood impacts.
- It is widely accepted in Chinese academia and the policy-making arena that government should dominate PWS schemes because of the public nature of watershed services. However, government dominance of PWS schemes in China results from two other major reasons besides this: firstly, the ambiguity of property rights for the land or forest which provides environmental services. Secondly, the Chinese government is powerful with plenty of resources (financial/institutional/political) that can lower transaction costs.
- The market has a role to play where the watershed is relatively small, the number of involved parties is limited, services are well defined, and the demand-side downstream party shows clear willingness to pay.
- Large public schemes face financial constrains and other limitations. Local PWS initiatives usually have a single objective, i.e. payment for watershed services, and are more robust in a volatile macro-economic and political environment.
- China's accession to the WTO and over 50 international environmental treaties has had positive impacts on the development of local market-led PWS initiatives. Ambiguity in property rights for land, forest, water and other natural resources is the biggest obstacle to market development in China.
- The market has little room to play its role if the ambiguity of property rights remains unchanged. The role of government in eco-compensation schemes should be changed from that of buyer to facilitator. Facilitation work includes i) defining property rights and making these workable and legally practical; ii) monitoring and measuring environmental services in a timely and transparent manner; and iii) dealing with litigation and enforcing the PWS contracts.

ABSTRACTS

DAY 2, SESSION A

**Research and technical options to improve watershed
management**

Hillslope Sediment Trapping of Natural or Cultivated Riparian Vegetation in Northern Laos

O. Vigiak¹, O. Ribolzi², C. Valentin² and O. Sengtaheuanghoung³

1 International Water Management Institute, Colombo, Sri Lanka

2 Institut de recherche pour le développement, Paris, France

3 National Agriculture and Forestry Research Institute, Vientiane, Lao PDR

Riparian areas are ecozones at the interface of terrestrial and aquatic ecosystems. Because of its proximity to water, riparian land provides a potentially interesting sediment sink that can prevent non-point source pollutants from reaching water bodies. The effectiveness of riparian vegetation in trapping sediment depends on many factors, such as (i) incoming flow rates and sediment particle size; (ii) vegetation cover and type; (iii) the hydrologic and topographic settings of the riparian area. Research on the effects of riparian vegetation in temperate climates showed that riparian areas can retain up to 70%-99% of pollutant loads. However, there is still a lack of information about tropical riparian areas. In the wet tropics, McKergow et al. in 2004 reported lower efficiencies in trapping incoming sediment (37%-46%) and even negative values when exfiltration was observed in the riparian area.

In the two last decades growing human pressure on agricultural land in northern Laos has been accelerating degradation processes along hillslopes and increasing the sediment load delivered to streams. Trapping sediments in riparian areas could be an effective way of reducing the downstream impacts of these increased sediment loads. However, little is known about the effectiveness of riparian vegetation types in northern Laos in trapping hillslope runoff and sediment flows. The issue is particularly important because in recent years high demand for fresh vegetables in urban centres is attracting farmers to cultivate riparian land, where irrigation is easier. These changes in the use of riparian land may bear important consequences for the quality of water in the streams.

The aim of this research was to (i) assess the efficiency of riparian vegetation in trapping hillslope sediments in northern Laos, and (ii) assess the potential effect of cultivation of riparian land on this efficiency. This study is the continuation of research on riparian land started in 2005 by Vigiak et al.

The study was conducted in Houay Pano catchment (Luang Prabang province). Average rainfall amounts to 1,259 mm per year, most of it during the monsoon season of mid-May to mid-October. The catchment is representative of Southeast Asian no-input slash-and-burn systems, with a fallow period that has diminished from between 10 and 15 years to the current two to five years.

During the 2006 monsoon season, fluxes of surface runoff and sediment were monitored across three riparian sites, using Gerlach troughs. The sites were arranged into pairs of adjacent riparian land plots with homogeneous upslope land use and topography. Each pair consisted of one plot covered with riparian vegetation (natural grass, banana or bamboo), and one plot cultivated with upland rice to represent the effects of the most common annual crop and to act as a control. Plots were equipped with three Gerlach troughs placed at the upper rim, and three troughs at the lower rim to measure event inflow and outflow runoff volumes and sediment loads. The efficiency of each riparian plot was measured as the portion of incoming runoff and sediment trapped in the riparian area (trapping efficiency, TE). TE was calculated per event on both runoff volumes and sediment load fluxes.

This paper presents and discusses statistical distributions of event runoff and sediment load trapping efficiencies for the period May-October 2006 and the correlation of trapping efficiencies with event rainfall characteristics, incoming fluxes and vegetation properties. Preliminary results show that occurrence of seepage may be important in riparian land, reducing the effectiveness of vegetation in trapping hillslope sediments.

Our study agrees with the observation of McKergow et al. (2004) that in wet tropics the potential retention of sediments in riparian areas may be limited by the presence of seepage and exfiltration of return flow. Natural vegetation and banana stands were most effective in retaining in situ water and sediments. Comparison with adjacent plots shows that sediment concentrations exiting upland rice plots are around five times larger than those from riparian vegetation plots. Only the trapping efficiencies of bamboo and upland rice were comparable. While cultivation of banana stands does not affect pollutant delivery to streams, the conversion of riparian vegetation into annual crops would transform riparian land from a sink to a source of sediment, and would thus have major impacts on sediment yield and water quality.

Impact of Land-Use Change on Earthworm Diversity and Activity: the Consequences for Soil Erosion and Fertility

Pascal Jouquet¹, Nicolas Bottinelli¹, Didier Orange^{1,2}, Pascal Podwojewski^{1,2}, Tran Duc Toan³

1 IRD, France

2 IWMI, France

3 NISF, Vietnam

Earthworms are considered useful indicators for monitoring different farming practices, landscape structures and transformations because they respond quickly to land-use change. Earthworm biodiversity is modified when natural (i.e. undisturbed) ecosystems are replaced by agro-ecosystems. There are many articles dealing with the effects of soil macrofauna (termites and earthworms) on soil properties and the functioning of ecosystems. These soil animals are usually considered to have a positive influence on soil organic matter decomposition and nutrient cycling. They increase the concentration of nutrients in their biogenic structures (casts, sheetings, nests, galleries etc.) and promote the growth and diversity of plants. They are also considered good indicators of soil quality in terms of structural stability. However, there is a paucity of data concerning their impact on tropical ecosystems with steep slopes. This study is part of the Management of Soil Erosion Consortium project, which examines the effects of land-use changes on soil erosion on a southern Asian regional scale. The aim of this study is to analyse the effects of land use change on (1) earthworms, in term of diversity and abundance, and (2) dynamic of soil aggregates and nutrients, in an experimental watershed in mountainous area of northern Vietnam (Hoa Binh province).

This study points out that earthworms respond strongly to de-intensification. *Pheretima leucocirca*, a specialist eucalyptus and forest cover species, is epi-anecic as determined through field observations and analysis of litter and casts. The presence of this earthworm species is probably determined by litter incomes and/or specific microclimatic conditions (e.g., surface temperature, soil humidity) that occur under forest cover. Conversely, the *Metaphire californica* and *Dichogaster modigliani* species prefer living under bracharia forage, old fallow and cassava covers, but not under eucalyptus or forest. These species are endogeic and can therefore be regarded as bioindicators of crops with less plant cover and litter availability. Obviously land-use change can drastically affect soil macrofauna communities. This study points to the importance of litter content in controlling soil macroinvertebrate populations, and to the reliability of considering earthworms bioindicators of land-use changes.

Endogeic species (mainly *californica*) have little effect on soil surface. Forest and eucalyptus plantations are characterized by anecic species (mainly *Pheretima leucocirca*) that produce large, globular and very water-stable casts on the soil surface. The activity of *Ph. leucocirca* leads to a typical granular soil structure with more surface roughness, and infiltration than in annual

plantations. As a consequence, earthworm activity leads to an increase of water infiltration, a decrease of water runoff and soil erosion.

Although soil cover plays an undisputed role in soil conservation, our data clearly shows that other biological parameters, and especially earthworm populations, must not be neglected in studies of the determinants of soil erosion. Studies are actually in progress to determine if these modifications of soil macrofauna diversity and abundance could affect soil properties such as nutrient retention against runoff, and soil structural stability against erosion.

Day 2, Session A, Paper 3

Challenges for Sustainable Litchi Production Systems in Northern Thailand: an Ecological Perspective

Dirk Euler¹, Konrad Martin¹, Joachim Sauerborn¹ and Vichian Hengsawad²

1 Institute for Plant Production and Agro-Ecology in the Tropics and Subtropics, University of Hohenheim, Stuttgart-Hohenheim, Germany; deuler@uni-hohenheim.de

2 Postharvest Technology Institute, Chiang Mai University, Thailand

Sustainable agriculture in the upland watersheds of northern Thailand is being challenged by increasing land pressure associated with loss of biodiversity, soil erosion and degradation, weed pressure and pest problems. Establishment and extension of litchi (*Litchi chinensis* Sonn., Sapindaceae) monocultures in the upland watersheds resulted in a landscape matrix with low complexity and high fragmentation of natural ecosystems. Litchi cultivation is characterized by high pesticide inputs, resulting in contaminated water resources and agro-ecological communities of low diversity with limited attractiveness for beneficial organisms. Although weed pressure and pest damage are identified as major negative indicators for the agronomic sustainability of hillside farming systems, biological implications are often underestimated in the development of sustainable land use strategies. Fruit tree production in northern Thailand's upland watersheds can provide long-term benefits for production and conservation, provided that alternative measures for pest management and ecosystem self-preservation are integrated into the production system. This requires knowledge of the dynamic and complex interactions between pests, beneficials and vegetation, on the field and landscape scales. This paper presents the major results derived from a system-inherent and multiple scale approach in a litchi production area of northern Thailand.

On a general level, the ground cover vegetation occupies a key position in relation to various ecological functions and services. Therefore the ground cover vegetation of 49 litchi orchards and ten other land use types were analyzed in the vicinity of two Hmong villages with different land-use and management traditions. Species quantities were measured through

cover-abundance scales of the Braun-Blanquet method in three stochastically distributed and homogeneous surveys per location. On the field scale, the studies were concentrated on the improvement of habitat conditions for beneficial insects with a specific focus on the role of additional resources provided by the ground cover vegetation. Four different combinations of two pesticide (with vs. without) and mowing (monthly vs. once per year) treatments of the attendant ground cover vegetation were established in four subplots of a litchi orchard. The effects of these four different combinations on the attendant ground cover vegetation, and its influence on the occurrence of parasitic wasps (Hymenoptera: Parasitica plus Chrysidoidea), were evaluated. Plant species coverage (%) and flowering was recorded using ten randomly placed vegetation quadrates (1m²). Abundances of parasitic wasps were obtained by four randomly positioned malaise traps (MT) in each combination plot.

On a landscape scale the team examined the influence of the functional landscape coherence on the constitution of two pest insect populations and the parasitic wasp populations in the litchi orchard. Since adjacent landscape elements are potential colonization sources and places for refuge, the spatial movement patterns of two major pests – the Asian Ambrosia beetle (*Euwallacea fornicatus*, Scolytidae) and the Litchi stink bug (*Tessaratoma papillosa*, Heteroptera) - and the parasitic wasps were recorded between a litchi orchard and an adjacent woodland. Insect trapping was conducted using six MT and six window traps (WT), which were randomly placed along the forest border. The adjusted construction of the MT and WT allowed a distinct capture of organisms with regard to their in-coming direction. The results from two-way indicator species analysis (TWINSPAN) of the ground cover vegetation of the study plots (275 plant species in total) and evaluation of plant species constancy indicate that intensity of land use and corresponding vegetational succession were the most relevant factors in the formation of ground cover vegetation in litchi orchards. Species composition at the study sites was affected by management measures (such as frequency of herbicide applications) and structure of the surrounding vegetation. In general, functional relations on landscape and field scale can not be regarded as segregated units and both need to be considered in sustainable land use planning. Interlinked by seed dispersal, plant species composition of ground cover vegetation is influenced by (i) the successional stage of vegetation in surrounding landscape elements, which are affected by the land use intensity and (ii) the successional stage of vegetation in the orchards, which is influenced by the mode and duration of management measures.

This trend appears to be validated on a more detailed level. Vegetational changes due to mowing or herbicide application depended on the reactions of individual plant species and were not significantly related to plant diversity. The total numbers of parasitic wasps at monthly and annually mown sites, with or without insecticide application, were also not significantly different. Differences in wasp abundances also depended on the responses of specific wasp families. The results based on the specific management conditions in each subplot indicated that large scale and simultaneously applied homogeneous treatments, such as regular mowing of ground cover vegetation in orchards, are apparently insufficient to sustain distinct successional stages of vegetation with high diversity on higher spatial and temporal scales, and therefore suitable habitat complexes required by beneficial insects. The results indicate that only spatial

and temporal stochastic treatments might generate the desired patch-dynamics of vegetation to provide a suitable environment to increase biodiversity. Rotating mowing treatments, combined with free range pig grazing or mechanical clearance of areas occupied by problematic species could generate and sustain appreciated patch dynamics.

Similar to plant species composition, surrounding landscape elements play also an important role for insect populations. The recorded movement patterns on landscape scale of the wasps indicated a permanent exchange of individuals between forest and orchard, suggesting that woody habitats are a crucial (re)colonization source for such beneficials. Correspondingly, the movement patterns of selected pest species showed also that woody habitats can act as colonization sources or refuge for certain pest insects. As a consequence of exchanging individuals, conventional pest control methods will be ineffective, if the population in the orchard can be easily replaced by immigrants of adjacent habitats. Litchi orchards are not isolated compartments, but open systems within in a particular landscape matrix of different quality, size and fragmentation of woodlands and other landscape elements. These structures affect the interactions of plants, pest and beneficial insects and the biodiversity of litchi orchards. Therefore, sustainable land use and alternative pest control can only be attained, if the relationships between field management, attendant vegetation, inhabiting pest and beneficial insects as well as landscape structure and fragmentation are considered.

In summary, the challenge for new sustainable approaches is to implement dynamic management systems at the plot or farm scale and to establish sustainable cultivated landscapes. There is a need to develop comprehensive multi-scale and multi-species based strategies for maximizing pest control, while maintaining suitable on-field habitats for beneficials and woodlands as natural elements for biodiversity conservation. A long-term goal in the study of cultivated landscape biodiversity is to predict the effects of dynamic landscape transformation on the diversity of insect species originating from natural habitats, as well as on species within agricultural systems. Further studies are required on the synergetic effects of dynamic landscape transformation on the diversity of arthropod species originating from natural habitats, as well as species in agricultural systems. This may include the use of multi-scale and -species simulation models, which determine dispersal and inhabitation as well as metapopulation dynamics in interdependency to the landscape context. Results from such models would allow the development of comprehensive strategies for maximizing pest control, while maintaining suitable on-field habitats for beneficials and natural elements for biodiversity conservation. In conclusion, the results suggest a rethinking of (i) pest management strategies; (ii) traditional land use planning, which is presently solely determined by the physical and socio-economic environment; and (iii) sustainability concepts.

How Erosion of Upland Fields Contributes to the Dispersal of Weed Seeds

A. de Rouw¹, M. Douillet², H. Tjiantahosong², O. Ribolzi³ and J.-P. Thiébot³

1 Agronomist, IRD

2 Student in Agronomy

3 Hydrologist, IRD

This study was conducted in Houay Pano, an upland valley with steep slopes about 10 km from Luang Prabang. Almost the entire valley is cultivated by the Kmhmu farmers of the nearby village, Lak Sip, using slash-and-burn techniques. Weed infestation and low yields are problems resulting from very short fallow periods, making excessive weed growth the major constraint in upland production, particularly where only hand tools are used. Not only are labour inputs enormous, but frequent hoeing on the very steep slopes promotes soil loss through erosion. The study is part of the regional Managing Soil Erosion Consortium programme. Soil and water studies have been underway alongside vegetation and agronomic studies at the Houay Pano study site since 2001.

The land degradation associated with short-cycle slash-and-burn practices is tightly related to weed infestation. Weed vegetation typically produces huge quantities of seeds that are to be transported away from the parent plant by an external agent such as wind, water or animals. It is a relevant question whether the erosion (runoff water and sediments) caused by rainstorms contributes to the dispersal of weed seeds, and to what extent.

Slash-and-burn cultivation typically produces a mosaic of fields and fallow plots on the hill slopes. Where fallow periods have been reduced to one to four years, like in Houay Pano, not only are upland fields infested by weeds, but also the fallow plots carry a weedy vegetation because the same species persists in field and fallow. All weed species become adapted to the slash-and-burn system, meaning that they produce seeds at the end of the rainy season or the beginning of the dry season. Most of these seeds are simply shed on the ground surface. Thus at the end of the dry season, the agro-ecosystem carries a maximum 'charge' of ripe seeds awaiting dispersal. In such an environment, the first big rainstorm of the season will carry away these seeds.

The study was conducted in a watershed where all the sample catchments are headwater catchments and where the existing infrastructure allows sampling from well-determined sub-catchments. Houay Pano is equipped with eight hydrological stations, each consisting of a cement tank acting as a sediment trap and a water sampler. The automatic water level recorder at each hydrological station notes the peaks in water flow produced by runoff during rainfall events, and triggers the suspended load samplers that take samples every five minutes. By

checking the automatic level recorder at each rainfall event, the first erosive rainstorm of the 2005 rainy season was identified on the 7th of July. Subsequently, sediments and suspended load generated by this event were scrutinized for viable seed using the simple seedling-emergence method (nursery established in Lak Sip village). In addition, each hydrological station drains a topographically well-defined area whose land use, past and present, as well as its floristic composition is known in detail. This information was used in the analysis to establish a link between the number and kind of transported seeds with their site of departure.

Another advantage of Houay Pano is that it hosts testing of three promising innovative techniques in separate mini catchments: i) improved fallow with pigeon pea and *Crotalaria*; ii) mulch planting without tillage; iii) conventional slash-and-burn practice. Because these mini catchments were equipped with an individual sediment trap and water samples, the effect of land use on weed seed transport could be assessed.

The rainstorm of the 7th of July 2005 produced a total water discharge in the stream of approximately 817,000 litres, spread over a period of six hours. In total about 4,000 kg of suspended material left the 62-ha catchment, and an average concentration of 2.63 sediment content per litre was measured. Suspended in the water were about 970,000 viable weed seeds, transported by run off water. Most of the seeds were troublesome composite weeds and grasses. The same rainfall event also yielded a sediment load of 1,100 kg of soil that was trapped in the tanks (drained from 8.4 ha). This bed load carried 43,500 viable seeds. The study of the mini catchments revealed that fields that were slashed, burnt and recently planted with rice following local practice, had a total seed flow of 61,000 viable seeds per hectare. Land covered by well-developed fallow vegetation on the other hand had a seed flow of 1,000 viable seeds per hectare.

The study shows that there is transport of a large amount of weed seeds, and that weed seed pollution of the cultivated lands downstream is likely. It explains that land cultivated in catchment basins after many years of fallow could be reinfected soon after the first run-off-inducing rain if fields or weedy fallow plots are located uphill.

Impact of Upstream Soil Nutrient Losses on Soil Fertility in Paddy Fields

Nguyen Van Dung, Tran Duc Vien, Nguyen Thanh Lam and others

Centre for Agricultural Research and Ecological Studies (CARES), Hanoi Agricultural University

nvdung2006@vnn.vn; cares@hn.vnn.vn

In the uplands of northern Vietnam, swidden agriculture has come to constitute the most serious threat to the natural environment as the human population has increased well beyond the carrying capacity of traditional farming systems. In some parts of this region, however, ethnic minority farmers employ a system of 'composite swiddening,' a unique type of agro-ecosystem that integrates permanent wet rice fields in valley bottoms with rotating swidden plots on hill slopes to form a single household resource system. This appears to be a sustainable form of shifting cultivation and could offer a model for use elsewhere in the northern mountains region.

This study was designed to measure both water discharge and nutrient flows from upland to lowland, and to calculate nutrient balances in the subsystems over the full rotational cycle of cultivation. It also assessed the contribution of inter-subsystem nutrient flows towards maintaining a nutrient balance in the entire system. In order to collect nutrient flow data in a controlled fashion, the 3.54-ha experimental site is located in a small watershed in Tat Hamlet. An experimental field was established in 1999 with three patterns of land use: a) forest (bamboo and trees) on the top of the slope; b) swidden crops (upland rice, cassava, and fallow) on the middle slope; and c) paddy rice in the lowland valley at the base of the hill. The total amount of water flow from the upland to the paddy field was estimated as the sum of the total amount of water losses from the paddy field through evapotranspiration, percolation (P) and discharge by water balance. A weir system was set up at three positions on the paddy bunds to measure the discharge of surface runoff out of the paddy field.

The results clearly showed nutrient flows from the upland to the paddy fields were directly proportional to the amount of rainfall and prevailing soil surface/cropping conditions. Nutrients flows from the upland to the paddy fields increased from 97 kg to 227 kg total N between 2000 and 2001 and decreased sharply thereafter, to 78 kg N in 2002 and 51 kg in 2004. P and K outflows from the watershed showed similar trends.

Part of the sediment discharged from the watershed settled in the paddy fields. Approximately 27%-63% of the sediment discharged remained in the upper three paddies under measurement. The amount of sediment retained in the paddy fields increased from 5.23 tonnes to 15.41 tonnes between 2000 and 2001, then decreased to 6.66 tonnes in 2002, and was as low as 2.29 tonnes in 2004. On average, the inflows of available nutrients to the upper three paddy fields were equivalent to available nutrient additions of as much as 453, 58 and 1455 kg/ha for N,

P and K respectively. Even when considering the whole paddy area, potential inputs could on average account for up to 151; 19 and 485 kg of N, P and K respectively. Potential total nutrient contributions were even larger. However, in reality farmers do not divert all the discharge into paddy fields, but drain paddies during the summer rice harvest.

The net nutrient flow balance varied considerably between years. In 2000, N flow balances were positive for both total and available N. However, available N was reduced to -0.7 kg in 2001 and then to -24.0 kg in 2002. Net flow P balances varied least. Potassium net in-outflow balances showed as large a yearly variation as N. Potassium net flow balances, although mostly negative in the first years, became positive in the last year. There was no consistent relationship in the net in-outflow balances between the three nutrients tested.

The complete system's paddy nutrient balances revealed that the N and P balance were generally positive. In fact, they were strongly positive for P, reaching +88 kg P/ha in 2001. This was due to high P fertilizer inputs. As excess P was not lost in the out-flowing water, it is likely to build up in the soil system and would probably lead to reduced input requirements over time. N was also positive in most years, with levels of up to about 80 kg of N/ha/year. Unless a build up of organic matter occurred in the soil, it is likely that a large proportion of this excess was lost by denitrification, which was not accounted for in the partial balance approach applied. As in the upland nutrient balances, K balances in the paddy system were negative, suggesting that despite the large upstream flow-through of K, not enough was retained in the paddy fields to offset losses. It thus appears that in the current upland and lowland systems, the nutrient replenishment patterns of K are poorly understood and need further investigation.

Capability of Satellite Imagery for Land-Use Analysis

Yukiyo Yamamoto¹, Thomas Oberthur², Rod Lefroy³, Junichi Kashiwagi⁴ and Somsak Sukchan⁵

1 Japan International Research Center for Agricultural Sciences; yuki@affrc.go.jp

2 International Center for Tropical Agriculture (CIAT), Colombia; t.oberthur@cgiar.org

3 CIAT Lao PDR; r.lefroy@cgiar.org

4 Hokkaido University Graduate School, Japan; kashi@env.agr.hokudai.ac.jp

5 Land Development Department, Ministry of Agriculture and Cooperatives, Thailand; somsaksc@hotmail.com

Satellite imagery has been providing reliable and spatial information representing land use history. In this paper, two kind of satellite-based remote sensing applications were applied using different spatial resolution imagery, TM/ETM+ and QuickBird. Using TM/ETM+ over eight years of meso-scaled and periodical satellite imagery, cropping and fallow periods were identified and spatially illustrated. TM/ETM+ was appropriate for time series analysis owing to the abundant data archives. QuickBird is represented by high resolution. The resolution of Panchromatic and four-band multi-spectral data are 0.6 m/pixel and 2.4 m/pixel, respectively. The superior resolution was very useful in identifying plot boundaries and making land use maps efficiently. In addition, various derived indices such as NDVI and texture indices were correlated with some field information on vegetation and soil. Although it is necessary to reveal the relationship between satellite data characteristics and field properties more robustly, spatial analysis with satellite imagery has wide capabilities for land resource management.

Agrarian Land Use Transformation in Northern Laos

Khamla Phanvilay, Yayoi Fujita, Sithong Thongmanivong and Jefferson Fox

Faculty of Forestry, National University of Laos

Farmers in northern Laos are experiencing rapid transformation from subsistence agricultural production to intensive cash crop cultivation in the last decade. This transformation has been accompanied by conversion of forest land into permanent agricultural land. Introduction of new crops such as sugar cane, maize and rubber brings new economic opportunities but also risks. Surging commercialization of agricultural production is deemed to complement government policy on rural poverty alleviation, and is thought to provide an alternative to shifting cultivation and opium production in the upland areas. However, realities in rural areas are complex, and not everyone in rural areas is benefiting from the current transformation. This paper examines land use change patterns and the driving forces behind farmers' decisions

on changing land use and selecting crops. In order to assess land use change, the team analysed LandSat ETM+ and Aster satellite images from two time periods (2000 and 2005) in Sing and Vieng Phoukha districts of Luang Namtha province, and Houayxay district in Bokeo province. In addition the team conducted cognitive mapping and stratified household interviews. This article also reviews the influence of government policies on land use change in the study sites.

This work forms part of on-going multidisciplinary research conducted by the National University of Laos and the Environmental Program of the East-West Center in the US. The project aims to understand dynamic patterns of land use and livelihoods in mountainous mainland Southeast Asia, and to predict future of land-use scenarios in the region based on past experience.

<i>Day 2, Session A, Paper 9</i>

Estimation of Erosion and Erodibility of Soil in a Slash-and-Burn Cultivation Area of Northern Laos

Junichi Kashiwagi¹, Takashi Kotera¹, Koji Watabe¹, Shuichi Hasegawa¹, Yukiyo Yamamoto² and Kongkeo Phachomphon³

1 Graduate School of Agriculture, Hokkaido University, Japan

2 Japan International Research Center for Agriculture Sciences

3 NAFRI, Laos

Using ¹³⁷Cs as a tracer, this team estimated erosion rates in a slash-and-burn cultivation area of the Lao PDR. There was great variability in the estimated erosion rates at each site investigated, including, in one village area, 2.5 mm year⁻¹ in a low-yielding field, 1.25 mm to 1.88 mm year⁻¹ in moderately-yielding field A, and 3.13 mm year⁻¹ in moderately-yielding field B. Net accelerated erosion rates caused by cultivation were evaluated by deducting the erosion rates recorded on a forested slope. The study attempted to explain the variations in erosion rates in terms of the topographic conditions and soil properties associated with erodibility. Erosion that occurred on the low-yielding field was explained by the fact that the soil had relatively poor aggregation and was easily dispersed by the impact of raindrops. No evidence could be found for a significant association between erodibility and the severe erosion that occurred in moderately-yielding field B. Soil erosion remains an often undetectable problem of soil degradation and does not directly lead to readily apparent decreases in production. For sustainable cultivation it is important that we begin taking measures now to prevent soil erosion.

Applying GIS-Assisted Modelling to Predict Soil Erosion for a Small Agricultural Watershed within Sloping Lands in Northern Vietnam

Do Duy Phai¹, D. Orange², J.-B. Mignaine², Tran Duc Toan¹ and Nguyen Cong Vinh¹

¹ National Institute for Soils and Fertilizers, MARD, Hanoi, Vietnam

² IRD (Research Institute for Development, France) and IWMI-SEA, posted in NISF, Hanoi
phaidduy@yahoo.com

Recent studies on soil erosion and soil conservation (i.e. MSEC and ASIALAND programs in Southeast Asia) have proved that land degradation brought by soil erosion on sloping lands is a major constraint for sustaining uplands agriculture and food security in most of Asia. Soil erosion by water is the major cause of soil degradation. It decreases arable surface, reduces soil fertility, causes harmful effects like soil and water pollution, silting of reservoirs and irrigated fields. Many studies about soil erosion on sloping lands have produced considerable results, but almost all research in Vietnam has been carried out on experimental plots of around 1 m². Upscaling these results for a farming system is impossible because the erosion quantification is subject to thresholds according to the scale of each study. How then can accurate information be found on erosion consequences for sustainable natural resource management?

The use of GIS-assisted distributed modeling is well adapted to satisfying the requests of decision-makers on land-use and water management, and on environmental protection. This study attempts to find a way of predicting soil losses by distributed modeling within an experimental watershed in northern Vietnam (Hoa Binh province). The water budget and soil losses are recorded for five stream points in three-minute time steps. The whole watershed area is 50 ha, divided into four sub-watersheds according to land use: forest with *Acacia mangium* (W1, 2.6 ha), cassava (W2, 7.7 ha), fodder with *Bracharia ruziziensis* (W3, 1.5 ha), and fallow (W4, 8.4 ha). The PLER model is a GIS-assisted model that simulates runoff and soil erosion at a small catchment scale (< 1 km²). It can predict the spatial and temporal distribution of soil erosion rates and can thus be used to identify erosion hot spots in a watershed. This model has been specifically built to take into account high slopes. Indeed, the models applied so far were empirical models that only used topography with small slopes. The PLER model is a conceptual erosion model on a physical base. The model imitates soil erosion as a dynamic phase that includes three processes: detachment, transport and deposition. The calculation of soil erosion quantity for each cell relies on the GUESS (*Griffith University Erosion Sedimentation System*) mathematics erosion equation. The concept of the model is to use the equilibrium of sediment in the area. It calculates the movement of sediment under current conditions and then the deposition place by runoff flow in each event. Two types of soil are considered, original soil and newly deposited soil. The original soil has varying cohesion and aggregation, while the newly deposited soil has no cohesion and aggregation. Therefore in each rainfall event the soil cohesion in the area will not be the same.

The model uses PC-Raster language and a Nutshell platform. This software is capable of cartographic and dynamic modeling that allows easy simulation of the hydrologic and sediment transport processes occurring in a three-dimensional landscape. The model outputs are time series with values of erosion quantity at the outlet selected by the user, and maps showing soil detachment, sediment storage and erosion quantity at each cell (generated every time step / every hour / every day according to the user's needs).

The disparity for the soil erosion quantity between experiment and run model was 5.1% in 2003 and 4.9% in 2004, even though these two years had very different amounts of rain. 40% of rain events in 2003 were of strong intensity ($> 75 \text{ mm.hr}^{-1}$), whereas only 4% of the 2004 rain events fit this description. The respective rainfall records for 2003 and 2004 were 1,583 mm and 1,353 mm. The model has taken this discrepancy in rainfall characteristics years into account. From April to September, the disparity fluctuates between only 4.7% and 5.3%.

The capability for leaching, eroding and transporting of sediments varies according to the period tested. In 2003, the soil detachment quantity (i.e. for each cell) reached a strong grade (0 to $37.2 \text{ tonnes.ha}^{-1}.\text{yr}^{-1}$), and the soil erosion quantity for each cell fluctuated from zero to $19.8 \text{ tonnes.ha}^{-1}.\text{yr}^{-1}$. In 2003, the surface areas with weak, average, strong-average and strong levels of detachment respectively covered 12.9 ha, 11.8 ha, 7 ha and 18 ha of the whole watershed; for erosion, the sequence is 16.3 ha, 12.6 ha and 20.8 ha. The maps drawn by the model underline that the erosion process occurs mainly on the top of the landscape and highlights differences in detachability and soil erosion between the western and eastern halves of the watershed. In 2004 soil detachment quantity was lower than in 2003. The soil detachment by cell reached the strong grade (0 to $24.6 \text{ tonnes.ha}^{-1}.\text{yr}^{-1}$), and the soil erosion by cell reached $2.1 \text{ tonnes.ha}^{-1}.\text{yr}^{-1}$. In 2004 the surface area with weak, average, average-strong and strong detachment was 21.4 ha, 8.5 ha, 7.9 ha and 11.9 ha respectively. Erosion showed only two classes, weak and average, at 35.4 ha and 14.3 ha respectively.

To conclude, this first running of PLER on erosion calculation within a small and sloping agricultural watershed has shown efficiency in calculating the amount of soil erosion at the outlet of the studied watershed. Moreover, the maps generated have confirmed field observations. It can therefore be expected that PLER can be used as a tool to study the effect of land-use change and management options on water and soil management. However, this model requires continued application in other areas and for longer time series.

How Do Farmers Make Decisions in a Land Degradation Context?

Floriane Clement, IRD/IWMI/NISF (Hanoi), University of Newcastle upon Tyne (UK)

Stemming from a three-village case study in northern Vietnam, this paper examines how farmers have coped with and adapted to land degradation in the uplands. It assesses how policies and research programs implemented in the area have affected local determinants, namely farmers' perception of the environment and local rules, and how in turn the latter impacted individual and community behaviour. Following a qualitative approach that draws from ethnography and institutional analysis, it hopes to contribute to the current literature by testing the effectiveness of this approach in understanding farmers' decisions in a land degradation context, and by highlighting new determinants that have so far not been much considered in the analysis of land-use change.

Land degradation has attracted the attention of donors, researchers and policy-makers in Vietnam over the past two decades. Deforestation and soil erosion were identified as the key issues to address, and officially incorporated into the design of new national policies and research programmes. Since the 1990s, specific policies have targeted uplands management in Vietnam, including forest land allocation, sedentarisation and reforestation programmes. Improving (or substituting) ethnic minorities' land management systems and reforesting barren hills have been two major goals for these government initiatives. If some of these objectives (such as reducing significantly shifting cultivation practices) have been reached, their success in improving people's livelihoods and the environmental attributes of the uplands has been widely challenged. In actual fact, social and economic inequities between mountainous and deltaic areas have increased over the last decade.

At the same time, considerable research effort has focused on developing soil conservation and sustainable land management practices. However, although some results have been technically promising, very few of them have been adopted by farmers. Recognition of this shortcoming emerged within the academic community in the late 1990s. The main causes were identified as a non integration of socio-economic determinants within the development of technical solutions, and a focus on the plot level with no consideration of how to upscale results. From this recognition, a new research paradigm emerged, guiding innovative research and development projects on land degradation in tropical countries. These have adopted a participatory, interdisciplinary, community- and catchment-based framework. Several research projects have been implemented in Vietnam following this new line of scientific enquiry. However, research techniques are still hardly transformed into farmers' practices.

This paper aims to highlight new key determinants for successful policies and research projects that address land management issues by analysing farmers' decisions on land use in three north-

ern Vietnamese villages, including one village where research programmes on soil erosion have been implemented. In these three villages, farmers have practised shifting cultivation in the uplands for a few decades, cultivating annual crops such as cassava, arrowroot and taro. Annual cropping has been identified by both local authorities and researchers as highly soil erosive. Policies modifying land tenure, restricting land use and encouraging reforestation have been implemented nationwide since the late 1990s. At the same time, researchers have organised farmers' field schools in one village and proposed soil conservation practices to limit land degradation. Recently, all farmers stopped annual cropping and have planted monoculture tree plantations or left land under fallow. This research work analyses the extent to which policies and research work have contributed to land-use change in the area, by examining farmers' perceptions of land degradation and their decision-making processes. This is not a research project or policy evaluation, in that it does not seek to systematically identify all factors in the adoption of sustainable land management practices. It seeks rather to link observed farmers' decisions with a range of factors and assess the relative contribution of these factors in farmers' behaviour.

Data collection and analysis rely on an approach drawn from ethnography and institutional analysis. Semantic realism is used as an ontological basis for addressing farmers' perceptions of uplands and soil erosion. It distinguishes 'brute facts' and 'institutional facts' to examine the social function of the term 'land degradation' and study how these meanings are shared by different social groups. Institutional analysis is then applied to decrypt farmers' decisions and behaviour using a refined version of the Institutional Analysis and Development (IAD) framework developed by Ostrom. The refined version proposed by the present research work integrates an historical perspective and pays special attention to the social constructions of land degradation by local actors.

Results suggest that the research projects have had little impact on farmers' perception of uplands and land degradation in the study area. Narratives brought up by policies were much more powerful in affecting farmers' beliefs. However, institutional analysis showed that the shift from annual cropping to tree plantations in the area was rather an accident than the result of farmers' new beliefs on national forest and reforestation incentives. Narratives on forest benefits carried out along with policies, even if assimilated into individual imaginations, have had little impact on final farmer decisions. The collapse of local rules, due to a combination of declining soil fertility and change in land tenure, was the decisive factor in land-use change.

This study defends the idea that when natural resources are managed by local users, local studies integrating acute models of individual behaviour have marked assets over meso- or macro-scale studies. Though a powerful tool in analysing the contribution of aggregated or macro-scale factors at the regional or national level, the latter might miss decisive factors that are only observable at the community level. It argues that, when seeking to explain human behaviour, a socially-constructed view of nature is required to assess the relative impact of external forces on individual decisions. Lastly, it showed that when examining commons management, individual decisions should be analysed together with community dynamics. In the present case study, collective determinants were as much responsible for land-use change as individual strategy.

IUARP: A Promising Integrated Approach for Poverty Reduction in the Lao Uplands

Phouthone Sophathilath

National Project Coordinator for IUARP, Head of NAFRI Planning and International Cooperation Unit

The Lao PDR, in spite of economic growth during the last decade, is still one of the poorest countries in Asia, with a GDP per capita of \$490 in 2005. Of the total population of 5.2 million, more than 85% inhabit rural areas, especially uplands, where poverty incidence is high (38% in 2003). This group of people is heavily dependent on subsistence farming practices and natural resources. While rice remains the main food, most of them practice slash-and-burn shifting cultivation to produce upland rice and other crops. They also raise livestock. To compensate for rice shortages, they generate income by selling NTFPs, wildlife, small livestock, vegetables and handicraft products, and by hiring out family labour to wealthier farmers in their own or different villages.

Shifting cultivation is the traditional farming system in the uplands, occurring on some extreme slopes (of up to 120%), but usually confined to gradients of 15% to 60%. The practice was considered to be a permanent upland farming system in the past when fallow periods were of sufficient length. However, increased population density has contributed to shorter fallow periods, leading to widespread problems of weed infestation, soil erosion and declining yields. Moreover, since rotational slash-and-burn agriculture requires an abundant supply of forested land for cropping, forested areas have been encroached. This practice is therefore seen as no longer sustainable and needs replacing with sedentary farming systems. Stabilizing shifting cultivation has become one of the top government policies in poverty reduction, alongside conservation of the country's natural resources and environment. Hence the Integrated Upland Agriculture Research Project (IUARP) was designed to support government policy by improving food security, alleviate poverty and stabilize the environment by conducting integrated research in the uplands of the Lao PDR.

As it is acknowledged that problems associated with poverty and shifting cultivation in the Lao uplands are very complex and unlikely to be addressed by a single technology or the use of a set of technologies in isolation, three main principles were used by IUARP: (i) application of an integrated research approach; (ii) use of participatory research; and (iii) focus on research for development. Aiming to assist the poor in solving complex problems, IUARP was designed as a nobody-owned project, calling for problem-oriented initiatives and resource contribution from all interested partners in an integrated and well coordinated manner. A number of partners participated in and contributed to implementation of the project, including NAFRI/MAF, NAFReC, PAFO, DAFO, IRRI, ICRAF, CIAT, IWMI, ACIAR, and RF.

Project activities encompass evaluation of a number of upland farming technologies: development of sustainable livelihood systems as alternatives to shifting cultivation; and development of

support in technical and managerial capacity and ownership for local institutions, including for farmers. The project has run since the end of 2001, starting with seven villages in Pak Ou district, Luang Phabang. Since the project started, a number of promising upland technologies have been evaluated, based on need and farmer preferences. These introduced technologies are related to rice variety improvement, pest management and weed control, nutrition management and fallows improvement, crop diversification, and improvement of livestock and fish production.

To ensure replication of promising technologies on a wider scale, scaling-up mechanisms such as sucker banks were developed and tested. These were supplemented by technical and managerial capacity development for both extension staff and farmers through various tools. By the end of 2005, 21 topics had been researched in nine villages involving 333 farmers, as compared to four topics with 35 farmers in 2001. Project evaluation results in March 2006 showed that the technologies farmers preferable to replicate are: agro-forestry systems with various crop combinations and green soil conservation measures; fallow improvement techniques with different intercrop species; and management techniques for teak plantations (thinning and pruning). With regard to cultivars and seeds, there are four varieties of upland rice; fruit trees, especially lychee; paper mulberry; pigeon pea; stylo; teak; and agarwood. From implementation of the project, the following lessons have been drawn:

- Strong local leadership and involvement is the key to success, because it allows rapid decisions and timely implementation, and ensures adequate follow-up through the year.
- Developing staff capacity in the area of participatory research from the beginning breeds success, but requires constant follow up, support and continuation.
- Training based on local needs is more effective than that based on researchers' needs and training should be applied immediately before implementation.
- Efforts are only valuable if there is increased trust between researchers and farmers, and farmers are eager to collaborate and test new technologies.
- The technologies that are preferred by farmers and are most likely to win farmers' trust are those with short-term economic benefits.
- Farmers need to become familiar with the new technologies before they can integrate them into an integrated farming system. Time is required as they test the technology, but once they become familiar with it, farmers begin to integrate these components into their farming systems. How farmers integrate varies according to individuals and the resources they have. Researchers need to provide technical options and expertise initially, and then monitor and document how farmers are adapting and integrating these components.
- Participatory research methodologies have increased farmers' trust in researchers and extensionists, making it much easier to work with communities. Involving farmers in the research process develops trust and helps spread technologies.

Root Crops for People and Pigs: Food Security and Income Generation Aimed at Supporting Transition from Upland Rice Cropping in Northern Laos

Keith Fahrney, Somsamouth Phongsavath, Gavin Varney, Lao Thao and Tin Maung Aye

k.fahrney@cgiar.org

Increasing population and land use restrictions in northern Laos have resulted in decreasing bush fallow rotation cycles and yield declines in traditional upland rice production systems. To maintain forest cover and the integrity of watersheds, Lao government policy promotes crop diversification and permanent cropping on fixed fields.

Livestock is a major source of cash income for upland villagers in northern Laos. Most households raise a few local-breed pigs (*mou laht*) in low-input, low productivity systems. Pigs are often free-ranging and subsist by scavenging and supplemental feedings based on household food waste, collected greens, and rice bran. Pigs are often kept for two to three years before they reach marketable weight. Undernourished pigs are prone to disease and significant losses occur even when adequate veterinary services are available. Improving the productivity of village pig systems could provide income for rice purchase and capital for diversification to more sustainable livelihood systems.

The CIAT/CIP *Participatory Research for Development in the Uplands* (PRDU) and the CIAT *Integrated Cassava-based Cropping and Livestock Systems* projects began technical support to provincial and district extensionists working with the Oudomxay Community Initiatives Support Project in June 2004. Seven dual-purpose sweet potato varieties (for food and livestock feed) and seven improved (high-yielding, high starch content) cassava varieties were planted by farmer groups for demonstration trials in four focus villages in Pak Baeng and Houn districts, and then compared with local varieties. Farmers and extensionists received training in production technologies at a sweet potato field school during harvest (November 2004) and during cassava harvest field days (May 2005). Extensionists received more detailed training on cassava production, and cassava and sweet potato processing and utilization for livestock feeding, during a week-long training workshop in April 2005. Interested farmers received sweet potato and cassava planting materials during harvest field days. Sweet potato and cassava planting spread within each village and then to nearby focus villages. Farmers began experimenting with feeding cassava roots and leaves and sweet potato vines to livestock. Villagers consumed sweet potato roots themselves or sold them, rather than feeding them to livestock. Both cassava and sweet potatoes are utilized by villagers as temporary staple alternatives, and provide food security during periods of rice deficiency.

During harvest field days in March 2006, provincial and district extensionists and research partners trained farmers in processing root crops (chopping, drying, silage-making). Research

partners used a feeding simulation model (developed by CIP and ILRI) to design reasonably-balanced feed rations, utilizing only locally grown feed resources (cassava roots and leaves, sweet potato vines, paper mulberry leaves, maize, soybeans, stylo leaves). Four farmers (two in each focus village) processed enough silage and dried feed materials from their harvests in 2006 to implement feed demonstration trials, in collaboration with provincial and district extensionists and supported by the PRDU project. Participating farmers received training on improved pig housing, hygiene, and management. They constructed improved pens and feeding troughs and installed clean drinking water systems. Cross-bred piglets of similar age were provided by the project (four per farmer) to compare two 'improved' feeding regimes. Piglets received basic veterinary services (de-worming and vaccinations) during quarantine and arrival in the village. Feeding demonstration trials began in late May 2006 and were monitored by students from Luang Prabang Agriculture College (Pak Xeuang). The pigs were sold in October 2006.

Data is presented on productivity of sweet potato and cassava varieties, production of improved feed resources, and pig growth during the demonstration trials. A rough economic analysis is attempted, comparing inputs and outputs of traditional and trial pig feeding systems. Farmers' preferences, adaptation of production practices, and the perceived strengths and limitations of root crop and pig production systems are discussed within the context of upland village cropping and livelihood systems.

<i>Day 2, Session A, Paper 14</i>

Sustainable Agricultural Productivity through the Farm Pond Option in Integrated Watershed Management in Northeast Thailand

Thawilkal Wangkahart¹, Prabhakar Pathak², Suhas P Wani², Bonyong Toomsan³, Somsak Idhipong¹, Somchai Chaujin¹, Pranee Seehaban⁴ and Preecha Chueychoom¹

1 Office of Agricultural Research and Development Region 3, Department of Agriculture, Khon Kaen, Thailand

2 International Crop Research Institute for the Semi Arid Tropics (ICRISAT), Patancheru, A.P. India

3 Faculty of Agriculture, Khon Kaen University

4 Office of Land Development Region 5, Land Development Department, Khon Kaen, Thailand

Northeast Thailand is handicapped by unpredictable and uncontrollable availability of surface water: usually either a shortage or an excess of water, both detrimental to sustainable agricultural productivity. The south–west and middle mountainous ranges divide the whole northeastern watershed into two main river drainage systems, namely the Sri-Songkhram system in the north and the Chi-Mun system in the south. Both drain east, down to the great Mekong river systems. The topography of each is characterized by mini watersheds in associated with various highland landforms in hilly, upland and rolling lowland patterns. This restricts large-scale water resource development. About 80% of farm families are favorable to using small-scale

water resources. Nevertheless, uncontrolled runoff water causes severe soil erosion and land degradation problems in the highlands, whereas drought and flooding problems are common in undulating areas. These factors influence overall agricultural productivity and farm families' livelihoods in this region.

The *Participatory Watershed Management for Reducing Poverty and Land Degradation in SAT Asia* project aims to integrate technologies in basins for the optimum and sustainable use of natural resources such as soil, water and vegetation. The project runs in two three-year phases, jointly implemented by a multi-sectoral consortium team under a trans-boundary approach by ICRISAT and Thai research organizations with financial support from the ADB. Work has been carried out in two benchmark watersheds: (i) the hilly Tad-Fa watershed in Phu Phamann district; and (ii) the rolling lowland Wang-Chai watershed in Phu Waing district, Khon Kaen province, since 1999 and 2003 respectively. This paper discusses the project interventions, especially the role of farm ponds in the watershed. Results show a significant increase in water availability and crop yields. With proper land-use planning and integrated soil, water and crop management options, land degradation can be controlled with soil loss dropping to 5 tonnes per hectare per year, as against 37 t/ha per year in traditional systems.

39 farm ponds, a key component of this integrated watershed management, have been built in the project area by the Land Development Department. These small structures on farm land capture surface runoff, and some are deep enough to utilize ground water. Each can store about 1,260 m³ of supplementary water. Use of these farm-ponds can not only increase crop yields in both rainy and dry seasons, but also reduce sediment load downstream. In the hills pond water is used to irrigate wet-season vegetables, orchards, and home garden crops, whereas in the rolling lowlands, the water is occasionally used for rice paddies, and also for various dry-season vegetables and crops such as cabbage, Chinese cabbage, corn, groundnuts, mung-beans, soy beans, etc. These ponds enable farm families to earn additional income. In the hilly Tad-Fa watershed, about 85%, 10% and 5% of this is derived from vegetables, fruit trees and local herbs respectively. In the rolling Wang-Chai watershed, about 78%, 10%, 8% and 4%, were derived from paddy, fish, vegetables and fruit trees respectively. The ponds' water levels over the year indicate that soil type plays an influential role in hilly areas, whereas the water level shows a close relationship with ground water level in the rolling lowland watershed.

It can be anticipated that if proper water-soil-crop management is applied to integrate small-scale water resources in watershed management, then farm ponds and other facilities such as village tanks, weirs, marsh rehabilitation, dug ponds, and deep wells, can play a significant role in enhancing farm productivity and livelihoods on small rainfed farms across the whole northeast watershed. Furthermore, the promising watershed management technologies developed at the project sites provide a good framework for increasing productivity and income on a sustained basis, while improving soil and water resources nationwide.

Collecting the Germplasms of Local Vegetable Varieties – A Treasure for Income Generation and Food Diversification in the Northern Uplands of the Lao PDR

M. Plewa¹ and K. Keovichit²

1 German Development Service (DED) at :

2 Haddokkeo Horticulture Research Center, NAFRI, Vientiane

matthias.plewa@gmx.de

Vegetables provide healthy food with a high vitamin and micro-nutrient value. They contribute to a diverse diet, improve nutritional status, and lead to better health conditions for people in the northern uplands of the Lao PDR. Vegetables are mainly grown in permanent home gardens, in riverbank gardens during the dry season, on irrigated fields, and in mixed cropping systems with upland rice. Vegetables have good market potential, primarily as fresh products at local markets. Price analysis carried out at the largest market in Vientiane over four years indicates good income can be earned from crops like tomato and leafy vegetables, e.g. coriander, dill, and lettuce, especially during the rainy season. During the rains, prices rise by between 290% and 828%.

Open-pollinated varieties of vegetables produced in the uplands could supply the local Lao market and provide an opportunity for export to neighbor countries in the future. Some varieties such as *brassicaceae* and carrots require a cool climate for flowering. Special seed production areas could be tested and established for these varieties. There is high biodiversity in the upland areas. To identify suitable species for the uplands, agro-ecologic conditions like soil, topography, altitude, rainfall and temperature should be surveyed, along with socio-ecological conditions like local traditions, food preferences and market access.

Between 2002 and 2006 a research team from Haddokkeo Horticulture Research Center (HHRC), in cooperation with the German Development Service (DED), conducted nine trips collecting local vegetable varieties from 76 districts across the 18 provinces of the Lao PDR. The researchers visited 281 villages, home to various ethnic groups. They collected seeds from traditional farmer varieties and from examples that had been selected by farmers and adapted to their local environmental conditions. The team took samples from upland fields (*hai*), home gardens, home seed stores and local markets.

As a result a vegetable gene bank with a total of 2,140 entries has been established at HHRC. The seeds are stored in refrigerators at 5° C. All relevant data, including village, district, province, farmer's name, ethnic group, local name of the crop etc., is stored in a database. Part of the gene bank material, including from chilli, tomato, lettuce, yard-long bean, and cucumber, has been applied in screenings and variety tests under lowland conditions at HHRC. A detailed

description of eggplant biodiversity, from collection across the whole country, is under research. After several years new varieties such as rainy season tomatoes could be released to Lao farmers for seed multiplication.

In the future, screenings comparable to those used for rice research at the Lao IRRI project should be conducted for vegetable varieties in the northern provinces to identify varieties suitable for upland conditions. The gene bank offers the opportunity to exchange upland varieties around the different mountainous areas of the Lao PDR.

<i>Day 2, Session A, Paper 16</i>

Local Knowledge and Land Degradation: A Participatory Case Study in the Uplands of Laos

Guillaume Lestrelin^{1,2*}, Aurélie Pelletreau¹ and Christian Valentin¹

1 IRD-IWMI-MSEC Project, Vientiane

2 University of Durham, UK

* Corresponding author: Guillaume Lestrelin, IRD / IWMI / NAFRI, P.O. Box 5992, Vientiane, Lao PDR

This paper presents the results of a study that used participatory techniques to approach the land degradation issue in Ban Lak Sip, an upland village located in the vicinity of Luang Prabang, Laos. It argues that ‘hybrid research’ approaches – integrating biophysical measurements and local perceptions of land degradation – allow a better understanding of local environmental issues and adaptive livelihood change. By extension, such approaches provide valuable insights for identifying potential solutions to land degradation that are well adapted to the local socio-economic context. Since 2000, soil erosion and related indicators have been measured in a 67-hectare watershed that makes up 15% of the village land. Measurements have included survey of rill and gully formation, and evolution and monitoring of sediment discharge in weirs. Due to the short time series, the measured soil erosion rates provide limited information on long-term environmental change in the village. However, several group discussions and the results of a questionnaire survey indicate that a large majority of farmers believe that, over the past fifteen years, there has been an increase in soil erosion across the entire village land.

In fact, local knowledge related to land degradation processes and factors appears remarkably detailed. During group discussions, farmers identified and sorted by order of importance the red colour of the soil surface, the development of gullies, and the presence of stones and particular weed species as main indicators of soil erosion in the village land. Again, by order of importance, a long history of agricultural rotations, cultivation on steep slopes and high elevation areas, and short fallow periods were described as the main factors that caused increased soil erosion

on village land. Decreasing yields and increasing workload were identified by farmers as the main adverse impacts of soil erosion on their farming activities. They then used the various identified indicators of soil erosion to describe successive stages of environmental change. On this basis, they reconstructed the history and predicted the evolution of the village land, showing a continuous degradation trend that, without change in current farming practices, would lead to the impossibility of cultivating annual crops in 10 to 40 years' time.

Accordingly, it appears that recent livelihood change in the village is in part related to this perception of land degradation. Over the past fifteen years, villagers have developed various socio-economic strategies which have been aimed at mitigating the impact of land degradation on their livelihoods. Notably, by diversifying their activities, adopting non-farm occupations and spending more time on alternatives to annual cropping, villagers have indirectly reduced the limiting effects of soil erosion on their livelihoods. While some – by devoting additional labour to annual cultivation and cultivating larger areas – have simply attempted to maintain agricultural production, others – by adopting full-time non-farm occupations – have successfully untied their livelihoods from land-related constraints. At the same time, many farmers have started to cultivate annual and vegetable crops in flatter parts of the landscape, which as observed by some scholars in northern Thailand, corresponds to an adaptive change linked with farmers' perception of higher erosion risk on steep slopes. By cultivating on flat areas, farmers take thus advantage of the sediments eroded from the slopes.

Along with a more participatory research process and a better understanding of the long-term environmental dynamics in the study village, this research has allowed the identification of 'socially-acceptable' solutions for combating soil erosion. While farmers could of course be encouraged to adopt farming technologies better adapted to the local environmental conditions, it must be remembered that such solutions must be appropriate to local livelihoods, influenced by local and broader socio-economic conditions and their likely continuing evolution. Taking the broader view inspired by the present study, it appears that the land degradation issue could also be solved through a shift to non-farm activities, to livestock farming, or towards more intensive agriculture such as vegetable cropping. This is already occurring in Ban Lak Sip. Therefore, beyond the 'technical issue' that soil erosion represents, a key question for government officials, development agencies and researchers involved with Ban Lak Sip and other similar villages in Laos, should be how to support local efforts at adaptation. This could be through increased education and training, improved transport networks, or market development consistent with Laos's opening economic environment.

How Can Research and Development Help Upland Farmers Improve Farming Systems? Experiences in Participatory Technology Development

K. P. Aryal¹, B. R. Regmi², P. K. Shrestha² and B. B. Tamang²

1 Swedish University of Agricultural Sciences, Ultuna, Uppsala, Sweden

2 Local Initiatives for Biodiversity, Research and Development, Nepal.

aryal.kamal@gmail.com , kam32263@yahoo.com

Shifting cultivation, locally known as *khoria*, is the predominant agricultural practice for most of the people inhabiting in the hills of Nepal. These areas are typically remote in access, marginal in agricultural production, and lacking in cash-generating opportunities. Soil erosion and land degradations have been a serious concern. This paper is based on the experiences of the *Participatory Identification of Integrated Agricultural Technological Packages Suitable for Shifting and Sloping Land Areas of Western Nepal* project (2001–2004) implemented in the Gorkha and Tanahun districts of Nepal by Local Initiatives for Biodiversity, Research and Development (LI-BIRD) a national NGO.

The participatory technology development (PTD) approach is used in the paper as an umbrella term to describe an approach or activity which combines technology development with participatory methods. The paper examines the various agricultural technological packages identified, tested and adopted by research farmers. The interventions promoted in the area are participatory contour hedgerows with a wide range of hedge and fruit species, intercropping of legumes with maize, mixed vegetable farming, strip cropping, forage and fodder integration with livestock. Participatory assessment of intervention was based on review of process documentation, interviews with farmers, focus group discussion, soil depth measurement and soil sample analysis. The introduction of these interventions, along with support mechanisms such as training and exposure visits, income generation activities, a revolving fund and group savings, have generated visible impacts on the lives of farmers. Farmers have tested these technologies and modified them according to their needs and the adaptability of species. Initial results demonstrate the effectiveness of contour hedgerows in increasing the nitrogen content of soil, improving soil texture and deposition, and maintaining pH. It has been observed that the technology is promising in biomass production, promoting species diversity and providing economic benefit to farming households. Adoption and adaptation of the technology is taking gradually place in the research area and nearby. Some of the government line agencies are already mainstreaming these technological interventions into their annual work plans. However, there is still a need for coordination and linkage among different stakeholders with possible mechanisms for wider scaling.

Farm Forestry and Buffer Zone Enhancement in Mountainous Southwest China: A Way to Enhance Rural Economies and the Environment

Horst Weyerhaeuser¹, Zhou Zhemei², Wu Xinfong³, Laura Ediger¹ and Chen Huafang¹

1 ICRAF-China

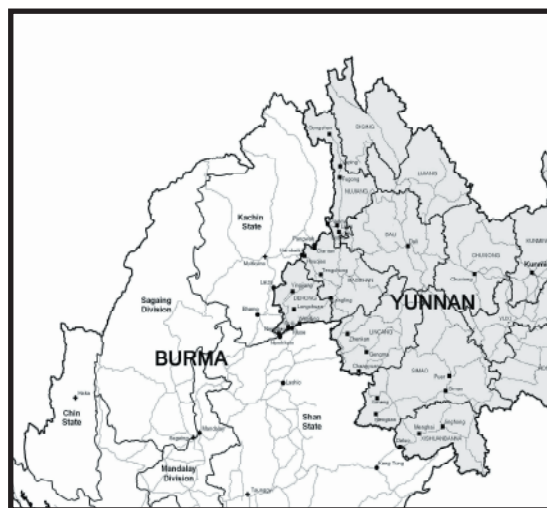
2 Baoshan Forestry Department

3 Kunming Forestry Vocational School

H.Weyerhaeuser@cgiar.org

ICRAF has been operating in China for five years. Field sites are mainly in southwest China and the research findings addressed in this paper are from Baoshan and Tengchong prefecture (see map). Both sites are in the vicinity of the Gaoligong mountain nature reserve.

In southwest China, agricultural land and forest land are traditionally considered to be separate. However, in addition to large-scale government-orchestrated plantations schemes, there is tremendous potential for planting trees on farms to improve agro-ecosystem mosaics. This can be done with single trees, with group planting, or through small-scale woodlots with one or more indigenous species. Agroforests can also increase agricultural productivity, and supplement farmer incomes through the sale of fruit, nuts, fuelwood, and timber. Trees on farms can alleviate fuelwood and timber shortfalls. The potential erosion and runoff control benefits provided by a mix of appropriately selected and placed trees can contribute to watershed and biodiversity conservation objectives. These benefits are more significant on farms than in plantations.



In the vicinity of conservation areas, selected species planted under an adapted framework species approach can enhance or help to establish real buffer zones with multiple functions. ICRAF is testing and developing suitable tree-planting and agro-forestry schemes with farmers and foresters in southwest China on several levels: through assistance in selecting species and improving nursery technology to raise high-quality seeds and saplings; by research on domestication and species phenology; with training in management and marketing; by documenting experiences to inform policy; and through supporting environmental education and rehabilitation programs.

Despite Chinese government and international donor emphasis on community forestry and forest restoration and conservation in Yunnan over the past decade, forestry is still far from

reaching its economic and conservation potential. Even when communities have some degree of use rights over their forests, community forestry is constrained by the quality of extension services. Forest conservation and restoration has suffered from a parochial approach to reserve management and a limited range of tree species in reforestation programs.

These seemingly disparate problems have their roots in the decades-old practice of provincial and local forestry bureaus. Forestry bureaus are in many cases still motivated by a 'task' mentality that emphasizes forest coverage statistics, stocks, and yields, with less regard for the economic or ecological usefulness of trees. Three tree species - Yunnan pine (*Pinus yunnanensis*), Simao pine (*Pinus kesiya*), and Armand pine (*Pinus armandii*) - account for more than 70% of planted area in northwest Yunnan's Baoshan prefecture. As a result, many of the same problems that plague community forestry, such as inappropriate technologies, low survival rates, and low value markets for mature timber, are common to conservation forestry as well.

In Yunnan, this attitude is gradually changing, and over the past five years the World Agroforestry Centre (ICRAF-China) has been a driver of new ideas and approaches among government line agencies and upland communities. However, given the national and international focus on forest conservation, much of line agency interest in new approaches has naturally tended toward conservation rather than community forestry. Because of the interrelated nature of the constraints facing both, there is considerable potential for leveraging improvements in conservation forestry into gains for community forestry, and for reducing conflicts between nature reserves and surrounding communities.

Framework trees are indigenous, non-domesticated, forest tree species, which when planted on deforested land, enhance forest regeneration and accelerate biodiversity recovery. The framework species method involves selecting and planting 20 to 30 such species and cultivating them for two or more years. The planted trees re-capture' the site by shading out herbaceous weeds, and re-establish forest structure by developing a multilayered canopy. They also restore ecosystem processes such as nutrient cycles, and improve conditions for seed germination and seedling growth of additional (non-planted) tree species ('recruits'), by creating a cooler, more humid microclimate and reducing weed competition.

Biodiversity recovery relies on wildlife attracted to the planted trees. Twenty to thirty tree species is only a small fraction of the total number of tree species that grow in most tropical forest ecosystems. To restore the forest's original tree species composition, wildlife must be employed. Once planted trees have created conditions conducive to tree seedling recruitment, they must then produce resources (e.g. nectar-rich flowers, fleshy fruit etc.) that attract seed-dispersing birds or mammals. These animals transport seeds from a wide variety of additional tree species from the nearest intact forest into the planted sites. It is the second generation of naturally established trees, germinating from these seeds, which ultimately restores the forest to its original condition.

The underlying idea in ICRAF and its partners' work with the framework species approach is to bridge the widening gap between conservation and community forestry in China by linking the ecological and economic benefits of forests. More specifically, a 'framework species approach' is applied to reforest areas around the Gaoligongshan Nature Reserve buffer zones with indigenous tree species that have higher conservation potential and economic value than either the existing vegetation or the small number of commonly-grown tree species. Despite its widespread use internationally, the buffer zone concept has yet to be assimilated into nature reserve management in China.

Many of the root problems that plague community forestry in China are common to conservation forestry. This paper introduces different methods for leveraging gains from improvements in nature reserve management for community forestry. More specifically, the paper will introduce ongoing research on the 'framework species' approach, which is to enhance species diversity in buffer zones around the Gaoligongshan Nature Reserve. In addition, high value species are then adapted to community forests, where they improve local livelihoods and generate income in the future. The research builds on ongoing technical research carried out by the Baoshan forestry department and nature reserve.

The paper also compares the framework species approach with ongoing tree species research for improved plantation and community forestry at the Baoshan forestry department. Line agencies have adapted these 'new' tree species to ecological conditions and market requirements, and the transfer of successful species to individual farms and community forests is in progress. Presently more than 50 different species are under trial at different field sites and within different planting schemes. Improving existing low quality monoculture plantations by interplanting a larger variety of broadleaf and adapted coniferous species, plus improving diverse plantations with more species, should not only benefit quality and henceforth generate higher income, but will also increase overall biodiversity and lower the risks associated with monoculture plantations.

In the medium and long term, the above methods have high potential for supporting a higher species diversification within the landscape mosaic of mountain watersheds in southwest China. These methods are poised not only to enhance biodiversity but also to increase farm diversity and generate higher income for small-scale farmers.

ABSTRACTS

**Parallel Session B: Watershed management: policy, processes
and practices**

Natural Resources and Governance – An Analytical Framework

Christoph Feldkötter

MRC GTZ Cooperation Programme, Watershed Management Project

This paper introduces a recently developed analytical framework, *Natural Resources and Governance*, and outlines the process of its pilot testing in the Mekong Region.

The management of natural resources is a core issue of development cooperation. A multitude of projects and programmes worldwide foster sustainable ways to use natural resources in fields such as watershed management, implementation of international environmental treaties, sustainable forestry, and land management. In contrast to the development assistance style conducted twenty years ago, recent approaches do not focus solely on the technical foundations of resource management. Increasingly, the governance of resource use comes to the fore: overexploitation of natural resources is often – explicitly or implicitly – due to governance problems.

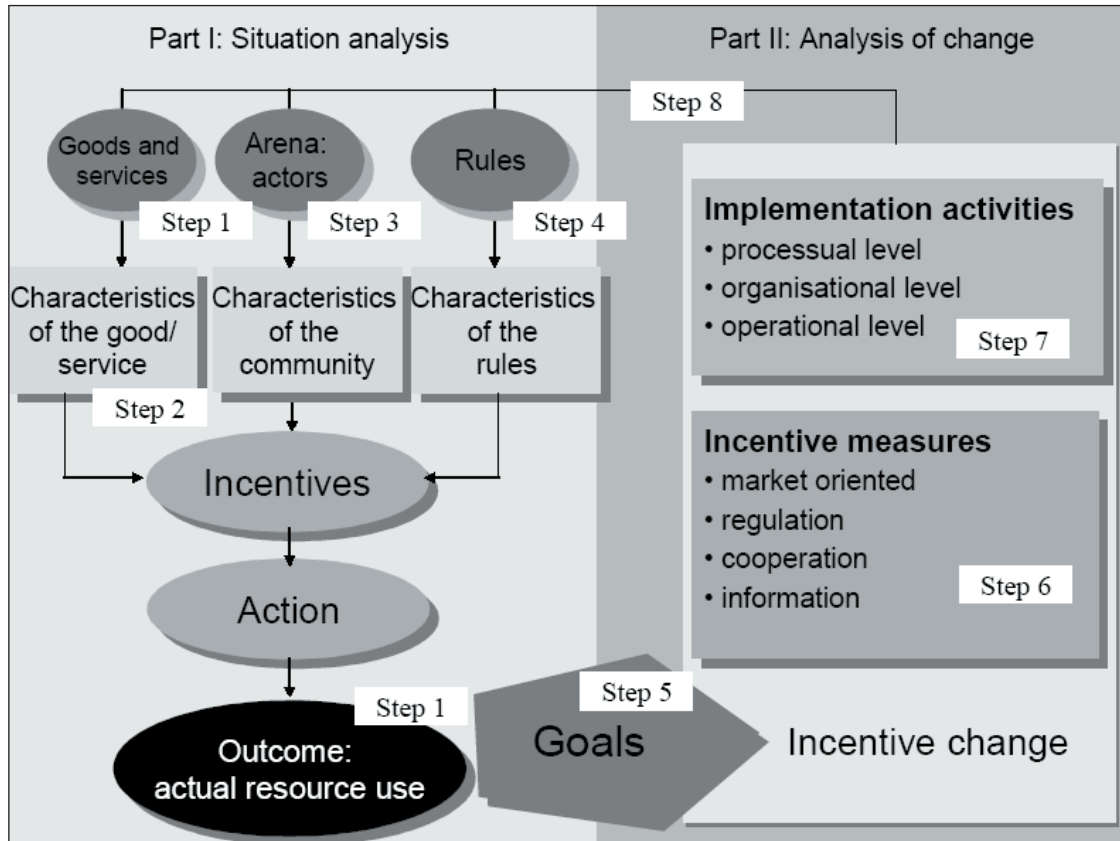
Within the context of the analytical framework introduced in this paper, the term governance includes all the rules (formal and informal) and mechanisms of their enforcement that guide and coordinate people's behaviour with regard to a concerted outcome. Many problems of unsustainable resource use result from a limited number of basic governance shortcomings, such as a lack of clearly defined property rights, and open access or insufficient enforcement of existing rules. The underlying problems are often quite similar, regardless of whether water, forests, land, the atmosphere, or biodiversity are at stake.

In development cooperation, there is an abundance of ideas and approaches with regard to governance in environmental affairs. Often, however, concepts and terminology remain sector-specific and empirical, making transfer of existing experiences difficult. No common language exists, and an exchange of lessons learned is severely constrained. There is an enormous pool of data and experience, but it seems almost unmanageable. Additionally, access to international discussion is often hampered by a lack of common concepts and terminology in resource governance.

Based on these considerations, a group of resource economists and natural resource managers within GTZ compiled an overview of existing conceptual work and sectoral concepts that refer to governance and natural resource management, also taking into account the international discussion on these issues. The outcome of this work is an analytical framework that is firmly rooted in the modern theory of environmental and institutional economics and which:

- Is applicable to any kind of natural resource-use questions;
- Provides a common terminology suitable for analysing governance problems;
- Reduces complexity without losing its depth.

The framework consists of eight interconnected analytical and planning steps, an overview of which is given in the figure that follows. The first part (steps 1 to 4) guides the analysis of the initial situation (the *status quo*), whereas the second part (see steps 5 to 8) supports the design of interventions and activities that aim to change the incentives conditioning resource-use patterns.



Through this framework, it might be possible to:

- Better understand governance problems in resource management;
- Improve the capacity for analysis;
- Link regional work more closely to international discussion;
- Establish a basis for an *ex ante* as well as *ex post* analysis of development assistance projects;
- Create a framework for the planning and design of future projects;
- Suggest a reference point for comparing projects and underlying governance problems in order to benefit from these experiences in future work.

The framework features practical applicability and has been used in several case studies world wide. The Watershed Management Project has conducted pilot tests in the Mekong region. Initial scepticism about the applicability of the framework in practical work in the Mekong region was high, particularly for the two following reasons:

- The framework was considered 'too academic' for use by practitioners outside the scientific world;
- There were concerns about the readiness to address the potentially highly controversial issue of adverse incentive structures (vested interests, rent seeking behaviour, etc.), which thorough application of the analytical framework almost inevitably brings to the fore.

Pilot testing took place through three workshops, which between them involved participants from all four lower Mekong Basin countries, including one to specifically address issues in Laos. The objective of these workshops was to a) apply the framework to case studies; and b) thereby evaluate its relevance to participants' work and its usefulness in analysing natural resource management problems in watersheds and in proposing options for their solution; and finally c) conclude whether the framework is suitable for subsequent practical application. The national workshops were held in the respective riparian languages, with all course materials being made available in those languages.

Workshop participants evaluated the relevance and potential applicability of the analytical framework very positively. They pointed out that it is highly practical for application in project analysis and planning, and for supporting policy design, and they recommended some next steps. In a similar vein, the Canadian International Development Research Centre has recently identified the framework as a model adaptation which could suitably be applied within the context of community-based natural resource management in Cambodia.

Among the remaining challenges is the process design for integrating the analysis results and suggested interventions into actual policy making. The Watershed Management Project is planning to address this challenge within its current phase (2005 to 2008), and to support broader application of the analytical framework *Natural Resources and Governance*, through, for example, cooperation with multipliers such as universities and other national research institutions.

Initial Diagnostic Analysis for Companion Modelling to Accommodate Multiple Interests in Upper Watershed Management

C. Barnaud^{1,3}, P. Dumrongrojwatthana², J. Marie¹, C. Le Page³, G. Trébuil³ and N. Ganjanaseni²

1 Department of Geography, Paris X University, France

2 Faculty of Science, Chulalongkorn University, Thailand

3 GREEN Research Unit, CIRAD, Montpellier, and CU-CIRAD ComMod Project, Chulalongkorn University

In the highlands of northern Thailand, ethnic minorities have long been accused of degrading the upper watersheds of the country's major basin. For the past three decades, the impressive amount of agronomic research carried out to control soil erosion in these sloping highlands has limited the impact of erosion on farmers' fields. In the meantime, environmental policies have been reinforced and the government has further restricted highlanders' access to farm land by creating forest reserves managed by the Royal Forestry Department, and new National Parks. This has resulted in an increasing number of land-use conflicts between local communities and state agencies. The limits of past research and policies in the field of land husbandry call for more integrated, transdisciplinary, and truly participatory approaches to better deal with both the agro-ecological and social dynamics of complex collective land management issues. These need to be examined and mitigated in an adaptive fashion.

From the lessons of numerous participatory watershed management projects conducted in the past, more and more authors argue that because of a lack of attention to the political contexts in which these projects were embedded, the less powerful stakeholders are often left behind. Researchers and practitioners argue that institutional settings and power relations need to be analyzed prior to any participatory intervention, in order to limit the risk of this intervention deepening existing social inequities. In this paper, we examine how far preliminary institutional analysis implemented prior to the launch of a collaborative modelling process could help to avoid such a pitfall. The study relies on the original results of an initial in-depth diagnostic-analysis of the local agro-socio system. The analysis was conducted prior to a Companion Modelling (ComMod) experiment on conflict between two Mien communities and a National Park in Nan province, northern Thailand. The objective of the ComMod approach is to stimulate a process of collective learning and coordination among multiple stakeholders, in order to mitigate a common problem of renewable resource management. It uses tools such as role-playing games and simulation models to represent different stakeholders' points of view. These views are then used in collective exploration and assessment of various future scenarios.

The authors argue that this kind of initial diagnostic-analysis is needed to: (i) identify the feasibility and potential usefulness of a ComMod process; (ii) identify the constraints towards equitable outcomes of the participatory process (who is likely to benefit?), and provide means to adapt the ComMod process to mitigate them; and (iii) provide a picture of the initial stakeholders' perceptions and interactions to be used as a baseline scenario for monitoring and

assessing the effects of the ComMod process in terms of communication, collective learning, and coordination mechanisms for collective action. The team elaborated a specific conceptual framework to analyse the initial situation and its changes along the process. First we examined the main interacting socio-economic and agro-ecological dynamics of the local system, and typified the different farming households based on their specific amounts of productive resources, socio-economic constraints and opportunities, and related strategies. Institutional analysis was then conducted to further improve understanding of the local socio-political context.

In this paper, institutions are defined as sets of formal and informal rules that regulate interactions among people. In the context of decentralization of resource management, the team in particular analyzed i) horizontal interaction among villagers; ii) vertical interaction between villagers and forest officers (from the National Park and Royal Forestry Department); and iii) the role and accountability of village leaders and representatives, especially village headmen and the two elected members to the sub-district (*tambon*) administrative organization (TAO). Because of the need to examine how the ComMod process would produce changes in the system, we also used inputs from the learning theory to assess changing perceptions and interactions. The following set of qualitative indicators were selected and monitored along the ComMod process to analyze the effects of the process: i) stakeholders' perception of the problem under study (based on their interest and knowledge); ii) their perception of other stakeholders; iii) their interaction with other stakeholders; and iv) their perception of future possible scenarios to mitigate the problem at stake.

The paper shows how the results of the initial analysis were used to tailor the ComMod process, and the preliminary results this process yielded. When the initial analysis was conducted, the National Park was about to be formally established, and there were as yet neither agreed-upon boundaries nor clear resource management rules, in particular regarding villagers' rights to gather the non timber forest products (NTFPs) essential to the livelihoods of many resource-poor households. The initial diagnosis revealed an impressive diversity of perceptions, as well as poor communication among stakeholders, and therefore also showed the potential usefulness of a ComMod process in improving communication and building coordination mechanisms. However it also uncovered the following constraints to equitable process outcomes: i) unequal access to information and unequal ability to participate in collective decision-making among the different categories of stakeholders; ii) the diversity of interests among villagers; the most concerned are vulnerable near landless farmers, who are highly dependant on NTFP such as arenga palm fruit to raise cash incomes, and on an array of wild plants and animals for family consumption. Compare these with village representatives belonging to a local elite of well-off farmers whose livelihoods are not threatened by the new National Park, and who are not accountable to resource-poor villagers; iii) 'top-down minded' National Park officers who have prejudices against ethnic minorities and are not open to dialogue.

Based on the findings of the preliminary diagnostic-analysis, several methodological choices were made to design the ComMod process in order to mitigate these constraints. These involved choice of interactive tools (role-playing game and simulation models), procedure for the selection of

participants, choice of communication modes, and the sequence of the process (separate meetings for villagers and forest officers at first, followed by joint meetings). The first village workshop increased villagers' awareness of the National Park issue. They exchanged their views on it and realized that they needed to enter into collective negotiation with the National Park. A second workshop held with the National Park and forest officers allowed them to better understand the diversity of villager situations and perceptions. The next step will see the organization of a third workshop, to be attended by both villagers and National Park officers, to stimulate better mutual understanding and elaborate a new set of rules for the co-management of NTFPs.

Two main lessons can be drawn from this experiment so far. Firstly, it illustrates the usefulness of an initial diagnostic-analysis of stakeholders' perceptions and interactions prior to the launch of a participatory process. Such analysis can better fine tune the process to the local socio-political system, and assess its effects in terms of collective learning and establishment of new coordination mechanisms. However, the accommodation of multiple interests in renewable resource management is a long process, and attention must be paid to power heterogeneities throughout the process. Likewise, continual and critical monitoring of the effects of the participatory process, and constant adaptation of the process to ensure mitigation of inequity, are also required. Finally, this case study illustrates the need for legal recognition of institutional pluralism in the management policies of forest resources. This would facilitate the emergence of co-management rules jointly designed, implemented and evaluated by state agencies and local communities.

Learning devices and mediation tools for collective management of natural resources: experiences from northern Vietnam uplands

Jean-Christophe Castella

IRD, Montpellier, France

j.castella@ird.fr

In northern Vietnam uplands the successive policy reforms that accompanied agricultural de-collectivization have triggered very rapid changes in land use. From a collective centralized management of natural resources a number of individual strategies have emerged that contributed to new production relations among farming households, evolutions in landscape structures, and conflicting strategies among local stakeholders. In such a context of transition, learning devices and mediation tools can help local communities in designing collectively their own pathway towards sustainable management of natural resources.

The collaborative approach presented in this paper combines a number of participatory tools and geographic representations (i.e. participatory 3-D models, spatial graphic models, multi-agents computer models, role-playing games, GIS) that share the common characteristic of analyzing and representing the interactions between: (i) the individual strategies of farmers (decision-making process according to the resource profile of the farm); (ii) the institutions which regulate the access to and use of resources; and (iii) the biophysical and socioeconomic environment. The methodological pathway that led to a negotiation platform on natural resources management is illustrated by a case study in Bac Kan province. The geographic information generated through a participatory process was incorporated into a village level GIS. By coupling a multi-agents model with the GIS we have created a virtual world, which reproduces the real one as it has been observed on-site by an interdisciplinary team. This modelling tool facilitated discussions between researchers with different disciplinary background and led to a common graphic language among scientists and local stakeholders. The extreme diversity of local situations and the complexity of the most recent dynamics have led us to develop, along with local stakeholders, more and more realistic models. These collective learning devices helped creating and exploring scenarios of agricultural and environmental evolution. They were gradually refined through interactions with different groups of stakeholders and became mediation tools between villagers and district policy makers to formulate new options for local management of natural resources that are compatible with regional development plans. However some questions remain about how to facilitate the use of the proposed tools by different groups of stakeholders involved in natural resource management, and beyond, how to reinforce the interplay between local and regional institutions in a context of decentralization.

A key lesson from this experience is related to the level of abstraction provided by the series of learning devices that we mobilized through our collaborative approach. Each of them was devel-

oped to respond to a specific question with specific groups of people. For example, abstract visualization supports were conducive to scenario building and discussions about individual behaviors or decision making processes. More realistic representations were necessary to contextualize the stakes at hand before designing and implementing collective action. The combination of different levels of abstraction showed its relevance to support both communication for diffusion of technical innovations, and negotiation for collective management of natural resources.

Day 2, Session B, Paper 4

The Impact of Development Interventions on the Poverty–Environment Nexus in the Lower Mekong Basin: Understanding Environmental Services on a Meso-Scale Perspective

Dr. Peter Messerli and Dr. A. Heinimann

Swiss National Centre of Competence North-South

Peter.Messerli@cde.unibe.ch, Andreas.Heinimann@cde.unibe.ch

The riparian countries of the Lower Mekong Basin (LMB) are endowed with a richness of natural resources such as forests, water, agricultural land, mineral resources, and biodiversity. These natural resources provide a wealth of different environmental services to stakeholders from the local to the international level. However, their heterogeneous spatial distribution indicates that this service provision is uneven throughout the LMB, and that recent and current processes reinforce trends towards unsustainable development. These processes comprise general macro-economic *dynamics* among the riparian countries, resulting in socio-economic *disparities* that impact on natural resource management, as well as socio-economic and political *dependencies* that lead to inequitable configurations of decision-making governing environmental service provision in different sub-regions.

In light of these general trends we argue that environmental services provided by forests and upland agriculture must be considered as key for future development policies in the LMB: on the one hand, the weaker parts of the region are facing an increasing pressure to catch up with the high pace of economic growth. Whatever the engine of this growth will be in the long term, development will inevitably pass through agricultural transformation and intensification in the short term. On the other hand, we have to take into account that the vast majority of people living in the LMB depend on agriculture and forestry. From an ethical point of view it is therefore essential that the livelihoods of these people and their natural resource bases be put at centre stage when considering future development pathways.

In order to develop innovative pathways towards sustainable development, a close dialogue between policy and research is crucial. Despite the growing number of studies dedicated to environment and development in the LMB, knowledge-dialogue continues to face two

important challenges. Firstly, the omnipresent propagation of the Millennium Development Goals fosters sectoral rather than integrative approaches to knowledge production. In the context of the LMB, where trade-offs between socio-economic development and environment must urgently be negotiated, this is highly critical. Secondly, integrative approaches oriented towards sustainable development cannot fulfil the knowledge demands of decision-makers. Trying to grasp the high complexity of poverty-environment interactions, they increasingly zoom in on local case studies, where each situation seems incomparable to another and generalisation and relevancy for decision-making at higher levels is lost. Furthermore, decision-making by local stakeholders on environmental and economic issues is being increasingly influenced by development interventions, policies, and institutions at higher levels. Understanding these factors and their variation from one place to another is crucial not only for developing innovative solutions, but also for planning their implementation. This field cannot be excluded from scientific research any longer.

The Swiss National Centre of Competence in Research North-South has initiated a new research project in the LMB, aiming to understand spatial patterns of the poverty-environment nexus by studying the impact of development interventions and underlying decision-making processes on a meso-scale. The approach comprises three important elements. First, it will try to determine spatial patterns of the poverty-environment nexus, using high-resolution land-cover and socio-economic data. Second, a spatially explicit analysis of development interventions and underlying decision-making processes by stakeholders shall allow description of so-called 'governance landscapes'. Third, the different configurations of the poverty-environment nexus shall be related to 'governance landscapes' in order to explain specific poverty-environment configurations. The ultimate aim is to establish a typology of spatial contexts which are homogenous in terms of constraints and opportunities for future development pathways. This 'context-knowledge' will allow conception of more realistic, more efficient and above all spatially differentiated policies for pro-poor and environmentally sustainable development.

First results from the LMB illustrate spatially discrete patterns of natural resource dynamics related to forests and agricultural land. Taking multi-temporal land cover inventories beyond net change analysis can reveal interesting insights into on-going processes. Certain land cover categories (e.g. forest mosaics) do not seem to change in surface from one time to another in conventional analysis. Yet, by accounting for increasing as well as decreasing surfaces, it has been shown that the highest resource dynamics are not taking place in closed canopy forests but rather between forest mosaics and cropping mosaics. Considering the value of these vegetation types for biodiversity, as well as for the livelihoods of millions of people, more emphasis has to be placed on management of these vegetation types. The data can also detect spatially discrete deforestation trajectories, revealing the influence of different economic and political contexts.

Further results allow the contextualising of natural resource dynamics on a regional scale. Among different proximate causes studied, insights into the role of accessibility from villages, district capitals and neighbouring countries are particularly interesting. The significant change among land cover types with decreasing accessibility is a first important indicator for

determining the involvement of various stakeholders in resource extraction. For Laos it can be shown that lack of access accounts for by far the biggest share of deforestation in protected areas, where the mere fact that an area has been declared protected accounts for very little. Conversely, the strong link between resource degradation and accessibility also reflects on future strategies. These should consider out-scaling certain innovations in terms of accessibility, and also the effect of infrastructure projects such as the recent ADB 'economic corridors' initiative.

The way forward will be based on initial results, and shall be briefly sketched out in order to stimulate discussions and to interest potential partners. First, the spatial land cover data will be complemented by high-resolution socio-economic data. Second, development interventions and stakeholders will be analysed in a spatially explicit way. The presentation ends by presenting a vision of how generalised knowledge on the poverty-environment nexus and related stakeholders could be the basis for conception of more realistic, efficient, and spatially differentiated policies for pro-poor and environmentally sustainable development.

Day 2, Session B, Paper 5

Payment for Environmental Services: An Approach to Sustainable Watershed Management

Xing Lu and Hetong Li

Regional Development Research Center, Yunnan University

The Supa River is a tributary of the Nu-Salween River in Longling county, Yunnan, China. It is 71.2 km long with a watershed area of 667 square meters. There is plenty of hydropower potential in the watershed, which already has a reservoir and five hydropower stations. Due to the good geography and climate, trees can easily here. The Supa watershed is home to four townships and 26 villages. In 2002 the total population was 62,000 people, of whom 8.5% are from ethnic minorities. Population density in the watershed is 94 persons per km², with a per capita arable land of 1.5 *mu* per person. Poverty is endemic across villages in the area. At RMB 5.53 million in 2002, the revenues of the township governments in the watershed comprised only 14.78% of total county revenues and these township governments were dependent on the county government to cover the RMB 15.14 million deficit in their revenues for that year. The watershed has no backbone industry, and the region has historically been dependent on agriculture. Total grain output is 25.46 million kg, equating to an average of 196 kg per *mu* and 408 kg per person. Per capita income is RMB 961 (US\$118.5).

The concept of payment for environmental services (PES) provides a way of solving ecological degradation and poverty in the poverty-stricken areas in China. Most poor people live in ecologically fragile mountains, and rely on natural resources for their livelihoods. Unsustainable natural resource utilization often leads to environmental degradation. The decaying environment limits

sustainable livelihoods. On the other hand, restrictive policies to protect the natural environment prevent local people from benefiting from natural resource protection. PES mechanisms in such areas enable poor local people to earn payment through providing environmental services. The ecological system then benefits from protection and reasonable utilization of its natural resources.

The people in this watershed are willing to plant trees and protect forests for timber production and to maintain the watershed function. They recognise that forest damage leads to insufficient water, land slides and damage to fields. Communities in the Supa watershed have taken collective initiatives to manage their forests, establishing a fund to hire individuals who work as forest guards. Every household has to contribute to the fund according to their forest area. The guards prevent illegal tree-cutting, prevent fires, monitor firewood collection, and stop livestock from foraging in the forest. The most common offence is people cutting trees on their own land without permission. The Forestry Bureau and local people share the cost of the guard's salaries, with 60% coming from the community.

There are still many critical areas of land that need to be converted from farmland to forest in order to stop soil erosion and improve the watershed's function. The issue under consideration is how to establish a mechanism that will enable the local community, the hydropower company and the local government to increase forest cover in the Supa Watershed and improve watershed functions that will benefit both the community and the company. Can PES achieve this goal?

This study firstly undertook a survey to identify critical areas in the Supa watershed, using GIS, slope, rock, and land use. Some farmland was found in the critical areas along with forests that were not managed well. A second survey was undertaken to assess the economic outputs of different land use. By calculating the opportunity costs of farmers converting farmland to forests, a base can be created for negotiating the price of PES. Thirdly, the ratio of soil erosion to forest cover rates was simulated by use of a Universal Soil Loss Equation. Soil erosion could then be given an economic value as part of hydropower company loss. Lastly, the team conducted interviews in the community to learn about local forest management best practice. Stakeholder perspectives on PES were also collected during these interviews. The paper then suggested a PES mechanism for stakeholder discussion.

The study has provided some lessons: there are currently insufficient funds for reforestation and maintenance of forests; there is a basic lack of common understanding of the benefits and necessity of supporting maintenance of environmental services; more time is needed to convince the hydropower company to pay for watershed maintenance. Moreover, beginning PES negotiations will be very difficult since there is no legal framework for PES in China. The study has recommended a mechanism of paying for watershed services in the Supa watershed. A watershed fund will be established to reward communities who manage forests well, in line with the forest management plan agreed by the Forestry Bureau, the hydropower company and local people. A committee comprising of village representatives and other stakeholders will be established to ensure the fund will be used for forest protection. A mechanism that stipulates each stakeholder's rights and responsibilities could then be formalized.

Criteria and Indicators for Ecosystem Service Reward and Compensation Mechanisms: Realistic, Voluntary, Conditional and Pro-Poor

Meine van Noordwijk¹, Beria Leimona¹, Grace Villamor² and Minh Ha Fagerstrom³

1 World Agroforestry Centre (ICRAF), Bogor

2 ICRAF, Los Baños

3 ICRAF, Hanoi

Poverty alleviation requires both 'goods' and 'services' from the environment. Economic growth tends to be based on the 'goods' at the cost of the 'services'. Achieving the triple goal of poverty alleviation, sustainable economic development and environmental protection requires careful management of tradeoffs. The concept of 'payments for environmental services' and the use of market-based institutions for such is one way to balance 'goods' and 'services'. This can also link downstream effects (negative or positive) to the decisions made upstream for sustainable use of sloping lands and watersheds.

Markets are by definition realistic, voluntary and conditional. Their effects on poverty are mixed. Many environmental issues, and the increasing scarcity of ecosystem services, are linked to 'market failure'. Time-lags, complex cause-effect and the multiple layers of rights and responsibilities involved with environmental issues make 'service' considerations externalities of decision-making processes that are focused on 'marketable goods'. Which combination of characteristics, short of full markets, is needed for effective, efficient, sustainable and equitable mechanisms that will avoid environmental degradation beyond the thresholds of sustainability? Are pro-poor market-based mechanisms possible?

This study set out to identify mutually-beneficial opportunities for the 'modifiers' and 'beneficiaries' of environmental services to interact as an alternative to a purely regulatory approach to environmental issues. The team combined principles and insights from social welfare theory, institutional economics, and integrated natural resource management approaches to obtain a general framework of criteria and indicators and to clarify the multiple pathways (eight identified so far) and challenges of poverty reduction through reward and compensation mechanisms.

Criteria concerning the *effectiveness*, *efficiency* and *sustainability* of reward mechanisms were formulated according to the following questions:

- 1) Would rewards be realistic?
- 2) Will they be voluntary?
- 3) What conditionality will apply?

The criteria concerning the **equity** dimension are related to the following three questions:

- 1) Is poverty linked to ES issues?
- 2) Who is/will be excluded?
- 3) Are the rewards 'pro-poor'?

These questions are used for mainstreaming in the scoping, stakeholder analysis and negotiation plus implementation stages. A review of cases in Indonesia, the Philippines and Vietnam reflects the situation and the concepts mentioned above.

The *Rewarding the Upland Poor for the Environmental Services they provide* project (RUPES), which runs in cooperation with COMMITTEES – the Indonesian national network on environmental services - is facilitating the development of government regulations (*Peraturan Pemerintah* - PP in Bahasa) on forest environmental services. Currently, funds from environmental services such as sustaining water quality and availability go to the general treasury. The proposed regulations would ensure that revenues from these services would go to a proposed new financial institution, to be used directly on forest and watershed conservation. Ministry of Forestry regulations would apply only to state-owned forest area. Nevertheless, communities could work with their local governments to apply the principles to their own lands. Under the Rupes project, the Ikalahans in the Philippines are exploring the possibility of marketing their rich plant diversity. Plant species used for jams and jellies are ginger (*Zingiber officinale*), passion fruit (*Passiflora edulis*), roselle (*Hibiscus sabdariffa*), santol (*Sandoricum koetjape*) and guava. The Ikalahans are also testing the potential of these plants for pickles, juices and condiment production (e.g. teas based on ginger powder, and herbal teas).

The Ministry of Environment and Natural Resources Management in Vietnam is working with IUCN to develop a PES mechanism for biodiversity. The ambition is to incorporate this mechanism into biodiversity protection law. The criteria for reward and compensation mechanisms is being discussed with the ICRAF Vietnam team, who have analysed the use of bamboo species for balancing both environmental goods and services, by combining perspectives on livelihoods and landscapes.

Economic Growth and Watershed Management: Drivers of Research and Development Innovations

D.C. Catacutan, C.E. Duque, R.E. Margate, and L.J. Arbes

World Agroforestry Centre (ICRAF-Philippines)

delia_icraf@yahoo.com

The Municipality of Lantapan is wholly contained in the Manupali Watershed, Bukidnon province, in the southern Philippines. Lantapan's economy, landscape, and political environment exemplify tensions between rapid population growth, economic changes, and environmental stress. Recent growth in agribusiness has spurred changes in land use and economic and social structures. This paper discusses the research innovations and lessons learnt from the World Agroforestry Centre's (ICRAF) work in the Manupali watershed. Initially, ICRAF's study focused on assembling the elements of realistic buffer zone management in Mount Kitanglad Range Natural Park on the northern border of Lantapan. Agroforestry intensification and community-endorsed social contract were important elements of effective buffer zone management. The Landcare approach, which centres on formation of landcare groups, was used to rapidly disseminate agro-forestry and conservation farming technologies, with apparent success. 13% of farming households adopted conservation technologies, covering 17% of cultivated land and 23% of critical areas of the watershed. However, the landcare groups began to backslide a year after it they started, due to availability of off-farm employment in the agri-business sector and the ambivalent support of the municipal government, which encouraged the proliferation of agri-business to boost the rural economy. To address this dramatic change in farmer decisions and local government priorities, ICRAF refocused its research activities on the multiple functions of trees, environmental services, and policy innovations. The lesson learned is that economic growth and watershed management goals are key drivers to Research and Development (R&D) innovations. Rooted in adaptive management, R&D organizations must learn and then adapt their programs to make them relevant to local needs. Salience, legitimacy and credibility are thus essential ingredients in R&D innovation.

Problems and Prospects in the Hilly Watersheds of Bangladesh: Priorities for their Conservation

Dr Khaled Misbahuzzaman

Institute of Forestry and Environmental Sciences, Chittagong University, Bangladesh: kmzaman_for@yahoo.com

The forests of the Chittagong Hill Tracts (CHTs) in the south-eastern part of Bangladesh account for about 30% of the nation's total forest area and represent the country's most valuable watersheds. Their importance lies not only in providing soil and water conservation for sustainable natural resource management in this part of the country, but also in supporting the shifting cultivation subsistence farming of 13 forest-dwelling indigenous communities. Over the last two centuries land use in the area has undergone tremendous change, including the clear felling of forest trees to make way for establishment of mostly monoculture plantations of valuable timber species such as teak (*Tectona grandis*), fruit trees, and other economically important cash crops. Due to scarcity of land and flood havoc in other parts of the country almost every year, people have been migrating to the CHTs. Population explosion has necessitated an expansion of agricultural activities in the hilly landscape, which together with deforestation, is causing serious degradation in the watersheds. Watershed degradation has contributed to severe soil erosion and deterioration of water quality. However, in some parts of the area forest-user groups still maintain traditional 'mauza reserves' or the Village Common Forests (VCFs) that serve various livelihood needs. VCFs are crucial for watershed management as many of them contain the headwaters of streams, natural springs and other aquifers, and are large repositories of biodiversity. However, no attempts have been made by government agencies to formalize the management systems concerning VCFs. VCFs have been declining both in numbers and in size due to various factors concerning the sustainable livelihoods of hill people. The present study has therefore been undertaken to explore the livelihood and resource conservation strategy of the people that live in VCF areas by interviewing them with semi-structured questionnaires, and to critically assess the relationship that exists between their indigenous knowledge of resource conservation in the watersheds and their livelihood patterns.

Traditionally, the communities practice a farming method called *jhum*, which basically involves cultivation of food crops in forest land through clearing and burning of undergrowth in the dry season, usually leaving a fallow period (3-15 years) between successive crops on the same piece of land. However, population pressure has necessitated higher production from an ever-shrinking land base for *jhum* (due to inclusion of *jhum* land in reserved forest). This has resulted in a gradually shortening fallow period that has dropped to as low as one year in some places. Thereby contributing to a sharp decline in *jhum* productivity and deterioration of forest ecosystems.

Successive governments have leased out big chunks of forest land to often wealthy individuals for cultivation of monoculture crops such as rubber. This policy was based on economic

considerations only, ignoring people's traditional user rights and values. Also, land parcels were distributed to ethnic communities to encourage monoculture-based farming. Unsystematic tillage in the hill slopes to establish monoculture plantations has led to serious land degradation. The extent and intensity of exploitation of natural resources in the hilly landscape is an important controlling factor in the conservation of watersheds and sustainable livelihoods. Seasonality of resource extraction or harvesting of forest produce affects food security and plays a key role in controlling soil and water quality in the watersheds.

In the clear-felled natural forests, land preparation prior to establishment of plantation involves uprooting tree stumps and burning debris on the forest floor. This leads to serious soil erosion and depletion of soil moisture. The most serious problem with regard to gardening, particularly of pineapple, citrus fruits, and some root crops such as ginger and turmeric, is the direct exposure of soil surface to heavy downpour and surface run-off. This results in top soil erosion, which not only leads to a gradually diminishing harvest of crops, but ultimately renders the land virtually useless for cultivation or plantation purposes.

Bangladesh has lagged behind its neighbours in the promotion of watershed management largely because the subject has failed to receive adequate attention from relevant policy makers and major international development partners. The reported increase in sedimentation and soil erosion in the CHTs, however, has significantly increased the level of concern in the government. The Forestry Department is planning to introduce participatory agro-forestry in the degraded land through adopting cropping models that would involve cultivation of crops by exposure of surface soil between rows of trees.

The key focus of this study identification of indigenous resource conservation and livelihood techniques. The system is examined from a holistic point of view that includes biophysical and socio-politico-cultural dimensions. The study carefully evaluates and compares the ethno-ecological knowledge and resource management practices in a VCF with those in government-rehabilitated areas. A comparative assessment on resource use between the VCF and the rehabilitated communities has been conducted and impacts on watershed conservation and local livelihoods have been examined. Existing plantation establishment or forest management techniques are also compared.

The indigenous techniques of *jhum* cultivation such as terracing, minimum tillage, controlled burning of debris, mulching and gully control through vegetative cover appeared to have a time-tested and proven positive impact on soil and water conservation. The presence of good understorey vegetation, which includes many medicinal herbs is the primary indicator of good site conditions where they prevail in the VCF areas. Harvesting of forest products from the VCFs is only permitted by village leaders for internal use, and not for commercial sale. One striking example of plant conservation is that only the local *kabiraj* or medicine men who treat the sick are permitted to enter VCFs for collection of medicinal herbs. Generally people in the VCF communities have been found to be meticulous in gathering forest produce or hunting animals. They do not harvest or hunt anything in short supply and they strictly maintain seasonality

in harvesting. Respondents who were familiar with 'Sloping Agricultural Land Technology' or 'SALT' appeared to have shown interest in this as it helps formation of natural terraces through gradual stabilization of soil as farming progresses in contoured lines of hedgerows among forest trees. Therefore, if VCF areas remain protected and the communities that look after them are given better living conditions, for example through introduction of suitable farming technology, the hilly watersheds may in parts save themselves from further degradation. The sustainability of VCFs is threatened by population pressure, scarcity of agricultural land etc. These threats will have to be met primarily by the villagers themselves, although external agencies can extend a helping hand. Awareness and capacity building seem to be the important measures for helping sustainability of the VCFs. Ultimately, the tenurial security of the VCFs will be crucial in their long-term sustenance and will require the political support of the government.

Day 2, Session B, Paper 9

People and Resource Dynamic Project – Participatory Options for Sustainable Sloping Land Management in Five Watersheds in the Himalayas

Isabelle Providoli, Sanjeev Bhuchar, Roger White and Keshar Man Sthapit

International Centre for Integrated Mountain Development (ICIMOD), GPO Box 3226, Kathmandu, Nepal

The Hindu Kush-Himalayas happens to be one of the most fragile mountain ranges in the world. The range is suffering from increasing population pressure, especially in the 'middle mountains', where catchments are degrading rapidly due to unsustainable land management practices. The rehabilitation and sustainable management of these upland catchments is seen as not only important, but also challenging for all mountain societies and governments in the region, and for associated downstream communities.

In response to this concern the *People and Resource Dynamics Project* – PARDYP (1996-2006) was launched, with a focus on natural resource degradation in the 'middle mountains' of the Himalayas. PARDYP is a research for development project, in particular addressing marginalization of mountain farmers, the use and availability of water, issues on land and forest degradation and declining soil fertility, carrying capacities of the resource base, the speed of regeneration, and the ability of the natural environment to support the growing needs of the increasing population. The main objectives were to 1) find options and approaches to support sustainable and equitable access to water, land, and forests; 2) improve productivity of farming systems; 3) increase productivity of agricultural land; and 4) test and disseminate improved water management options. The project operated in five middle mountain watersheds across the range - two in Nepal, and one each in China, India and Pakistan.

The first phase of PARDYP (Oct 1996 - Sept 1999) had a strong biophysical research dimension. The two following phases (Oct 1999 - Dec 2002; Jan 2003 - June 2006) shifted to stronger socio-economic and community-based approaches, focusing on development through community-based decision-making processes and the development of relevant methodologies. These participatory approaches were mainly participatory applied research (PAR), participatory technology development (PTD), and community-based management of natural resources. The basic idea was to test, develop and promote simple options for sustainable land management, while building on local knowledge and practices involving local people. The key approach was social empowerment through awareness raising, involvement of local institutions and users, encouraging women involvement, user committee formulation and technical backstopping.

Initial baseline surveys of the watersheds helped in understanding major socio-economic and biophysical constraints to sustainable crop production and improved livelihoods. Many of the issues thought to be crucial at the beginning of the project, such as flooding and soil erosion, turned out to be of less importance than issues such as loss of soil fertility, and reduced low season flows of water. It was recognized that to be able to promote community participation to address these problems, it was necessary to provide tangible economic benefits to individual farmers and families. To improve farming systems and agriculture productivity, an integrated approach had to be kept in mind and the farming and market systems had to be properly understood. Examples from Pakistan and Nepal showed that by learning and applying black plastic and vermi-culture composting methods, and by using bio-fertilizer and improved seed quality, both soil quality and crop production could be increased. One particularly successful option for farmers was to take advantage of a niche by producing off-season vegetables using simplified poly-houses/poly-pits and kitchen gardening.

Scarcity of water in the dry season is an increasing problem as demand exceeds supply. Case studies from India and Nepal showed that communities, if made aware of the possibilities and given the confidence to develop their ideas, can improve and effectively manage water sources. Effective water management was achieved by strengthening community-based water management. The options for increasing water availability were pitcher irrigation, eye-brow terraces, terracing and re-vegetation. In addition, water harvesting was improved by building open storage ponds and tanks. Improved methods of water management and supply are being adopted, often associated with another enterprise. For example, storage ponds are combined with fish farming to provide lucrative extra income for farmers. Other successful water supply methods include pipe tap systems, spring boxes, dug wells, and roof-water harvesting. To improve water use efficiency new irrigation methods such as drip and sprinkler irrigation, SRI (system of rice intensification) and lining of canals have been used. In Nepal, the drip irrigation was very successful for bitter gourd production.

The PARDYP project identified the centrality of people and the factors influencing their land use systems, along with the holistic treatment of natural resources, as an essential step in management of watersheds as an integrated pool of resources. PARDYP has stimulated local leadership and provided 'missing' technical know-how. Furthermore, PARDYP success has been largely due to the way it has built up the credibility of its research teams with local people so that these

people are willing to trust the teams' recommendations, and to try out new ideas and methods. The major lesson learnt in this project is that the opinions of land users govern whether new technologies and approaches are accepted. Therefore, the approaches are as important as technologies and peoples' perception matters strongly. This explains the need for a focus on capacity building. On-site training and farmer-to-farmer visits must be organized and working with the farmers is the key: market strategies have to be developed together with the farmers. In addition, local institutions have to be strengthened, or created if they do not yet exist.

A big challenge at the end of every project is the promotion of knowledge-sharing and the encouragement of cross-fertilization of ideas. In the case of the PARDYP project, this means with other middle mountain inhabitants and practitioners in the region. One outreach strategy was to organize farmers' days and cross-visits between farmers, as done in Pakistan. Furthermore, a national dissemination workshop was held in Nepal. On a bigger scale, one way to promote knowledge sharing is through networks like the WOCAT (World Overview of Conservation, Approaches and Technologies) database. This database has a subnet called HIMCAT (Himalayan Conservation, Approaches and Technologies) that includes an extranet platform for the Himalaya region in which good soil and water conservation practices can be documented. In the case of Nepal, ten technologies and four approaches from the PARDYP project are documented in the WOCAT database. Furthermore, ICIMOD is developing training packages on the lessons learned through PARDYP to share with a bigger audience.

<i>Day 2, Session B, Paper 10</i>

Improving Management of Natural Resources on Sloping Lands for Sustainable Agricultural Production in Northern Vietnam

Nguyen Van Thang¹, S. Wani², Tran Dinh Long¹ and Nguyen Thi Chinh¹

1 Legume Research and Development Center (LRDC) Vietnam Academy of Agricultural Sciences, Hanoi

2 International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Andhra Pradesh, India

Mountainous areas are fragile and highly prone to erosion. If they are not managed properly, their natural resource base will be rapidly destroyed. Nevertheless, they have great potential for agriculture and forestry production and play a significant role in food security, income generation, and the socio-economic and political life of Vietnamese society. The key constraints to development in such regions are the lack of a development paradigm tailored to their specific conditions, poor infrastructure, remoteness, low biological productivity, environmental degradation, disease and health problems, and population increase. Technologies suitable for diverse niches of agro-ecological and socio-economic conditions are urgently needed. These could facilitate rapid and sustainable agricultural development, food security, improve income for the poor, and environment protection.

The LRDC and ICRISAT started collaborative research in 1999 with financial support from the Asian Development Bank. The aim is to develop sustainable natural resource management strategies for improving the livelihoods of upland farmers in northern Vietnam through an integrated watershed approach. This paper summarizes research work carried out over the past six years, including selection of benchmark sites, base line surveys, establishment of monitoring devices, and various interventions in cropping system intensification and diversification, land, water and fertility management, and income generation activities. Research and application of watershed-based integrated natural resource management technologies offer excellent opportunities for crop diversification and intensification to meet market orientation. They can thus help sustain food production at higher levels, improve soil health, recharge aquifers, and enhance household income through better livelihoods in the mountainous regions of northern Vietnam.

Day 2, Session B, Paper 11

Economic Analysis of Improved Smallholder Rubber Agroforestry Systems in West Kalimantan, Indonesia - Implications for Rubber Development

Yuliana Cahya Wulan, Suseno Budidarsono and Laxman Joshi
World Agroforestry Centre (ICRAF)

Farm budget analysis is a tool for understanding the economic performance of agriculture practice. It can assess the impact of technology interventions and price and policy changes. This helps identify the strengths and weaknesses of farm operations. In farm budget analysis, the 'Olympe' modeling software developed by a consortium of INRA/CIRAD/IAMM provides an efficient way of constructing farm budgets, thereby analyzing and modeling farm systems performance. Olympe gives a comprehensive overview of farmer situations and links to technical innovations and practices. A range of analyses can be carried out, such as on the economic impact of technical choice, the effect of climatic or economic uncertainty, or the environmental impact of land-use options.

The Olympe application was used to analyze the impact of new Rubber Agroforestry Systems (RAS technology) in Sanggau, West Kalimantan, Indonesia. RAS technologies are developed for adoption by smallholder farmers with limited resources. Data on inputs and outputs for various RAS technologies, plus for monoculture rubber and oil palm, were collected and analyzed using the Olympe approach. The results show that while the RAS technology requires more capital input, both returns on labour and on land are much higher than they are from traditional systems. The return on labour from RAS technologies can be higher than that of intensive monoculture rubber, which requires much higher capital and input. The economic and environmental advantages of diversified RAS technologies over monoculture rubber and oil palm are evident.

Incentives in Enhancing Sustainable Land Management

Suraphol Chandrapatya

Senior Agricultural Extension and Development Specialist, IWMI, Phnom Penh

s.chandrapatya@cgiar.org

Most development projects provide incentives of various forms to target clients. This is a common practice since there is a need to demonstrate visible project outputs to donors within a predetermined timeframe. Incentives are often a prerequisite demanded by the target community, due to the mode in which previous development projects operated. The IWMI's *Sustainable Management of Sloping Lands* project (2001-2004), together with its participating organizations, used incentives such as seeds, seedlings, planting materials, a training and capacity-building program, technical guidance and support, trust funds, revolving funds and social recognition (certificates). The purpose was to enhance widespread adoption of soil and water conservation measures by small-scale upland farmers as an integral part of their farming systems.

This paper is based on an assessment of incentives in the above IWMI project to determine their impact on farmers, both individually and in groups, in practicing and replicating upland conservation measures after project termination. A challenging issue is whether incentives are necessary in enhancing adoption of integrated upland conservation farming. If yes, what form should the incentive, strategies and policy take? Project documents were reviewed and an open-ended questionnaire completed with project partners, whilst a survey tool/interview schedule was used for farmer-beneficiaries in the participating countries (China, Indonesia, the Lao PDR, Malaysia, the Philippines, Thailand and Vietnam). The results of the study revealed that project partners provide incentives based on their belief that conservation measures had limitations in tangible direct benefits (yield and income) in the short term, and that this resulted in reluctance among farmers to adopt such measures. For example, one of the conservation tools being promoted in the upland areas is the planting of hedgerows and perennial crops that are relatively difficult for small-scale farmers to afford.

Most farmers in upland areas live below the poverty line and the IWMI project experienced difficulty in encouraging them to make additional investment in conservation farming. Therefore, planting materials for hedgerows and perennial trees were provided as a one-off commitment that was deemed more appropriate than providing subsidies in every cropping season, every year. This was done through consultative meetings and other participatory methods such as PRA, SWOT analysis and Mind Mapping, to determine farmer and community needs, goals and preferences. However, it should be noted that the incentives provided by the project were not for 'persuasion' or to 'buy' participation, but rather for the 'enhanced self-reliance' of farmers who are resource-poor. The incentives were not regarded as 'gifts' that made the farmers 'receivers' or 'takers' but were rather designed to enhance their ability in carrying

out integrated conservation farming. Incentive strategies and policies to facilitate the adoption of conservation practices should be provided as necessary for farmers who normally are resource-poor and cannot afford costs associated with the adoption of conservation farming. However, incentives in the form of wages, grants, subsidies and loans should be avoided: a cost-sharing approach should be promoted with participatory extension. Training and capacity building (non-monetary and human resource development) programs and technical support are considered the best incentives for promoting self-reliance, responsibility and ownership among farmers and cohesiveness in the community. Social and cultural acceptability are perceived to be more important than the economic viability of conservation farming in some specific areas where farmers face problems of insecure land tenure and food insecurity. Information, education and communication (IEC) and participatory monitoring and evaluation (PME) are important supporting mechanisms for productive and sustainable integrated conservation farming.

It can be concluded that direct incentives (*in cash*, e.g. wages, subsidies and loans, and *in kind* through the provision of food aid, seeds, seedlings etc.) do not assure participation or adoption. However, indirect incentives (extension services, technical guidance and support, training and capacity building programs, social recognition etc.) promote desirable human behavioral changes which result in empowered human capital. Due to the low economic status of farmers, incentives cannot be avoid in enhancing integrated conservation farming. Land degradation in upland areas should be the responsibility of the nation and people, not only upland farmers. Therefore using incentives to encourage adoption of conservatory practices by upland farmers may be appropriate, since such practices decrease erosion in upstream areas and reduce sedimentation downstream, thereby bringing positive benefits to the wider community.

<i>Day 2, Session B, Paper 13</i>

Palong and Black Lahu Local Ecological Knowledge about the Sustainability of Forest Watershed Management and Agroforestry Ecosystems

Chalathon Choocharoen¹, Pornchai Preechapanya² and Andreas Neef¹

1 The Uplands Program, Chiang Mai

2 Queen Sirikit Botanic Garden, Chiang Mai

choocharoen@yahoo.com; pcpc@loxinfo.co.th; neef@uni-hohenheim.de

For decades the land-use practices of ethnic minority people in the uplands of northern Thailand have been described by many scientists and policy-makers as unsustainable and blamed for causing degradation of natural forests and watershed functions. Recent flashfloods, landslides and droughts affecting the lowland areas have also been associated with upland agriculture. The objectives of this case study, carried out in Ban Nor Lae and Ban Khob Dong,

Fang District, Chiang Mai Province, were to scrutinize these claims by exploring the knowledge of Palong and Black Lahu people on sustainable forest watershed management, and by contrasting their local ecological knowledge systems with scientific findings.

Key informants and randomly selected villagers were interviewed by means of semi-structured questionnaires. Selected Participatory Rural Appraisal tools, such as mapping and transects, were also employed to collect information. The elicited information was recorded in a durable and accessible way by the Agro-Ecological Knowledge Toolkit. This toolkit helped the study team create text statements and to determine causal relationships through diagrams and hierarchies.

Based on the collected information, the traditional agricultural systems of the Palong and Black Lahu can be divided into three categories: swidden cultivation, paddy fields and sylvo-pastoral system. Mixed orchards were only recently introduced as a major innovation in the farming system, partly on the initiative of the Royal Project Station in Angkhang. Lahu farmers in Ban Khob Dong – commonly labeled ‘pioneer shifting cultivators’ in Thailand – have developed a sustainable system of paddy rice terraces. They supplement their diet through crops grown in homegardens, thus enabling them to base their livelihoods on a low external-input system. The Palong of Ban Nor Lae – who very recently settled in the Thai-Myanmar border region and face a shortage of water – are not able to grow paddy rice, but instead have developed a sylvo-pastoral system, mainly raising cattle, horses and mules. Apart from providing a major source of family income, raising animals in the sylvo-pastoral and mixed orchard systems indirectly distributes the seeds of valuable multi-purpose trees and increases soil fertility through animal manure. On the other hand, scientists have found that the trampling of animals decreases soil infiltration and the water uptake of roots, thus reducing the growth rate of crops. Villagers have also stated that livestock trampling decreases soil porosity, thus increasing surface water runoff. These tradeoffs of animal husbandry can be countered by limiting livestock numbers and by regulating grazing activities in mixed orchard systems according to season. As regards forest watershed management, Palong villagers conserve tree species that store a lot of water and gradually release it to the creeks. In areas where some villagers have cut these trees, the Palong observe a decrease of the groundwater table. As a result they have stepped up their conservation efforts to ensure a continuous water supply for their village.

This study demonstrated that Local Ecological Knowledge collected from key informants and ordinary villagers was explanatory and of technical relevance. The knowledge and practices of ethnic minority groups contrast with the simplified and negative image that mainstream society tends to construct for highland agricultural systems. It can be concluded that if this knowledge is integrated into scientific analysis and policy-making it can provide a useful resource for improving the sustainability of highland watershed agro-ecosystems.

Farming System Options for Poverty Alleviation on Northern Lao Sloping Lands: How Pro-Poor Are They?

B.M. Calub¹ and S. Mahathirath²

1 Integrated Farming Systems and Agricultural Extension Division, University of the Philippines, Los Baños

2 Lao Swedish Upland Agriculture and Forestry Research Programme, NAFRI, Vientiane

bmcclub@gmail.com

Sustainable development of sloping lands in the Lao PDR requires striking a balance between natural resource conservation and poverty alleviation among upland communities. Participatory on-farm research could be one area where farmers, researchers and extension staff jointly develop pro-poor technology alternatives to shifting cultivation on sloping lands.

Responding to the National Growth and Poverty Eradication Strategy of the Lao government and to the UN Millennium Development Goals, the Lao-Swedish Upland Agriculture and Forestry Research Program (LSUAFRP) evaluated 12 farming system options in its nine project villages in Phonsay district, Luang Prabang and Namo district, Oudomxay in 2004. On-farm research (OFR) was used to assess the performance of each technology option, specifically in terms of productivity, profitability, sustainability and acceptability to farmers. Through these farm-tested technology options, LSUAFRP aims to alleviate poverty and improve the livelihoods of participating households. But how pro-poor was the research process? This paper aims to share the experiences and lessons learned by LSUAFRP in terms of ensuring a pro-poor focus in its research and development activities. It highlights the guiding philosophies and methodological processes that evolved in implementing the program.

The LSUAFRP was assigned to two out of the ten priority poorest districts classified under the National Growth and Poverty Eradication Strategy. Because of this, the implied assumption was that the program therefore was addressing the needs of the poor. At the end of the 2004-2005 cropping season, Participatory Monitoring and Evaluation revealed positive responses. Many participating farmers said they liked the new technologies because compared to their traditional farming methods, these gave higher yields, healthier livestock, diversified products for home consumption, cash from the sale of products, and reduced labor demands - especially among women. Recent consultations by the Sida- (Swedish International Development and Cooperation Agency) commissioned OPTO International AB Assessment Team revealed that "women farmers in participating households considered that the NAFRI (LSUAFRP) technologies had not imposed unfair burdens and saw the activities as new opportunities for improving living conditions or providing for their children's future."

In the 2004 cropping season, 26 out of 163 participating farmers belonged to the poorest households. In 2005, more poor households (59 out of 250) participated in the on-farm

research. In late 2005, a Participatory Poverty Assessment was conducted in all project villages in order to prioritize those farming and livelihood concerns of the poorest women and men that can be addressed by research. The aim was to understand their conditions more deeply and, jointly with them, to be able to fine-tune the various farming system options available under the constraints they face.

It is implicit that LSUAFRP activities are reaching the poorest and opening up opportunities for income generation and food security in the project areas. As a next step, LSUAFRP explored the formation of farmer groups to expand the coverage and benefits derived from the most promising technologies. This was initiated particularly among women duck raisers in Ban Thapho, Phonsay district and among goat raisers in Ban Saysamphan, Namo district.

The LSUAFRP faced various challenges. Many lessons were learned in terms of addressing poverty issues. The team followed an iterative action-research process of planning, implementation, evaluation and reflection, followed by another cycle of re-planning, modifying implementation strategies, re-evaluating, reflection and so on. The aim was to seek ways of doing things better, of improving in the next cycle, of responding to emerging challenges and of being pro-active. This iterative process was also participatory. Systematic methods purposively encouraged farmers to monitor and evaluate their on-farm trials together with the OFR teams of researchers and district extension staff. Mid-level research managers, senior program officers and project staff conducted periodic reviews and reflections to assess performance and make strategic adjustments as needed. The program itself is regularly assessed by external evaluation teams. The strong pro-poor policies of the donor agency, Sida, strengthened the poverty alleviation focus of the program. In response to the External Program Evaluators, LSUAFRP is addressing the need to present more quantitative and qualitative parameters that would explicitly show program outputs, outcomes, effects and impacts on the poor, on other stakeholders and on gender.

Poverty is one of its root causes of degradation of sloping lands and watersheds. Poverty by itself is a complex issue and solutions to reduce it are not simple. Alleviating poverty is like aiming at a moving target. The ability to diagnose and respond to changes in the bio-physical, social, economic, policy and institutional environment at village, district, provincial and national levels are challenges that any poverty alleviation program needs to face. There are no magic recipes for assured success but systematic documentation and assessment of experiences is imperative. Learning the lessons and communicating research results to policy and decision makers will help guide future planning and actions.

Women's Role in Use and Management of Rangeland Resources in the Semi-Arid Mountains of Pakistan: A Case Study from Karak District

Iffat Tabassum

Department of Geography, University of Peshawar, Pakistan.

Mountains occupy almost 60% of the area of Pakistan, with over 90% of them lying in arid to semi-arid regions. Agricultural land is limited either because of aridity or relief. Hence rangeland is the most widely-used land type in Pakistan.

Forests and rangelands provide important economic resources for the inhabitants of mountains and surrounding areas. There are a number of groups who are heavily dependent on forests and rangelands. Marginal groups, including landless, tenant and subsistence farmers; waged workers; nomads, and women depend on forests and rangelands to meet their subsistence needs and to generate additional income. Such groups gather a wide variety of products from commons, state forests and private marginal lands for both personal use and for sale. These include food, fuel, fodder, manure, medicinal herbs, oils, materials for house building and handicrafts, resin, gum and honey. Most of the rangelands are situated in community land, locally known as *shamilat*. There is no problem on common grazing land as long as herd number do not exceed the carrying capacity of the rangeland. The problems arise when this land is over exploited.

Mountain women have traditionally engaged in small-scale entrepreneurial activities based on the use of natural resources. In the study area, although their role in household economy is under-enumerated in official statistics, case studies have shown that women are traditionally engaged in various income-generating activities based on the use of natural resources such as grass and cutting fuel wood. They use the rangeland resources to generate household income and for their own consumption. In recent years environmental degradation, poor resource management and increased migration of men to the plains have added to the already high rate of food insecurity and the workload of women has drastically increased. In past, people in the semi-arid mountain regions knew how to manage their limited natural resources equitably and in a flexible way. However, in recent years rapid population growth, technological development, modern agricultural methods, better communication and transportation facilities have made it increasingly difficult for communities to rely entirely on their indigenous knowledge to safeguard the local environment. This has negative effects on both women and natural environment.

In spite of its great importance to the economy, rangeland management has largely remained neglected in the region. This is partially due to a lack of coordination and of clearly demarcated areas of responsibility between communities and line agencies. However, an even greater

problem is the lack of knowledge, research and technical expertise needed for rational use and management of these resources. Often decisions are made about natural resources without any input from women, who have an intimate knowledge, relationship and vested interest in the land and environment around them.

The main objective of this paper was to develop the methodology for collection of information about the users of these resources and to provide baseline data for future research. A case study was conducted in mountainous northwest Pakistan to find the key factors responsible for the higher dependency of women on rangeland products and their role in use and management of this resource. Primary data about the users was collected through questionnaires with added interviews. Information collected about the uses, management strategies, present status of resources and changes that have occurred during the recent past was crosschecked by group discussion with the elders of the study area.

Results indicate that the low socio-economic status of women is one of the major factors in their high dependency on rangeland resources. Many of these resources have declined in quality and quantity in the study area, though some species have reappeared after a long absence, due to limited use following the availability of alternatives. Women generate considerable cash income from these resources.

Generally, the very poor depend more on forest and rangeland resources than other groups. Poverty leads to dependency on grazing, fodder collection and woodcutting. Social status, low literacy levels and lack of awareness of the consequences of environmental degradation are important factors that have led to overgrazing and the widespread deterioration of rangeland in the area. Disintegration of local social institutions following changes in indigenous communities has also resulted in the mismanagement of the rangeland. As is commonly recognized, reforestation and rangeland rehabilitation cannot occur without the cooperation and participation of local users. Dialogue enables local communities and groups of users to make rational decisions about the optimal use of land and other natural resources. Normally the rights and subsistence needs of marginalized groups are the least protected, because such users are not given the recognition and protection given to those who hold some form of land tenure or ownership rights. Before sustainable development practices can be successful, poor forest-dependent communities need to be encouraged to protect forest and rangeland resources.

The key to sustainable development and natural resource management is to integrate marginalized rural people into the formal economy. The majority of such people are women from lower socio-economic groups in the study area. They can only be integrated if they are provided with alternate employment opportunities through skill development programs and micro financing. Moreover, their indigenous knowledge can be integrated as a resource in planning process. Sustainable forest policy must therefore consider broader social and gender issues such as poverty alleviation, women's rights and participation, and land ownership and tenure.

Agro-Enterprise Strategies for Linking Upland Farmers to Markets

John G. Connell, Ounkeo Pathammavong and Thiphavong Boupcha

SADU Laos, CIAT in Asia; j.connell@cgiar.org

Remote upland areas in the Lao PDR and Vietnam suffer from poor market linkages and a weak agro-enterprise sector. These are major obstacles to poverty reduction. The *Smallscale Agro-Enterprise Development for the Uplands* (SADU) project, has begun to pilot an agro-enterprise development process (AEDP) in districts of Laos and Vietnam. Activities have now expanded to 11 districts in five provinces across both countries, working with a range of products including grains, livestock and NTFPs.

In most cases strategies to improve livelihoods and make them sustainable in upland areas have relied heavily on improved technologies. Implicitly, this has a number of limitations:

- Extension processes are slow at the best of times, typically taking three to five years to establish a new technology. In the diverse environment of the uplands, new technologies must often be transformed and integrated into new production systems before they can be applied widely;
- Many products grown by farmers are minor products, or NTFPs. With no 'improved technology' for these, development workers have no entry point to improve them, leaving their potential untapped.

The AEDP provides a mechanism that can achieve impacts within a single season. Through market interventions it provides entry points to address development of previously neglected minor products. In the case of NTFPs, this can lead to domestication of products, thus providing an alternative to shifting cultivation. The AEDP first identifies which local products have robust market demand. Secondly, through participatory market chain analysis, weaknesses along the chain that have inhibited trade and production are identified. While there can be no prescription for the design of action plans, SADU recognizes that there is a hierarchy of interventions which can guide practitioners towards the most effective ways to stimulate change.

Mechanisms for scaling-out have also been identified. These include; (a) engaging the private sector to provide support to farmers for products with unsatisfied market demand; (b) using the *kum ban pattana* (a new sub-district level structure in the Lao PDR) as a forum for farmers and traders, in effect creating a face-to-face MIS; and (c) stimulating the emergence of new service providers. This last provides a powerful mechanism for dynamic scaling-up, as new entrepreneurs strive to develop their own enterprises and clientele.

Opportunities with paper mulberry bark, an NTFP, are particularly interesting for upland development. About 10,000 tonnes of what is locally known as *porsaa* are collected annually by

20,000 households in the north of Laos and exported as an ungraded raw material to Thailand. This Lao supply, with a total value of \$5m, comprises about 70% of the *porsaa* processed in Thailand. From there it is exported as (a) graded bark; (b) specialty papers and (c) handicrafts, and generates approximately \$50m. There is clearly an opportunity for Laos to gain a share of this added value.

Through the AEDP the main constraints in the *porsaa* trade have been identified as time-consuming post-harvest technologies and the overly-competitive buying habits of local traders, who undermine initiatives to improve grades and quality. The focus of action has thus been on the traders. Trader workshops and fact-finding missions are now leading to coherent purchase procedures, and have identified new markets for semi-processed *porsaa*. As these new opportunities mature, it will be in traders' own interest to ensure supply by supporting farmers in establishment of *porsaa* plantations and by introducing labor-saving post-harvest technologies.

Porsaa illustrates the potential for domestication of NTFPs as an alternative to shifting cultivation. The product can provide higher income than cultivation of commodities such as maize and is far more environmentally sound. Such opportunities could not have been identified or addressed through purely technical interventions. Similar application of the AEDP could be applied to a range of other NTFPs (broom grass, cardamom, sticklac etc.) which are currently exported as raw products. Together, domestication of these NTFPs could provide an alternative for significant areas of shifting cultivation. Domesticated NTFPs would also be niche products in which Laos could expect to maintain a competitive advantage, and at the same time, preserve its environment and culture.

Considered in a broader perspective, the AEDP provides a tool that area-based projects can use to identify local products with a market demand, and thus gain rapid impacts. The scaling-out strategies can be applied for most products, thus providing widespread and sustainable impact. As farmers scale up production to meet market demand, this will then generate demand for improved technologies, which were once the starting point. All this requires a review of our own project mindsets and development paradigms.

Watershed Conflict: Competition over Natural Resources in Northern Thailand

Nathan Badenoch, Apai Wanitpradit and Songphonsak Ratanawilailak

Unit for Social and Environmental Research, Faculty of Social Sciences, Chiang Mai University

Mae Chaem district of Chiang Mai province provides a window on the social complexity of resource competition. This area has been an area of concern for government policy since the 1960s, when official efforts to eradicate opium were supported by domestic and internationally funded watershed development projects. Crop substitution was successful in many areas of the district, and upland agriculture has continued its integration into regional and national markets.

Environmental concerns have followed closely on the heels of crop replacement. Cabbage, carrots, maize and shallots became common components of many upland livelihoods as the area under cash-crop cultivation increased sharply through the 1980s and 1990s. The common belief is that headwater forests were lost to permanent upland crops, disrupting hydrology at the local and regional levels while increasing rates of erosion and sedimentation. The result is a situation of wide-spread competition between upstream and downstream communities.

In recent years upland irrigation systems have been developed, enabling the cultivation of cash crops during the dry season. This has meant increased water demand in the uplands during the driest times. However, lowland agriculture is heavily dependent upon irrigation through the dry season as well, and data on actual environmental change is secondary to public perceptions. The situation is complicated by the ethnic composition of the region. Upstream areas are inhabited by Karen, Hmong and Lawa communities, with a diverse range of livelihood strategies supported by differing regimes of natural resource management. Northern Thai communities inhabit the downstream areas. Historically, relations between ethnic groups have experienced periods of both tension and cooperation, but watershed management and other conservation policies have tended to fuel the areas of conflict between upstream and downstream communities.

This paper draws on two main sources of information:

- Primary data from research in three sub-watersheds of Mae Chaem district – Mae Suk, Mae Khong Kha and Mae Hae watersheds;
- Secondary data from research and development projects in northern Thailand.

The analysis considers issues of scale and institutional response within the context of social diversity in an effort to understand the challenges of institutional adaptation and innovation.

What is watershed conflict? Tension between upstream and downstream communities is complex, and is often described in terms of ethnicity. However, there is a range of natural resource management issues at stake, involving forest, land, and water. Conflicts manifest themselves at different ecological scales and are driven by a number of social, economic and political factors.

Government policy has been largely ineffective in addressing environmental changes and social tensions at the watershed level. Community-based watershed management networks have proliferated throughout northern Thailand in response to these challenges. These multi-village networks are being formed at the sub-watershed level and have attempted to facilitate the negotiation of upstream-downstream competition. At the same time, a major effort is underway to establish a viable system of river basin organizations at larger scales.

The experience with watershed management networks has been mixed. Successful examples have been able to create platforms for negotiation and collaborative problem solving. Unsuccessful cases have been bogged down by lack of confidence and mutual trust, and difficulties in creating a legitimate institutional structure for negotiation. The challenge of matching multi-scale and cross-scale conflict with institutions at the appropriate scale has generally not been given adequate planning effort.

Findings from data collection and analysis in the three study sub-watersheds suggest that:

- There is an acute shortage of data on environmental change in upper tributary watersheds, which means that perceptions, prejudices and individual interests dominate the local discourse of conflict: *community-based data collection and external research can build a shared platform of traditional and scientific knowledge to support dialog.*
- Conceptualizing watershed conflict in ethnic terms can be problematic for understanding the socio-economic and political drivers of resource competition: *research on conflict in upper tributary watersheds should recognize the dynamic and complex reality of local livelihoods.*
- Watershed networks often do not recognize the complexity of conflict at multiple levels within the watershed: *there is a need for continuing research on how watershed conflict is embedded in multiple ecological and social systems.*
- Watershed networks often take the village as the basic unit of collaboration, but diversity within villages often creates difficulties for watershed-level activities: *in order to realize the potential of local institutions, research and policy should recognize and address the reality of diversity and tension within villages, e.g. by diversifying the range of local actors involved in governance processes.*

Land Degradation in the Sloping Uplands: Economic Drivers and Strategies for Promoting Sustainable Land Use

Sushil Pandey

Agricultural Economist, International Rice Research Institute

The use of unsustainable agricultural practices is an important factor contributing to soil erosion and land degradation in sloping uplands. In the humid tropics of Asia, farmers grow a range of subsistence crops in sloping and marginal uplands using practices that are highly erosive. In addition to reducing *in situ* productivity and sustainability, these practices also reduce the sustainability of agriculture through siltation and damage to irrigation infrastructures. Wider environmental impacts also occur in the form of reduced biodiversity, reduced ability of the ecosystem to regulate the stream flow, and reduced carbon sequestration.

The sustainable development of uplands in Asia poses important challenges. These upland areas are remote, and are mostly inhabited by ethnic minorities. The incidence of poverty in these areas is very high. Upland communities are caught up in a vicious circle of low food productivity, food insecurity, high incidence of poverty and environmental degradation (Figure 1).

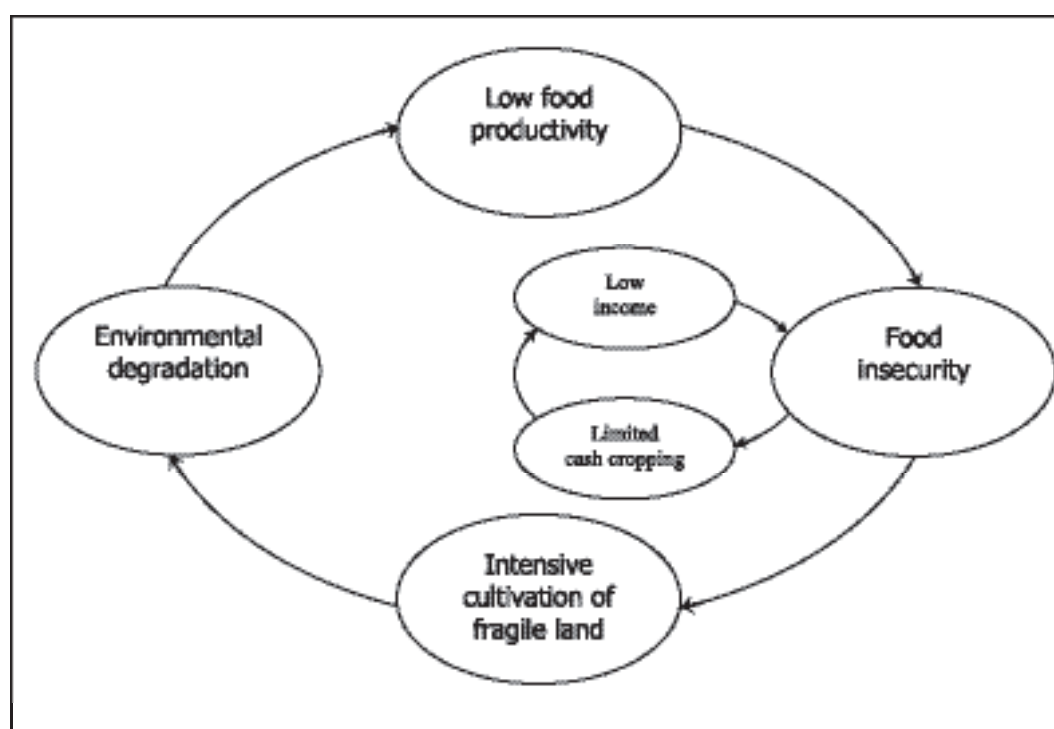


Figure 1. Vicious cycle of low productivity, food insecurity and environmental degradation

Rising population pressures, increasing land use restrictions, emerging opportunities for commercial agricultural production and tenure insecurity are some of the major drivers resulting in unsustainable use of land, and in land degradation in fragile sloping areas. The

paper provides an overview of the role of these broader ‘macro’ factors in determining the land-use practices in upper catchments. A simplified typology based on market access, population pressure and household resource endowments is developed and applied to describe the nature of transitions of agricultural land-use systems and the likely impact of such transitions on land degradation in the uplands of Southeast Asia. It is suggested that field-level interventions based on specific technologies for control of soil erosion are unlikely to be adopted unless they directly address farmers’ livelihood concerns in the context of ‘macro’ factors driving the land-use change. The literature abounds with field-level technologies that are proven to be scientifically sound, but farmers simply have not adopted them.

It is shown that, under certain conditions, soil conservation may be better achieved indirectly through approaches that reduce the intensification pressure in sloping land than directly through the promotion of specific field-level soil conservation technologies. A ‘landscape’ management approach, whereby interventions for food productivity enhancements are targeted to favorable parts of the landscape, is considered potentially effective for reducing the intensification pressure on fragile sloping lands. In the context of rice farming in Asian uplands, this implies concentrating efforts to increase rice productivity on lower slopes, terraces and valley bottoms, where yields are higher than in steeply-sloping fragile areas. An increase in the productivity of rice, a major staple in Asia, can be an important entry point for breaking the vicious circle, for providing options for income growth that are founded on household food security, and for inducing land-use changes that result in soil conservation at the landscape level (Figure 2).

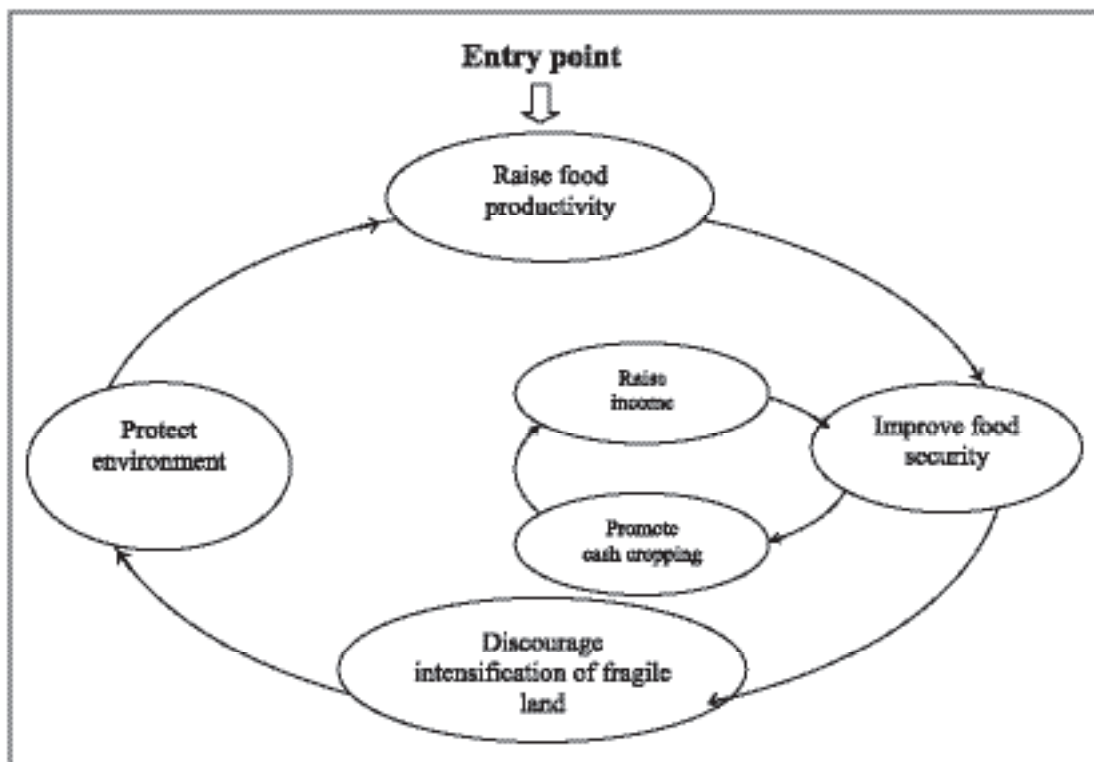


Figure 2. Rice research as an entry point in the process of converting the vicious cycle into a virtuous cycle

This concept of landscape management is applied to explain the transformation of upland agricultural production systems in Yunnan, northern Vietnam and northern Thailand. There is ample evidence that land-use changes which have taken place in these areas have resulted in an overall improvement in resource conservation while raising farmer incomes and improving household food security. Increased food productivity has played a critical role in initiating these broader changes in land use although several factors, including policy support, have also been important.

This paper also discusses application of this approach in an on-going research program in the context of rice-based systems on the sloping uplands of Laos and Vietnam. The research results indicate that there are now good opportunities to raise the productivity of rice substantially and thereby reduce the overall pressure to intensify the most marginal and erosion-prone areas for food production. These opportunities include not only the improved rice technologies that are now available, but also institutional progress that has been made in promoting community participation in planning and use of natural resources. Some of the preconditions for the success of such an approach are discussed along with environmental issues that might arise and potential interventions for addressing such concerns.

POSTER SESSION

Station 1: Soil erosion and land management focused research

Sustainable Watershed Management in Cultivated Sloping Lands

Orange, D.¹, Tran Duc Toan², Podwojewski, P.¹, Clément, F.³, Phan Ha Hai An⁴, Do Duy Phai², Nguyen Van Thiet², Pham Van Rinh², Nguyen Duy Phuong², Henry des Tureaux, T.¹, Huon, S.⁴ and Chu Thai Hoanh⁵

1 IRD (Research Institute for Development, France) and IWMI-SEA, posted in NISF, Hanoi, Vietnam

2 NISF (National Institute for Soils and Fertilizers), MARD, Hanoi, Vietnam

3 CLUWRR, University of Newcastle-upon-Tyne, England, seconded IRD

4 BIOEMCO, CNRS-University of Paris VI, France, seconded Faculty of Chemistry, Hanoi Sciences Univ.

5 IWMI-SEA (Int. Water Management Institute, Sri Lanka), Southeast Asia Office, Penang, Malaysia

Contact address: orange@ird.fr

This poster studies the impact of land-use change on soil loss from sloping lands, presenting research on biophysical processes and their environmental and economic consequences. Farming systems are also analysed to infer the driving forces behind farmer strategies and practices. The Vietnam MSEC research program works in a small agricultural experimental watershed of around 50 ha, northeast of Hanoi. The cultivated steep slopes have been equipped to assess water discharge and sediment loads. Soil erosion here has negative impacts on upstream and downstream communities. Increased sediment from these catchments reflects a loss of the fertile topsoil that farmers depend upon. In addition, increased sediment loads in streams and rivers have a negative impact on water quality and the longevity of water storage structures, both of which have significant economic and environmental implications.

From 2000 the predominant land-use feature has been changing from cassava to tree plantation, with the cassava area in the catchment declining from 40% in 2001 to less than 0.5% in 2004. The reasons for upland land-use change are complex, but always initially include soil fertility decline. With this decrease in area under crops, the opportunity has arisen to introduce a livestock component into the catchment. Over the past four years, the impact of *Bracharia ruziziensis* fodder, established under a no-tillage regime, has been evaluated with respect to its ability to reduce erosion. At the main outlet, annual soil loss recorded through bed load measurements decreased from 3.6 t.ha⁻¹.yr⁻¹ in 2001 to less than 0.3 t.ha⁻¹.yr⁻¹ by 2004, three years after trees were planted on around 20% of the total watershed area and a year after the forage was planted on 8.3% of the total area.

Land-use change also has a very clear impact in terms of water. Before 2003 the water budget was in deficit (i.e. water loss by surface runoff) but since 2004 the water budget has always been positive for the whole watershed, meaning that more water is being retained, mainly through infiltration. These conclusions form only a first part of our research studies on the processes of infiltration in association with rain and soil characteristics, vegetation cover, and soil microfauna. From 2005, fodders like *Avena strigosa* and *Panicum maximum* have been tested in three villages, integrating local knowledge on soil fertility management and erosion control. PLER modeling is used to simulate runoff and erosion in land-use and climate change scenarios. The overall aim is to stimulate the adoption of farming strategies that enhance water and soil quality, notably by development of fodder cropping, cattle raising and better fertilizer management in both uplands and lowlands.

Integrated Grass Planting and Cattle Fattening for Sustainable Erosion Control in Babon Subcatchment, Central Java, Indonesia

Kasdi Subagyo, T. Vadari and R.L. Watung

Many conservation technologies have been created, yet the implementation of these in upland farming is not yet sustainable. While technology adoption is widespread under the control of the project implementation, its sustainability is low unless incentives are provided by the project. In Indonesia, the planting grass to prevent soil erosion is familiar to most upland farmers. However, adoption of this technique is often low because it reduces the cultivated area and may be unsuccessful regardless of farmer involvement. Integrated grass planting and cattle fattening is a challenge for sustainable conservation practices.

This study has been conducted in Babon Subcatchment, Central Java. Integrated grass planting and cattle fattening has been tested in the catchments under a seasonal cropping system. This catchment covers 1.1 ha, with cassava and maize the major crops. The dominant soil is Andic Eutropepts. The average slope is 46%, which has been reduced by introducing bench terrace. Fodder grass was planted on about 60% of the area in December 2001 in integration with a cattle fattening program. Since late 1999, a V-notch gauging weir with Automatic Water Level Recorder (AWLR), staff gauge (manual water level recorder), and sediment trap has been installed to record soil loss through erosion. The AWLR was set to record water level at five minute intervals.

Results showed that the use of Benggala grass (*Panicum maximum*) for erosion control resulted in 50% lower sediment yields in the first year and almost 90% in the second year (Figure 1).

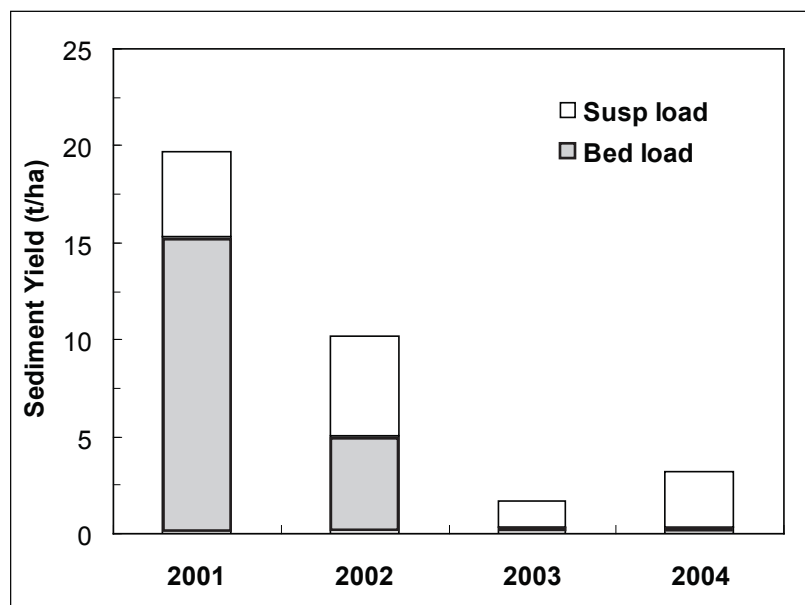


Figure 1. Change of sediment yield in the catchment under seasonal cropping system, as affected by grass planting

Since cattle provide an additional income for farmers, grass planting is well accepted. However, take up of grass planting was initially low due to availability of wild grass and the reduction in food crop area caused by grass planting. The solution was to plant grasses on terrace lips or on alternate terraces. Economic valuation has shown that before the introducing this technology, farmer income was US\$372.55 per year, almost equal to expenditure. Additional net income from cattle weight gain varies from \$8 to \$14 per month (Table 1).

Table 1. Additional farmer's income based on cattle weight gain

Farmer	Cattle weight (kg)			45% Carcass weight (kg)	Additional income range (US\$/month)	
	14/2/02	17/10/02	Additional weight		Gross income	Net income
Kasnin	240	370	130	58.50	21.13	14.13
Warsono	210	341	131	58.95	21.29	14.29
Muhyani	215	320	105	47.25	17.06	10.06
Supar	248	343	95	42.75	15.44	8.44

Source: Watung *et al.* (2003)

According to an earlier study each farmer needs at least four head to increase income by raising cattle. The daily fodder requirement is approximately 10% of cattle weight. Each family farms an average of 0.03 ha, which can supply about 570 kg of grass per month. Fodder requirement is given in Figure 1, assuming an initial cattle weight of 200 kg per beast, with a required growth of 0.4 kg per day and a daily fodder of 10% of animal weight: 20 kg of fresh grass. The amount of fodder required was fulfilled by a combination of natural grass, introduced grass and rice straw. Introduced grass was assumed as an average of 570 kg per month based production in 2003, when it was harvested twice a month from 1000 m² of upland. The daily optimum weight of 30 kg of natural grass can be collected by farmers, usually woman, around the surrounding area i.e. common land, estate crops land, and paddy fields. Since the income of farmers can be increased and the effectiveness of erosion control is significant, grass planting for erosion control has good potential for adoption.

Soil Fertility in Slash-and-Burn Systems in the Hills of Northern Laos

Koji Watabe¹, Junichi Kashiwagi¹, Yukiyo Yamamoto² and Kongkeo Phachomphon³

1 Graduate School of Agriculture, Hokkaido University, Japan

2 Japan International Research Center for Agricultural Sciences

3 NAFRI

For a long time slash-and-burn agriculture has been the major farming system in northern Laos. In recent years, however, government policies recommending that farmers cultivate limited areas have resulted in a shortening of fallow periods. This reduction in fallow length has led to soil degradation under these slash-and-burn systems. Our objective was to clarify soil chemical changes according to landscape and during the farming cycle, and to thus deduce the factors limiting crop production.

The study site was located about 30 km southeast of Luang Prabang in northern Laos. The average yearly rainfall in Luang Prabang is 1,248 mm, and 80% of the rainfall arrives in the rainy season (May to September). The major crop is upland rice cultivated by slash-and-burn agriculture on sloping land. At the end of the dry season, farmers cut down vegetation and burn it on the ground. After burning, they dig small holes with dibble sticks and plant the seed without the use of tillage or fertilizer. A single crop is usually followed by two or three years of fallow. Our field surveys were carried out in September 2004 to March 2005. The eight study plots were selected by yield, land use, and topography. In each plot, soil samples were collected from every soil horizon to a 100-cm depth. Soil samples were air-dried and sent to Hokkaido University in Japan for chemical and fundamental physical analysis. The chemical analyses performed were: pH (1:2.5 H₂O), EC (1:5 H₂O), total-C, and total-N (T-C, T-N; dry combustion method), extractable P (Bray2), extractable cations (extraction with N-NH₄OAc at pH 7; K and Na measured by flame photometer, and Ca and Mg by atomic absorption photometer), and cation exchange capacity (CEC; determined with N-NH₄OAc at pH 7).

In the six months after cropping (September 2004 to March 2005) the concentrations of extractable cations and extractable P decreased in the 0 to 25-cm-depth layer at the footslope position of sloping fields. This decline was caused by leaching and uptake by plants. T-C and T-N also decreased at the same depth (Figure 1). However, in other sloping fields after 24 months of fallow, T-C and T-N concentrations increased over the same period (Figure 2). It was suggested that soil organic matter (SOM) concentrations decreased with continuous decomposition during the early fallow phase, but a few years later they had increased owing to the addition of plant residues.

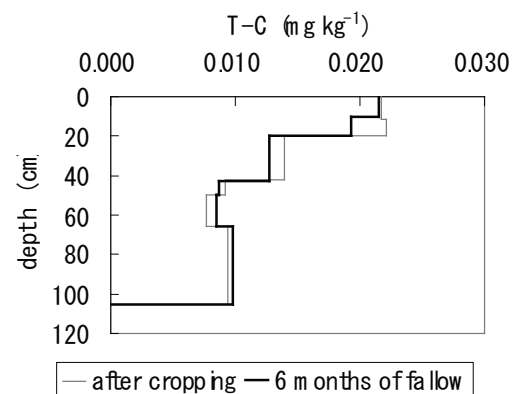
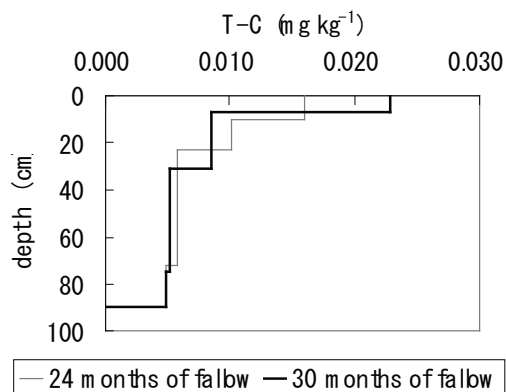


Figure 1



After burning, the concentrations of extractable cations and P at a depth of 0 to 25 cm were larger than in the deep soil layer (Figure 3). Burning provided nutrients only to the soil surface via the ash.

Figure 2

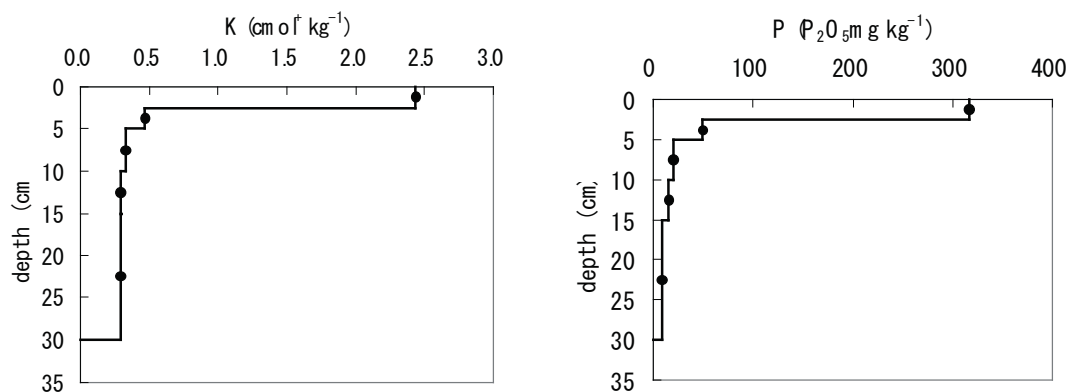


Figure 3. Distributions of K and P after a burning event

In the field with the lowest productivity, soil chemical properties were compared at four points: the footslope (L_{foot} ; nearly flat), midslope (L_{mid} ; 0.34 mm^{-1} incline) steep slope (L_{steep} ; 0.63 mm^{-1} incline), and summit (L_{sum} ; nearly flat, forested). At the two slope points the concentrations of extractable cations and P, as well as the CEC and pH, were lower than those at L_{sum} and L_{foot} . Furthermore, the A-horizon was very thin at these slope points (Figure 4). The results seemed to have been caused by erosion and leaching downward on the slope positions. The same results were achieved in other sloping fields: it was found that soil chemical properties varied according to landform.

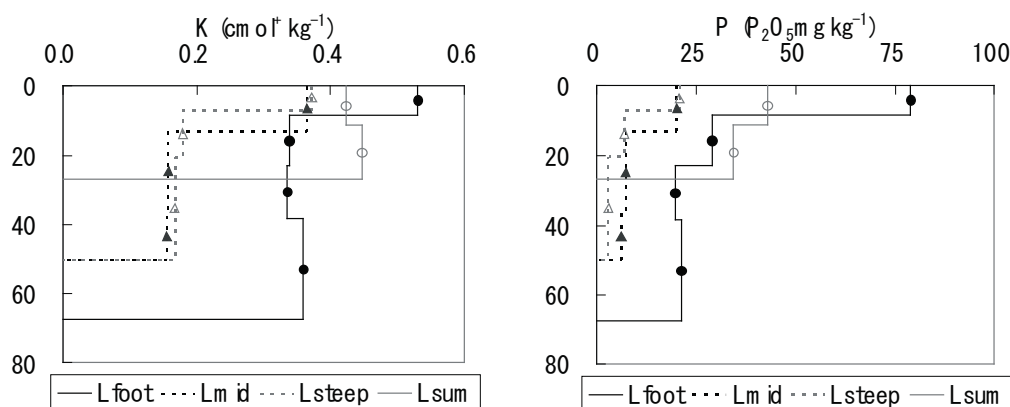


Figure 4. Distributions of K and P in the lowest-yielding field

The soil fertilities in three types of field - moderately productive sloping fields (0.5 to 0.6 Mg ha⁻¹ yield: M_{foot}, footslope; M_{mid}, midslope), the least productive sloping fields (0.3 to 0.4 Mg ha⁻¹ yield: L_{foot}, L_{mid}, L_{steep}), and the most productive flat fields (3.0 Mg ha⁻¹ yield: H_{flat}) - were compared to clarify the factors limiting crop yield. There was almost no difference in fertility between the two flat points (M_{foot} and L_{foot}), but there was a difference among the slopes that occupied most of the fields (M_{mid}, L_{mid}, and L_{steep}). At L_{mid} and L_{steep}, the concentrations of extractable cations and the pH were lower than at M_{mid}. These chemical properties seemed to limit crop production in the lowest-yielding fields. In addition, the presence of a high-gravel-content layer close to the surface limited root extension at L_{mid} and L_{steep}. At point H_{flat}, SOM content and CEC were high, but no differences in the other properties (for example, extractable cations and P) were detected. This productive field was treated by intensive weeding by farmers. Crop yield was reflected in not only soil properties, but also management strategies.

Nutrients, cations, and P were absorbed by fallowed vegetation during the fallow period and were added to the surface by burning on the stage of land preparation for planting. SOM decreased in the primary fallow stage, but after a few years its budget had changed to positive. The relationship between soil fertility and landscape was thus clarified. Nutrient retentivity, cation concentration, and extractable P level at the slope points were lower than at the flat points. Productivity was not explained by the chemical properties alone, but also by the soil physical properties and cultivation management.

Improvement of a Sustainable Rainfed Multiple Cropping System on Sloping Land in Northern Thailand

Panomtaranichagul, M.¹, Fullen, M.², Naruban, S.³ and Peukrai, S.⁴

1 Department of Soil Science and Conservation, Faculty of Agriculture, Chiang Mai University

2 RIATec, University of Wolverhampton, U.K.

3 Maehongson Rice Research Center

4 Department of Land Development, Region 6, Ministry of Agriculture and Co-operatives, Thailand.

Nowadays, traditional rainfed shifting cultivation on sloping land is being replaced by intensive single-annual crop cultivation. This is leading to degraded soil, lower productivity, and agro-ecological and socio-economic problems. Strategies to solve these problems include improvement of sustainable multiple rainfed cropping systems by increasing soil productivity and crop yields. Sustainable rainfed farming practices on sloping land can be achieved by increasing the efficiency of rain water use in multiple-crop production during both rainy and dry seasons, mainly by regulating soil water storage. Increased soil water and multiple-crop water use efficiency may be achieved by increasing infiltration capacity, and decreasing surface runoff, soil loss and soil water evaporation rates during both wet and dry periods. Several agricultural practices such as contour furrow cultivation, bio-geotextile and agro-horticultural alley cropping systems can be used as anti-erosion and water harvesting techniques to

improve rainfed multiple-crop production on sloping land. These may lead to increases in soil productivity, agro-ecosystem quality, farm household profitability, and in the socio-economic and cultural autonomy of the local community.

This poster presents experimental results from the first two years of the two main projects carried out in Mae-Chaem, Chiang Mai (Trial I) and Pang Ma Pa, and Mae Hong Son (Trial II), northern Thailand between May 2004 and April 2006. Both field trials aimed to evaluate the effects of different soil erosion controls (alley cropping as agro-forestry systems, with hedgerows of mixed fruit trees and Graham Stylo) and water-harvesting techniques (contour furrow cultivation with or without mulching of *imperata* grass panels or bamboo mat geo-textiles) in improving soil properties, water storage and crop yields, and in decreasing soil loss and surface runoff.

The two experimental plots were established in farmers' cultivated plots at altitudes of 1,234-1,242 m and 780-800 m, with average slope angles of 65° and 40° respectively. Trial I and Trial II comprised of 15 and 12 subplots (5x30 m each) with a completely randomized design (CRD) and three replicates of five- and four-treatment combinations (anti-erosion / water harvesting practices) respectively. The treatments in Trial I were:

- 1) Conventional contour planting after slash-and-burn or control (**CP**);
- 2) Contour planting mulched with bamboo mat geo-textile (**CP-BM**);
- 3) Contour furrow planting mulched with an *Imperata cylindrica* panel geo-textile in the furrow (**CF-M**);
- 4) Contour furrow planting in alley cropping (**CF-AL**);
- 5) Contour furrow planting mulched with an *imperata* grass panel in alley cropping (**CF-M-AL**).

Trial II used three of the same treatments as Trial I (**CP**, **CF-AL** and **CF-M-AL**) but its last treatment consisted of conventional contour planting and alley cropping plus vetiver grass rows (**CP-AL-VG**). Both experiments used alley cropping with mixed fruit-tree hedgerows (mango, lemon, and jujube) and ground cover with Graham Stylo (*Stylosanthes guianensis*). The annual multiple crops were rotations of sweet corn (*Zea mays*) followed by upland rice (*Oryza sativa*) during early-mid rainy season and lablab bean (*Lablab purpureous*) during late rainy season to mid-summer. Data was measured for basic soil properties, surface runoff, soil loss, soil water storage and crop yields.

Similar results were obtained from both experimental sites as follows:

- i) **CF-IM-AL** tended to give better soil physical and chemical properties than the other treatments;
- ii) The highest total amount of surface runoff and soil loss occurred in the **CP** plot whilst the lowest amounts were found in the **CF-M-AL** plot;
- iii) The five practices in Trial-I (**CP**, **CP-BM**, **CF-M**, **CF-AL** and **CF-M-AL**) and the four in Trial-II (**CP**, **CF-AL**, **CF-M-AL** and **CP-AL-VG**) gave similar amounts of soil water storage during the wet period, but significantly different amounts through the dry season. However, **CF-M-AL** and **CP** tended to give the highest and the lowest amounts of stored soil water for almost all the growing seasons;

iv) Maize grown in both Trials gave the lowest and the highest average yields under **CP** and **CF-M-AL** respectively. The crop development and yields of upland rice grown as the second crop showed similar trends to as maize in Trial I, but are not reported for Trial II due to insufficient data for statistical analysis. Destruction of the upland rice plants by mice, swine and aphid invasions during the middle of the rice-growing period led to non-uniform growth and poor yield production in Trial II. The lowest and highest amounts of lablab bean dry matter and yields were also obtained under **CP** and **CF-M-AL** in both Trials I and II during both experimental years, 2004 – 2005 and 2005-2006.

In general, **CF-IM-AL** tended to be the best treatment, **CF-AL** and **CF-IM** the second best, and **CP** and **CP-BM** the worst and second worst practices in this test of sustainable rainfed multiple-crop production on sloping highlands under tropical climate conditions. In conclusion, contour furrow cultivations mulched with biodegradable geo-textile mats in alley cropping, with hedgerows of mixed fruit trees and leguminous ground cover crops are expected to provide the best soil and water conservation practices on sloping highlands.

Interactions between Fine Root Growth, Slope Conditions and Soil Detachment under Different Land Uses in a Small Mountain Catchment of Northern Lao PDR

Alain Pierret¹, Keodoune Latchackak², Phouthone Chathanvongsa² and Christian Valentin³

¹IRD-IWMI-NAFRI, UR Solutions, Vientiane

²IRD, MSEC house, Vientiane

³IRD, UR Solutions, France

email: alain.pierret@ird.fr

The roles and functions of individual roots vary with time, depending on their position within the root system and in relation to local soil conditions. Since root growth induces, at least locally, changes in soil physical and chemical properties, it can be assumed that roots have some impact on soil detachment and erodibility. On the other hand, it is known that sloping conditions have an influence on root system architecture; for example, Di Iori and co-workers observed significantly different rooting patterns in oak trees growing on slope gradients of 25%-70% compared to those observed on slopes of less than 10%. The effects of sloping conditions on fine roots (<0.5 mm) have also been confirmed based by laboratory experiments.

While many annual and perennial plant species can develop dense networks of fine fibrous roots, at least near the soil surface, the majority of studies on the effects of roots on soil erosion and slope stability (root reinforcement) focus on the coarsest fraction of root systems. Although it is fair to assume that, on an individual basis, fine roots may have a negligible effect on soil mechanical properties, this can largely be counterbalanced by the facts that i) they also represent a dominant fraction of root length density and ii) they are most commonly concentrated within

the first few centimetres of the soil profile. Hence, an alternative view is that fine roots bind the soil in place and act as fibre reinforcement, reducing soil erosion and increasing topsoil stability. Indeed, Hairiah *et al.* recently found that, depending on soil type and plant species, fine roots could alter soil shear strength.

This paper reports the results of a field study aimed at assessing putative interactions between fine root growth, slope conditions and soil detachment under different land uses. The study investigated the relations between slope gradient and superficial (<30 cm soil depth) root-growth dynamics in a small upland catchment in Luang Prabang province during the peak of the 2005 rainy season (June to September, corresponding to 79% of total annual rainfall for 2005). Measurements were made on local smallhold farmland under three vegetation covers: annual crop (rice and Job's tears) on land cleared by slash-and-burn; 30-month-old fallow vegetation; and teak tree plantation. This work established the clear effect of slope conditions on superficial root growth in crops and fallow vegetations. Differences in soil infiltrability with slope, as a possible cause of the observed rooting patterns, is discussed. In contrast, no clear relation between fine root development and soil detachment was found. It can be concluded that, under the experimental conditions of this study, fine roots had no or very limited effect on soil reinforcement.

Elicitation of Local Soil Knowledge in Northern Thailand and Consequences for Land Use Decision-Making

U. Schuler¹, C. Choocharoen¹, A. Weiss², L. Herrmann², A. Neef¹ and K. Stahr²

1 The Uplands Program, Faculty of Agriculture, Chiang Mai University

2 Institute of Soil Science and Land Evaluation, University of Hohenheim, Germany

Available soil information for the highlands in northern Thailand remains scant. Present soil maps depict only one soil unit for highland areas, called 'slope complex'. This information is insufficient for appropriate land use decision-making. Conventional soil mapping techniques, however, are time-consuming and costly, and do not always provide relevant data for local stakeholders. There is a need for alternative, low cost methods that integrate other knowledge domains.

Three ethnic minority villages in northern Thailand were chosen in order to elicit their local soil knowledge, to compare this with scientific findings, and to blend it with scientific mapping techniques for regional scaling-up in later stages of the research. The village Bor Krai is located in Pang Ma Pha district, Mae Hong Son province, and is inhabited by the Black Lahu ethnic minority who recently migrated to this area from Myanmar. The area is dominated by limestone and Luvisols. More than 90% of the villagers live by crop cultivation and cattle breeding. The most important crops are upland rice and maize. In general, the cropping cycle is characterized by two or three years of cultivation followed by a fallow period of at least five years. Due to the population pressure, the fallow periods are continuously decreasing.

The village of Huai Bong is located in Mae Chaem district, Chiang Mai province, and is inhabited by the Karen ethnic minority, a group that has a long history of settlement in northern Thailand. Sandstone and Luvisols prevail. As in Bor Krai, the livelihoods of more than 90% of the villagers depend on crop cultivation and breeding of cattle. Maize is the most important cash crop with paddy rice and upland rice cultivated for home consumption. Paddy rice is cultivated during the rainy season. In flat areas or on moderated sloping land, maize is permanently cultivated. On sloping land, rainfed rice and maize are cultivated for only one rainy season, followed by a fallow period of at least five years.

Ban Mae Sa Mai is located in Mae Rim district, Chiang Mai province, and is inhabited by Hmong people who have been settled in the area for more than 40 years. The petrography is dominated by gneiss, and among the soils Acrisols are common. Due to the proximity to Chiang Mai city, less than 90% of the villagers depend on agriculture. Nearly all farmers produce cash crops such as litchi and vegetables.

The villagers of **Bor Krai** distinguish their local soils according to their colour on the surface. In the final local soil map Black Soil covers 38% of the map area, followed by Hard Red Soil (34%), Soft Red Soil (18%), Orange Soil (2%), Yellow Soil (2%) and Mixed Soils (7%). For each local soil unit the farmers have a clear idea of corresponding properties such as water infiltration rate, erodibility, and suitability for various crops. Black Soil is considered the most suitable for upland rice and maize production, but according to farmers also faces the highest weed pressure. The Hard Red Soil is generally used for rice production, while on Soft Red Soil maize cultivation is predominant. The rather infertile Yellow and Orange Soils can be only used for cultivation of mangos and bananas.

In **Huai Bong** three different local soil classifications were identified. One group of villagers distinguished their soils according to the topsoil colour and stone content; the second group distinguished their soils according to the subsoil colour and stone content. The third group distinguished their soils according to the colour and stone content of the lowest soil horizon which occurs within the depth of an elbow (approximately 30 cm). For the research area six local soil types were mapped. Thus the area consists of 65% Red Stony Soil, 14% Black Soil, 11% Red Soil, 9% Black Stony Soil and less than 1% Red Black Stony Soil and Red Sandy Stony Soil. In addition local maps of topsoil, subsoil, soil fertility, topsoil thickness and crop suitability were compiled here. The villagers had ideas about the various soil properties and crop suitability of each landscape unit.

In **Mae Sa Mai** soil types were mainly distinguished by soil colour at the surface and the thickness of the dark topsoil (where available). In total, six local soil types were identified. According to this classification the mapping area consists of 47% Red Soil, 32% Shallow Black Red Soil, 15% Deep Black Red Soil, 4% Black Soil and less than 1% Grey Soil and Black Red Yellow Soil. The locations of Grey Soils match the locations of former paddy rice cultivation. The Black Soils with the thickest topsoil are located at the highest elevation of the watershed. This corresponds to the few measurements of soil organic carbon carried out for the watershed. The Hmong farmers also

had opinions on soil properties and crop suitability. Due to their present farming system, which mainly relies on fertilizers and pesticide application, and the declining importance of agriculture for the household income, only few farmers had a detailed knowledge of local soil types.

In conclusion, local soil classification differs markedly among the study villages. Notwithstanding these differences, in all villages local soil experts with a profound knowledge of soil properties and crop suitability could be identified. This knowledge provides useful supplementary information for geostatistical techniques, land suitability analysis, and appropriate measures against soil erosion in highland areas and against flooding in lowland areas. In karst areas like Bor Krai, the integration of local knowledge is an important prerequisite for locally-specific and sustainable land use planning. Close attention should be given to prevention of pesticide application in order to protect the sensitive groundwater system.

Use of Erosion Modelling to Discuss Watershed Management Options with Stakeholders

R. B. van der Helm¹, O. Vigiak², G. Lestrelin³, B. Soulilad⁴, G. Sterk¹ and C. Valentin⁴

1 ESWC group, Wageningen University, the Netherlands

2 International Water Management Institute, Colombo

3 University of Durham, U.K.

4 Institut de recherche pour le développement, Paris

In the mountains of northern Laos, soil erosion is a recognized cause of land degradation. Soil erosion affects the livelihood of local populations both upstream, where the most fertile topsoil layer is removed, and downstream, where increased sediment loads reduce water quality in streams and lakes. In the last two decades, growing human pressure on agricultural land has been affecting the traditional no-input slash-and-burn system, causing a reduction of the fallow period and subsequent decreases in crop yields and increases in labour requirements. Under these circumstances, the traditional agricultural system is no longer sustainable.

Farmers are aware of the land degradation problems occurring in their fields, but changes of land use and/or adoption of soil and water conservation (SWC) practices require important capital and labour investments. SWC planning is best tackled at watershed scale, where both the on-site and off-site effects of erosion can be evaluated. Stakeholders should be involved from the early stages to ensure fruitful discussion in defining feasible, acceptable and interesting alternative SWC plans. Projection of SWC plans results would further help discussion before action takes place.

Distributed erosion modelling is a potentially useful tool in SWC planning, because (i) it allows location of the main sources of sediment in the catchment - erosion 'hot spots' where action would probably result in the highest benefits; and (ii) it may project the results of alternative SWC plans, for instance by creating 'what if' scenarios. Among several distributed erosion

models proposed in literature, the Annualized Agricultural Non Point Source Pollution model (AnnAGNPS) was designed for integrated watershed management planning purposes and is emerging as a preferred tool for evaluating SWC scenarios. The model can be run at the scale of event or for a continuous simulation. Runoff volume and peak flow rate are simulated with the SCS curve number method, whereas soil loss is calculated using the Revised Universal Soil Loss Equation. In Southeast Asia, the AGNPS is among the most applied erosion models, because it requires comparatively little data and yet is able to simulate SWC planning scenarios. However, to our knowledge the model has not yet been applied to very steep slope conditions. The aim of this research was to i) assess the potential use of AnnAGNPS in simulating soil erosion in northern Laos, and ii) use the model to discuss alternative scenarios with stakeholders. The AnnAGNPS model was applied to the small catchment of Houay Pano, in Luang Prabang province. This steep, highly-dissected 64 ha catchment is representative of the no-input slash-and-burn system common in Southeast Asia, and here fallow periods have shortened from 10-15 years to the current two to five years. Altitude ranges from 400 m to 800 m. Average rainfall amounts to 1,259 mm per year, mostly falling in the rainy season from mid-May to mid-October. The area has been studied within the MSEC project framework since 1998. The catchment outlet is equipped with a V-notch weir station to measure rainfall event discharge, suspended sediment load, and bed load. AnnAGNPS model inputs were collected in the field or from literature. Soil and topography data were already available. Land use input data was surveyed during the 2005 and 2006 rainy seasons. The spatially variable input data was built with a Geographic Information System interface (ArcView®). Curve number CN values and crop C factor were calibrated against discharge data from 2005 and will be validated against 2006 discharge data.

Farmers already show a good perception of soil erosion, recognizing several stages of degradation phenomena. This study asked farmers to map the indicators of erosion and to discuss causes of the problem and possible solutions. The map based on farmers' perception was compared to the AnnAGNPS spatial predictions for 2005 to prompt further discussion. The prediction model for 2005 is used as a basic scenario to evaluate possible alternatives in the catchment land use that were identified together with farmers, namely i) expansion of vegetable cropping in the most suitable areas, and ii) conversion from annual crops to tree plantation (banana and teak). Again, the results of scenario runs have been discussed with farmers.

Notwithstanding the good database already gathered by the MSEC project, data collection and input editing took several months. Model calibration shows that the AnnAGNPS model tends to overestimate runoff and erosion in the study area. Farmers welcomed the chance of being involved in land degradation discussions that aim at future action.

**Station 2: Watershed management, planning and
implementation processes**

The New Generation of Watershed Management Programmes and Projects

Food and Agriculture Organization of the United Nations

Contact person: Thomas.Hofer@fao.org

In order to meet the demands of growing populations, the conservation, use and sustainable management of watershed resources has been a high priority for many countries over the past several decades. Particularly during the 1990s, integrated watershed management through people's participation became widely accepted as a promising approach for conserving water, land and biodiversity, enhancing local livelihoods, improving the economy of upland inhabitants and people living in downstream areas, and supporting broader sustainable development processes at national and river-basin levels.

During the International Year of Mountains in 2002, FAO and its partners undertook a large-scale assessment and global review of the current status and future trends of integrated and participatory watershed management. The overall objectives were to promote the exchange and dissemination of experience in implementing watershed management projects in the decade 1990 to 2000, and to identify the paradigm, approach and methods for a new generation of watershed management programmes and projects.

Experts from four continents contributed to the assessment, which yielded four regional workshops held in Nairobi (Kenya), Kathmandu (Nepal), Arequipa (Peru) and Megève (France), plus an international conference in Porto Cervo (Sardinia, Italy). The workshop and conference findings are presented in five volumes, published in the FAO-FORC Watershed Management and Sustainable Mountain Development Working Papers Series. Two national case studies (Nepal and Burundi) and two regional case studies (the Mediterranean and Latin America) were also implemented and published as part of this review.

The resource book *The New Generation of Watershed Management Programmes and Projects*, published in the FAO Forestry Paper Series, represents a summary and critical analysis of the rich discussions and vast material that emerged during the review, as well as the review's findings and recommendations. It presents the state of the art in watershed management approaches and practical experience, promotes further reflection and creative thinking, and proposes new ideas and approaches for future watershed management programmes and projects. In particular, the publication is about:

- Rethinking watershed ecology;
- Watersheds' human ecology and economics;
- 'Integrated' vs. 'embedded' watershed management;
- 'Participatory' vs. 'collaborative' watershed management;
- Information systems and needs; and
- Conditions for success.

The resource book was written primarily for field-level watershed management practitioners and local decision-makers involved in watershed management at the district or municipal level. It is also a useful source of information for readers such as senior officers and consultants specialized in other areas, evaluators, policy-makers and students of watershed management.

The review's findings and recommendations are an important contribution to the implementation of Chapter 13 of Agenda 21, the follow-up to the International Years of Mountains (2002) and Freshwater (2003), the promotion of the Johannesburg Plan of Implementation, and the achievement of the Millennium Development Goals. For FAO, the results of the review and the approaches presented in the resource book are to be the basis for developing new programmes and projects on different continents in order to test, validate and implement the new approaches to watershed management over the next few years.

Village Clustering Development Planning Approach to Watershed Management: Some Initial Thoughts from LSUAFRP Experience

Khamphay Manivong¹, Peter Jones², Paulo N. Pasicolan³ and Khamphone Mounlamai⁴

1 Head of Information Service Division, NAFRI

2 Adviser, Land Management Component, LSUAFRP-NAFRI

3 Adviser, Forestry Research Component, LSUAFRP-NAFRI

4 Head, Forestry Research Component, LSUAFRP-NAFRI

The village clustering approach is an emerging area-based planning and resource management strategy aimed at accelerating economic growth in rural areas of the Lao PDR, particularly in the 47 declared poverty districts. The government has announced plans to implement this planning and development initiative during the period 2007-2010. The key programs in this initiative are the District Land Zoning for Agricultural Development Program (2006-2008) and the Plan for Substituting Rice-Based Shifting Cultivation Practices (2006 to 2010).

To date village clustering, referred to as *kum ban patana* is based on administrative boundaries within the *khet* system, but these do not necessarily lie within the same micro watershed. The Ministry of Agriculture and Forestry (MAF) also advocates a watershed approach to upland development and poverty alleviation. This is outlined in the MAF document *Integrated Watershed Management Approach for Sustainable Upland Development and Poverty Alleviation in the Lao PDR*. However, a question associated with the 'watershed' and 'kum ban' initiatives is how to decide, at the village grouping level, on a 'spatial management unit' that satisfies both administrative and ecological functions. This is a subject of on-going exploratory research by the Forestry Research, Land Management, and Information Services Components of LSUAFRP in Na Mo district, Oudomxay province.

Since 2004 the LSUAFRP has been piloting and developing agro-ecological zoning and agro-ecosystem analysis (AEZ –AEA) as a tool for district land-use planning. Experience with AEZ and AEA indicated that ecological zoning and zone descriptions support the watershed approach. They also delineate village management areas (village boundaries) and provide a framework for cluster village planning and development. The socio-economic data gathered is also important for village cluster and village planning. Recently, the LSUAFRP has launched community forestry research that is characterized by *local demand-driven, process-oriented* and *internally evolved systems*. The AEZ-AEA and the community forestry research initiatives converge in the area of natural resource planning, leading towards sustainable watershed management.

This poster presents LSUAFRP lessons and experiences in land-use planning and zoning, plus the community forestry social processes in Ban Mixay, Oudomxay. The aim is to explore an improved approach to village cluster development planning that would enable ecological principles to be workable within the established administrative framework. The ultimate goal is to develop an integrated, administratively compatible and ecologically sound area-based approach for watershed management.

Water for Life: A project to empower upland ethnic communities in the upper Ko River watershed of Oudomxay Province

CUSO Lao PDR and Oudomxay Provincial Science Technology & Environment Office

The Oudomxay Provincial Science Technology and Environment Office, a Lao government agency mandated to monitor and evaluate the state of the environment, identify environmental threats, risks and impacts, and to develop and implement strategies to address them, has initiated a watershed and land-use management project in the upper Ko River Basin with the participation and cooperation of ethnic upland communities. The project focuses on communities living in the upper Ko River catchment area (Xay district), and who are struggling to improve their food security through cultivation, animal raising and the harvesting of non-timber forest products without endangering the health of the Ko River, which they rely on for household, agricultural and other vital uses. The significant changes and disruptions to their livelihoods have resulted in economic insecurity, new poverty, and hardship. By applying participatory research methodologies this project is working to assist disadvantaged villages in the Nam Ko River catchment area in protecting and managing their watersheds and water resources, with the goal of attaining greater environmental security and economic self-sufficiency.

The goals and objectives for this project are to:

- Address root causes of poverty by empowering ethnic communities to sustainably use, manage, preserve and protect the critical land and water resources that provide for their livelihoods;

- Reintegrate indigenous knowledge and practices into land-use management strategies and the contemporary planning processes;
- Train government staff in the utilization and application of basic skills in Geographical Information Systems;
- Provide land-use and environmental protection strategies that are practical, effective, culturally appropriate and reflect local needs and realities;
- Improve land tenure among the poor by addressing and improving upon current land tenure and land allocation programs;
- Affirm and elevate the status of women and enhance their capacity to participate in decision-making processes and management strategies;
- Develop a model of community engagement, sustainable development and environmental protection that can be used as a basis for similar work throughout Oudomxay, the Lao PDR, and the Lower Mekong River Basin.

Formation of Broad-Based Partnership in Watershed Management: Philippines Experience

Paulo N. Pasicolan¹ and Simplicia A. Pasicolan²

1 Forest Research Adviser, LSUAFRP, NAFRI

2 Senior Science Research Specialist, College Laguna, the Philippines

The Philippines government has recently implemented a new approach to watershed management, referred to as the *Philippine Strategy for Improved Watershed Resources Management*. As part of the World Bank's loan package arrangement, the pilot project design conformed to Agenda 21's call for a single coherent strategy as a guiding principle: "there should be a demand-driven and community-based approach involving two parallel components. Firstly, one where the demand is determined by national priorities and concerns. Secondly, one in which the direct stakeholders can articulate their needs and actively participate in the conservation, planning, management and sustainable utilization (for multiple purposes) of their local watershed resources." This strategy brought stakeholders from varied political, cultural, socio-economic, and spatial divides into mutual partnership.

Watershed councils in the 1980s and 1990s were created under government direction. On-site stakeholders were not consulted, while affected sectors had no involvement in the council's affairs. The lack of participatory process in evolving these councils resulted in short-lived interagency collaboration and local participation in watershed management. This poster

presents the participatory processes adopted by the pilot project in forming a watershed management council. It advocates the need to create more enabling spaces for grassroots and on-site stakeholders, so that they can actively take part in co-managing common resources. These processes are:

- 1) Alliance and constituency building. The pilot project conducted intensive Information Education Campaign at the start with different stakeholders as part of the strategy to recruit partners from various sectors inside the watershed.
- 2) Capacity building. Continuous stakeholders' training became the pilot project's major thrust towards local empowerment.
- 3) Consensus building. Community consultations, public hearings and multi-stakeholder convergence conferences were held as a means of arriving at crucial decisions affecting the watershed.
- 4) Social negotiation. On-site stakeholders were encouraged to negotiate their occupancy and resource access rights through consultations and public hearings.
- 5) Scenario building/visioning. Stakeholders were asked to articulate their corporate vision and the aspirations that led them to formulate goals and action plans towards enterprise building and watershed protection.
- 6) Legitimization and institutionalization. After a two-year period of much social and technical preparation, a multi-stakeholder partnership of 30 members was formed. Of these, 14 are 'on-site' actors, representing almost 50% of the total number of seats. This body attained a more permanent and functional status when it became a Protected Area Management Board.

This participatory process:

- 1) Improved the world view of local actors: it heightened the locals' political awareness and social responsiveness towards taking part in nature conservation;
- 2) Enhanced widespread local participation: it brought previously uninvolved sectors of society into the watershed management council;
- 3) Enabled stakeholders to express their collective aspirations: it provided enabling conditions for stakeholders to articulate their corporate vision for the watershed;
- 4) Built a sense of worth for neglected sectors: it restored 'on-site' actors' self-esteem, motivating them to unite in protecting community resources;
- 5) Stirred strong communal concern for the watershed: it developed a clear common rallying point for stakeholders to work together as a team;
- 6) Challenged local government units to take charge: it mainstreamed local governance in natural resource management;
- 7) Created more political space for the locals: it slowly brought powerless and neglected sectors to the fore of the natural resource management system by legitimizing their participation;
- 8) Strengthened the collective bargaining power of the locals: it enabled on-site stakeholders to organize against a private sector move to construct a dam that could have displaced local residents;
- 9) Created a common platform for stakeholders to resolve resource conflicts: it provided an avenue for various resource users to discuss their differing resource interests openly, objectively and peacefully;

10) Challenged the bureaucracy: it brought new management culture to government line agencies involved in natural resource management, encouraging them to shift from a top-down to a participatory governance approach.

The Kaliwa Stakeholders have expressed their corporate vision as follows:

“Our dream is to have a watershed with clean water and fresh air, in which the downstream and upstream communities have stable and productive livelihoods resulting from our harmonious collaboration and a closer communion with the Almighty God, fully abiding with the ecological principles towards sustainable economic growth”.

Farmers’ Adaptation to Rural Development Policy Under Theun-Hinboun Hydropower Project: A Case Study of Sobngouang Village, Khamkeuth District, Bolikhamxay Province, Lao PDR

S., Channuan¹, S. Prabudhanitisarn², J. Thomas³, N. Badenoch⁴ and B. Ekasingh⁵

1 World Agroforestry Centre (ICRAF), Thailand

2 Faculty of Social Science, CMU, Thailand

3 ICRAF, Thailand

4 Unit for Social and Environmental Research, CMU, Thailand

5 Faculty of Agriculture, CMU, Thailand

The Theun-Hinboun Hydropower Project (THPC) is a large joint-venture hydroelectric project between the Lao government and foreign investors that was created in 1994. Its development activities have aimed to improve the livelihoods of people and communities affected by the dam construction. This project has also applied upland management policies as a framework for implementing agricultural development activities in the area. THPC has affected the livelihoods of communities in many aspects, especially in economic conditions. The key question is whether the villagers have adapted themselves to their new situation and limited resources such as loss of riverbank gardens and fisheries, and the rotation of upland rice? The objectives of this study were: 1) to study farmers’ adaptation to new agricultural practices due to land-use change after dam construction; and 2) to investigate how farmers have adapted, in terms of household economy and marketing, to land use change and expansion of consumption and modernization.

The research employed quantitative and qualitative methods. Literature and secondary data were collected and analyzed to complement primary data obtained through a questionnaire survey with 66 farmer households. Other data-collecting methods included field walks, observation, in-depth interviews and group discussions to acquire other relevant information. This data was reviewed and compared to the basic information compiled by THPC and the district administrative office. The data was then qualitatively and quantitatively analyzed using descriptive statistics including numbers, percentages and means. The results were descriptively presented with figures and tables.

The study found that government development policy and dam construction have affected all farmer households. Two main policies have had most effect, namely the drive to stabilize shifting cultivation in the highlands, and the land and forest allocation policy. Both have had positive and negative impacts. Prior to dam construction, 83.7% of land in *Bon Phu* (highland area) was used for shifting upland rice cultivation and other crops, while 7.7% of land in *Bon Piang* (lowland area) was utilized for the same activities plus riverbank gardens. As a result of implementation of government policy through THPC activities and assistance, land use and cropping practice have now changed. In *Bon Phu*, only 47.5% of the area is now used for shifting upland rice cultivation and other crops. 6.4% of land is currently under permanent upland rice farming and agarwood agro-forestry systems. Meanwhile, in *Bon Piang*, farmers have upped their land use from 12.7% to 23.6%. 2.2 ha of land was allocated to compensate for the loss of riverbank garden area, which dropped from 2.5% to 0.6% of total agricultural land. In this area, farmers have switched from shifting cultivation to permanent systems. They received support in growing fruit trees mixed with field crops or permanent orchards, which now account for 9.8% of the area, and also in growing agarwood or practicing agro-forestry. Moreover, some farmers have adapted the land use pattern by themselves to grow paddy rice in the *Bon Homhuai* (valley area). By 2003, this land-use pattern covered 16% of the village's total agricultural area. At the same time, what used to be fishing areas (10 *wang* and 7 *kaeng*) disappeared after dam construction. Animal husbandry was also affected as village grazing areas in natural forest were reduced from two large areas to only one limited area.

Due to these changes, farmers had to adjust cropping systems, especially for upland rice. The 5–12 year fallow period of the rotational upland rice cultivating system has given way to permanent systems with a fallow period of three to five years. Consequently, the average upland rice yield has dropped from 1.4 tonnes/ha to 0.7 tonnes/ha. Although paddy rice systems in the *Bon Homhuai* tend to produce greater yields, at an average of 1.9 tonnes/ha, the rice grown is not adequate for consumption throughout the year. This situation has led to increasing use of agricultural technologies in the area, for example, two small tractors, water pumps, chemical sprayers and other production devices. Fruit trees, including mango and lychee are grown in the permanent orchard systems, mixed with pineapple, watermelon, maize and upland rice. THPC supplied fruit tree seedlings, pesticide, and chemical fertilizer, provided training for proper husbandry methods, and assisted in terms of marketing. The most important factor for adaptation was economic potential as the costs for changing land-use patterns and for crop and animal production have increased. Other significant factors include leadership and use of local wisdom in adapting processes, as some farmers were able to invent and adjust production methods to suit the new situations. Other factors played only minor roles. Farmers who live above the level defined by the government as 'poverty', have adapted themselves by focusing on growing rice and raising animals to gain savings. Poorer inhabitants have attempted to improve themselves by cropping upland rice, raising animals for sale, also trying to gain more off-farm income (labour and collection of non-timber forest products) in order to buy rice for consumption. Overall, this research found that 94% of the farmers felt that changes following dam construction have led to an overall improvement in their livelihoods.

External Push and Internal Pull of Sustainable Upland Rice Production and Its Interrelationship with the Ecology of Theun-Hinboun Hydropower Project: A Case Study of Sobngouang Village, Khamkeuth District, Bolikhamxay Province, Lao PDR.

Mr. Vilaphorn Visounnarath, Electricite Du Laos

Despite strong government policies to suppress traditional slash and burn agriculture, these systems are still a major method of rice production in the uplands of Lao PDR. However, national target aims to totally suppress slash and burn agriculture by the year 2020. In the meantime, national and international assistance projects have helped government to implement alternatives to slash and burn agriculture. After the completion of Theun-Hinboun Hydropower Project, one of the major commitments is to the mitigation of environmental impacts. An important component of this support is to rehabilitate areas of degraded forests that have resulted from inappropriate practices of shifting cultivation. To assist implementation of the program, the Project applied the principles of national policy on upland management to the target population in the area.

As upland rice is the most critical component in traditional agricultural system and given the changes due to development support from the Project, the present study attempted to examine the impacts of development on the rice systems of the farming households with specific objectives of ascertaining (i) Can rice production be maintained or even increased for household requirements after a sudden shift from traditional shifting cultivation to other forms of rice production in permanent systems? and how? (ii) How would the above alternative rice production systems impact biodiversity and ecological recovery of vegetation? (iii) Would the above changes lead to any positive ecological outcomes as a whole, while maintaining rice sufficiency?

On the basis of these questions, a conceptual framework for field study was developed and proposed for analysis. The framework is based on intensification theory where push and pull factors impinge upon land use changes toward more intensification with alternative forms of land management. In this context, attentions is given to rice production systems and the regeneration of natural ecology with respect to system changes from traditional slash and burn cultivation. The overall outcomes of this process are measured in terms of rice productivity and improvement in the ecology of upstream areas of the watershed, for example the Nam Theun river.

Several approaches were adopted to collect primary and secondary data. Also interviews with key informants were conducted to gather information from farmers, formal and informal groups, government officials, Project staff, and policy makers at all levels. Field walks with villagers, formal field surveys and setting up of sample plots were employed for field measurements and assessment. Participatory approaches are the core research methodology in this study. After the completion of the Project in 1998 with strong push factors, slash and burn fields in the village were reduced by almost 50 percent. Alternative land uses for both rice and cash crops were developed to replace slash and burn cultivation. These included some 12.9 ha of

paddy, 5.2 ha of permanent upland terraces, 2.6 ha of mixed annual perennial fields, 2.4 ha of tree plantation. However, the amount of rice produced fell behind their consumption needs. Almost 90 percent of the total number of households in the village faces severe rice deficits for at least six months. In 2005, most of the farming households in the village returned to upland rice in former slash and burn fields. Assessment of rice productivity has shown that despite the differences in practices and production systems, yields of upland rice in the village are very poor, varying between 1.2-1.9 t/ha. The amount of phosphorus content in both grain and straw of rice was very low, varying between 0.05-0.22% in grain and 0.11-0.44% in straw respectively. Other factors have also involved and required further investigation, such as sterility, pests and disease incidence.

It is not clear how much direct impact slash and burn agriculture has on the degradation of natural forests. The premise which was generally believed is that natural regeneration proceeds productively after shifting cultivation has been terminated as fallows are released for regeneration. Evidence indicates that this is unlikely in this particular area. Natural regeneration of secondary forests in Sobngouang was found to be fairly slow with less species composition. Above all, growth of vegetation as measured in the terms of DBH is relatively small, even in currently undisturbed forests have experienced no significant disturbance for more than 12 years. Considering the nature of the poor natural resource base in Sobngouang, any human activity could be judged as easily destroying natural forests.

In this thesis, much discussion is devoted to the assessment of rice productivity and improvement of the production systems that could promote systems of high biodiversity and positive contributions to both agriculture and sustainable land use, so that the ecology of the upper watershed could be improved and conserved on a sustainable basis. Finally, recommendations were made specifically to the Project for future improvement of the development plan and implementation. As Theun-Hinboun Hydropower Project differs significantly from other projects to stabilize shifting cultivation, a recommendation was made to extend project research and experiences beyond project boundary. The possibility of national-level demonstration was suggested. Diversified strategies for agriculture development were recommended for the Project to absorb the range of farmers' strategies in production, ranging from subsistence to market-oriented economy. The role of rice in the household economy was raised for future Project activities. While improvement of livelihoods and conservation of natural resources and watershed are recognized, a broader understanding of degradation and rehabilitation of upland ecosystem was recommended.

Moreover, Project should take local knowledge and indigenous technologies into account in planning and implementation of the project activities. These are expected to be highly cost effective and adaptable to the heterogeneity of the biophysical setting of the uplands.

**Station 3: Social and technical options and results to improve
upland livelihoods**

Conservation Agriculture for Sustainable Land and Water Management

Food and Agriculture Organization of the United Nations,
FAO Regional Office for Asia and the Pacific, Bangkok, Thailand
Contact person: Yuji.Niino@fao.org

Conservation agriculture (CA) is the integration of ecological management with modern, scientific, agricultural production. Conservation agriculture employs all modern technologies that enhance the quality and ecological integrity of the soil, but the application of these is tempered with traditional knowledge of soil husbandry gained from generations of successful farmers. This holistic embrace of knowledge, as well as the capacity of farmers to apply this knowledge and innovate and adjust to evolving conditions, ensures the sustainability of those who practice CA. A major strength of CA is the step-like implementation by farmers of complementary, synergetic soil husbandry practices that build a robust, cheaper, more productive and environmentally friendly farming system.

By 2002, Conservation Agriculture had been introduced to 158 million ha in 70 countries using ten different crops. This is 11.3 % of total arable land in the world. There are lots of successful cases in South America and Africa, but less is known about CA in Southeast Asia. Through case studies in Cambodia, East Timor, the Lao PDR, Indonesia and Malaysia, it is seen that CA practices have not been promoted in Southeast Asia. The main constraints to promoting CA are lack of knowledge about CA, lack of skill concerning technology, lack of suitable equipment/ machineries/tools, and an absence of understanding of the need for CA practices.

Most countries consider the initial cost and the potential for success or failure of CA practices. Successes in countries like Brazil and China show that in tropical conditions like those in Southeast Asian countries, CA can be effective and beneficial to farmers. CA should be promoted in Southeast Asia through research and by strengthening the institutional framework for introduction of CA. Several constraints expressed by farmers include initial cost, risk, and scale and condition of farms. Appropriate strategies are needed.

Sustainable Rice-Based Cropping Systems in the Uplands of Laos – Enhanced Fallows and the Restoration of Soil Fertility

B.K. Samson¹, Khamla Phanthaboun² and Khamdok Songyikhangsuthor²

1 International Rice Research Institute (IRRI)

2 Northern Agriculture and Forestry Research Center (NAFReC)

Rice production from upland fields has consistently been reported to decline annually from the time that forested land was first opened for agricultural production. Manifold causes for falling

agricultural productivity have been posed – among them are decreased soil fertility, increased soil compaction, and increased weed and pest pressure.

In what ways can the soil fertility of upland agricultural fields be maintained to sustain crop production from year to year? How can upland fallows be enhanced so that soil and vegetation can be renewed to allow the inception of another cycle of crop production? What management options can be exercised to optimize the rapid renewal of soil and vegetation? How can these interventions be made so that they minimize demand on farm labor and provide households with a continuous stream of income?

The International Rice Research Institute, with NAFRI partners, undertook research to address these issues. A number of leguminous and pasture grass species, *Arachis pintoii*, *Cajanus cajan*, *Calapogonum muconoides*, *Centrosema pubescens*, *Crotalaria anagyroides*, *Lablab purpureus*, *Leucaena leucocephala*, *L. diversifolia*, *Gliricidia sepium*, *Stylosanthes guianensis*, *Pueraria phaseloides*, *Mucuna cochinchinensis* and *Brachiaria brizantha* were tested for their ability to raise soil organic matter and nitrogen levels.

Experiments to demonstrate the benefits of growing legumes for rice production in the uplands have been undertaken. A four-year study, begun in 1995, intercropped rice with *Leucaena leucocephala*, *Gliricidia sepium*, and *Crotalaria anagyroides* but showed no consistent increase in rice productivity. Rotation of rice and *L. leucocephala* also gave inconsistent results. *Stylosanthes guianensis* intercropped with rice may decrease rice productivity if established at the same time as the rice crop. Close management of the legume crop has to be exercised to prevent it from competing with rice.

The ecological thinking on which these technologies were based on, while sound, does not strike a significant chord in upland farmers' symphony of options. Direct benefits in terms of a continuing stream of benefits have not been demonstrated decisively. In at least one of the experiments, moisture availability seemed to be an important factor in eliciting positive benefits from the legume intercrop. Interactions between moisture availability and nutrients may be of great significance in the uplands.

This poster presents a summary of the findings and results from these experiments and explores their implications for future technology development and extension in the Lao uplands. The paper is divided into three sections. The first section is a synthesis of the major findings from experiments and trials on improved fallow management. The second section assesses the needs for further research on fallow management and rotational systems. The paper ends with an overview of how this research is being incorporated into IRRI's current research program.

Impacts of Sloping Farmland Conversion Policy on Biocultural Heritage in the Dulong River Watershed, Yunnan, China

Andreas Wilkes and Shicai Shen

Center for Biodiversity and Indigenous Knowledge, Yunnan, China: andy@cbik.ac.cn

With the aim of increasing forest coverage and preventing soil and water erosion, the Chinese government in 1999 announced a policy of promoting conversion of arable land on slopes of over 25° to forest, providing grain and cash subsidies for converting households. In 2003, when the policy was implemented in the Dulong River watershed (a tributary of the Irrawaddy River), this brought an end to the traditional rotational agricultural practices of virtually all members of the Dulong ethnic group within China. This poster describes the impacts of policy implementation on agro-biodiversity. Because rotational agriculture is central to Dulong culture, the loss of agro-biodiversity and agricultural practices is affecting the survival of the biocultural heritage of this ethnic group. This paper reports views on the impacts of the policy and suggests possible actions to mitigate adverse impacts on agro-biodiversity and bio-cultural heritage.

Thailand Farmer to Farmer Extension Approach: A Study on the Competency of Smart Farmers as Technology Transferring Agents

Kukiat Soitong, Pornsiri Saenakus and Orachun Sarnphinit

Rice Department, Bangkok, Thailand: ksoitong@doae.go.th

The large number of the grass root extension programs in Thailand is a result of Thai government policy. The Farmer to Farmer Extension Approach has been applied to sustain widespread adoption of technologies. Well-trained selected lead farmers called 'smart farmers' are designated as technology transferring agents. The success of the program depends on their competency. The objective of this research is to study these lead farmers' knowledge, skill and related attributes and their willingness to play a role as technology transfer agents. The results of the study will be used to design further action to develop their competency.

The study found that most of the smart farmers have high levels of knowledge and experience and show good attitude and effort towards their assigned activities. The average level of their competency was measured at 3.96. The highest level was 4.56. Their attitudes showed a good match to government policies, and their positive attitude allows them to encourage others to develop similar competencies. It was found that the smart farmers' Experience and Skills competency averaged 4.07, but their knowledge competency was 2.62, meaning that work is required to develop this area. Most of the smart farmers have a positive attitude to their role (level 4.26) and are satisfied with being rice farmers, but dissatisfied with the price they get for their rice.

The recommendations of the study are as follows:

- Most of the smart farmers are men. It is recommended that more women farmers be considered, as they see different aspects of the problems and potential solutions for farmers.
- Mobile telephones should be used as an extension tool to aid communication and support the extension activities.
- The scale of extension activities should be appropriate to production capacity: most of those involved are small-scale rice farmers who plant not more than 4 ha (25 *rai*) per year, yielding a capacity of not more than 15 tonnes per annum.
- In line with the results of the study on the knowledge, skills and experience of smart farmers, the project training program should in the future place more emphasis on post-harvest technology, marketing, food processing and integrated pest management.
- The smart farmers show a good ability to work at high levels, but their knowledge, experience and skill on technology transfer was found to be lower than their other competencies. The researchers recommended increased focus on this area.
- Attention should be paid to sustaining the positive attitude of smart farmers to government policy, through frequent and continuous public relations work.
- As most smart farmers were found to be satisfied with their living and occupations but less satisfied with marketing and pricing, it is recommended that future development should be more concerned with marketing factors and other related market activities.

From Watershed Research to Agricultural Strategies in a Commune of Northern Vietnam: Local Knowledge for Natural Resources Management

Tran Duc Toan¹, D. Orange², P. Salgado³, Le Hoa Binh⁴, Do Duy Phai¹ and F. Clément⁵

1 NISF (National Institute for Soils and Fertilizers), MARD, Hanoi

2 IRD (Research Institute for Development, France) and IWMI-SEA, NISF, Hanoi

3 CIRAD (France), posted in NIAH, Hanoi

4 NIAH (National Institute for Animal Husbandry), MARD, Hanoi

5 CLUWRR, University of Newcastle-upon-Tyne, U.K.

Contact address: toantrantnnh@yahoo.com.vn

In spite of the green revolution of the 1990s, guaranteeing food security remains a challenge in large parts of the mountains of Southeast Asia. It is largely accepted that the most suitable farming systems for the uplands are based either on tree crops or mixed crop-livestock systems, both to manage the soil fertility and to maintain the soil in place. How can this be applied for a sustainable farming system? This project, from the *DURAS international program* to promote sustainable development in agricultural systems, aims to develop and enhance sustainable agriculture that makes the best use of: 1) the local knowledge and skills of farmers; 2) social capital - people's capacities to work together to solve common management problems; 3) nature's goods and services; and 4) public goods - rural jobs, clean water, flood protection, landscape quality, etc.

More specifically, the Vietnamese part of this project works specifically on a better understanding of local-knowledge implications from the disadvantaged communities living in mountainous areas through the spontaneous innovations of farming systems. Local participation has been strengthened along the research and extension processes by a case study: the introduction of fodder crop in the farming system. After completion and evaluation of the first round of fodder tests within experimental plots, on-farm tests have been conducted under farmer management for the most promising species. The farmers selected the fodder species (temperate and/or tropical), the planting place (upland and/or lowland) and the surface on which to cultivate. Interactions with farmers and local extension officers were initiated at the very onset of the project through a former project on watershed management (MSEC program). In addition, experiments and surveys of fodder crops (yield, harvesting and forage management, agricultural calendar etc.) were conducted in close cooperation with farmers in their own fields. Dissemination of the results of these two activities have after one year been greatly facilitated, not only at the village level but also at the commune level.

Thus, it seems that methodologies tested and developed by the project will contribute to an improvement of extension approaches for extension workers and local managers as well as to a better linkage between researchers, development agents and farmers. On the other hand, the project is also carrying out experiments on soil and water quality to improve water and soil fertility management at the watershed level, as well as an assessment of the productivity and nutritional value of tested fodder species and their seed production capacity in Southeast Asian mountain conditions. Based on knowledge gained during farmer meetings and experience from the experimental fields, farmers have already defined their strategy. They cultivate only tropical species in the uplands and temperate species in the lowlands, in keeping with scientific knowledge. During the first year, 2006, around 4 ha of forage have been planted; next year more than 20 ha will be planted with fodder. So, by involving village groups as participants, all arguments are mobilized for the successful identification, definition and extension of new agricultural practices for husbandry integration. Furthermore, effective dissemination can be expected in the future.

List of Participants

As of November 29, 2006

Bangladesh

Dr. Khaled Misbahuzzaman
Associate Professor
Institute of Forestry and Environmental
Sciences
Chittagong University
Chittagong, Bangladesh
Email: kmzaman_for@yahoo.com

Bhutan

Mr. A Karma Rinzin
Senior Planning Officer
Policy & Planning Division
Ministry of Agriculture
Royal Government of Bhutan
Thimphu, Bhutan
Email: ak_rinzin@moa.gov.bt

Ms. Dema
Planning Officer
Policy and Planning Division
Ministry of Agriculture
Royal Government of Bhutan
Thimphu, Bhutan

Mr. Rinzin Dorji
Planning Officer
Policy and Planning Division
Ministry of Agriculture
Royal Government of Bhutan
Thimphu, Bhutan

Ms. Mumta Chhetri
Research Officer
RNR-RC Yusipang
Ministry of Agriculture
Royal Government of Bhutan
Thimphu, Bhutan

Botswana

Dr. Benedict Kayombo
Associate Professor
Agricultural Engineering & Land Planning
Private Bag 0027, Gaborone
Gaborone Region, Botswana
Email: bkayombo@bca.bw

Cambodia

Dr. Suraphol Chandrapatya
Senior Agricultural and Extension Specialist
IWMI
P.O. Box 1135
Phnom Penh, Cambodia
Email: s.chandrapatya@cgiar.org

Mr. Khom Sok
Focal Point
AIFP
MRC-GTZ Cooperation
Phnom Penh, Cambodia
Email: khom@cnmc.gov.kh

Mr. Bunnara Min
Country Coordinator
WSMP Cambodia
MRC-GTZ Cooperation
Phnom Penh, Cambodia
Email: bunnara@mrckmekong.org

Mr. So Than
Deputy Chief
Forestry Administration
Siem Rap, Cambodia
Email: so_than@yahoo.com

China

Ms. Xiaoqian Liu
College of Humanities and Development
China Agricultural University
No. 2 Yuanmingyuan Xilu, Haidian District,
Beijing 100094, P.R. China
Beijing, China
Email: lxqcici@yahoo.com.cn

Dr. Horst Weyerhaeuser
Country Coordinator
ICRAF-China
#12 Zhongguancun Nan Dajie,
CAAS mailbox 195,
Beijing 100081, China
Email: H.Weyerhaeuser@cgiar.org

Dr. Leshan Jin
Professor
College of Humanities and Development
China Agricultural University
No. 2 Yuanmingyuan Xilu, Haidian District
Beijing 100094, China
Email: jinls@cau.edu.cn

Dr. Xiaoyun Li
Dean
College of Humanities and Development
China Agricultural University
No. 2 Yuanmingyuan Xilu, Haidian District
Beijing 100094, China
Email: xiaoyun@cau.edu.cn

Dr. Ting Zuo
Vice Dean
College of Humanities and Development
China Agricultural University
No. 2 Yuanmingyuan Xilu, Haidian District
Beijing 100094, China
Email: zuoting@cau.edu.cn

Dr. Xing Lu
Director
Regional Development Research Center
Yunnan University
No. 20 Xuefu Road
Kunming, Yunnan, 650223, China
Email: lvxing@ynu.edu.cn

Mr. Shicai Shen
project staff
Livelihoods Program
Center for Biodiversity and Indigenous
Knowledge
3F, Building A, Zhonghuan Dasha, Yanjiadi,
Kunming
Yunnan, China
Email: shenshicai@cbik.ac.cn

Mr. Hetong Li
Regional Development Research Center
GMS Study Center of Yunnan University
No.20 Xue Fu Road Kunming
Yunnan 650223, China
Email: helten@21cn.com

France

Dr. Patrice Cayre
Director
Research Department on Living Resources
IRD
213 Rue La Fayette
75010 Paris, France
Email: drv@paris.ird.fr

Dr. Emmanuel Mouche
Engineer
Laboratory for Climate and Environment
Sciences
Atomic Energy Commission
LSCE, Orme des Merisiers,
91191 Gif sur Yvette Cedex, France
Email: emmanuel.mouche@cea.fr

Dr. Christian Valentin
Project leader
IRD-IWMI
IRD
32, av. H. Varagnat,
93143 Bondy , Cedex, France
Email: valentin@bondy.ird.fr

Dr. Sébastien Barot
Researcher
LEST/IRD
32 Av. H Varagnat
93143 Bondy Cedex, France
Email: barot@bondy.ird.fr

Dr. Pascal Jouquet
Soil Scientist
UMR 137 BIOSOL/IRD
32, av. H. Varagnat
93143 Bondy Cedex, France
Email: pascal.jouquet@bondy.ird.fr

Dr. Jean-Christophe Castella
Researcher
IRD
B.P. 64501, 34394
Montpellier Cedex 5, France
Email: j.castella@ird.fr

Dr. Anneke de Rouw
Agronomist
UR176/IRD
Tour 56/66 cc 120, Universit Pierre et Marie
Curie, 4 place Jussieu, 75005
Paris, France
Email: de_rouw@bondy.ird.fr

Indonesia

Dr. Meine van Noordwijk
Regional Coordinator
ICRAF
Bogor, Indonesia
Email: m.vannoordwijk@CGIAR.ORG

Dr. Laxman Joshi
Ethno-ecologist
Agroforest Management Unit
ICRAF
P O Box 161, Bogor 16001
West Java, Indonesia
Email: L.Joshi@cgiar.org

Mr. Degi Harja
Computer Modeler
Ecological Modeling Unit
ICRAF
Jl. Cifor, Situgede, Sindang Barang, Bogor
West Java, Indonesia
Email: d.harja@cgiar.org

Dr. Kasdi Subagyo
Director
Indonesian Agroclimate and Hydrology
Research Institute (IAHRI)
Jl. Tentara Pelajar No. 1A, BOGOR 1611
West Java, Indonesia
Email: kasdi_s@yahoo.com

Japan

Dr. Ryuichi Yamada
Senior researcher
Development Research Division
JIRCAS
1-1, Ohwashi, Tsukuba, Ibaraki, Japan
Email: ryamada@jircas.affrc.go.jp

Mr. Junichi Kashiwagi
Lecturer
Graduate School of Agriculture
Hokudai University
Sapporo, Hokkaido, Japan
Email: kashi@env.agr.hokudai.ac.jp

Mr. Koji Watabe
Student (Master's course)
Graduate School of Agriculture
Hokudai University
Sapporo-060-8589 , Hokkaido, Japan
Email: xxkojixx@env.agr.hokudai.ac.jp

Dr. Vemuri Chowdary
JSPS Postdoctoral fellow
CSEAS
Shugakuin Kyoto University
International House, 508, 1- Ichoda cho,
Yamabana, Sakyoku
Kyoto, Japan
Email: vemuri@cseas.kyoto-u.ac.jp

Lao PDR

Mr. Somephonpheng Lasasombat
Teacher
Bolikhamxay Agriculture and Forestry College
Ban Houay Khoun, Bolikhan District
Bolikhamxay, Lao PDR

Mr. Somsavat Xomkhamnilandone
Deputy director
Bolikhamxay Agriculture and Forestry College
Ban Houay Khoun, Bolikhan district
Bolikhamxay, Lao PDR

Mr. Sisavath Khanthaboun
Head of DAFEO
District Agriculture and Forestry Extension
Office
Bolikhan district
Bolikhamxay, Lao PDR

Mr. Bounngouane Sengthanouxay
District Agriculture and Forestry Extension
Office
Pakkading district
Bolikhamxay, Lao PDR

Mr. Sithpaseuth Maniphon
National project coordinator
Lao-Luxembourg
Paksan city
Bolikhamxay, Lao PDR
Email: Laolu006@laotel.com

Mr. Vanvay Chitpaseuth
NTFP specialist
Integrated Rural Development Project
Lao-Luxembourg
Bolikhamxay, Lao PDR
Email: vvay_ntfp@yahoo.com

Mr. Buntheung Thanaxay
Forester/PAFEO
Conservation unit of Provincial Forestry
Section
Provincial Agriculture and Forestry Office
Bolikhamxay, Lao PDR

Mr. Rob Murdoch
Rural Development Adviser
EU Microproject
Viengphoukha, Luang Namtha, Lao PDR
Email: mpvpk@laotel.com

Mr. Soum Nilsvang
Rural Development Advisor
EU Microproject
Long District, Luang Namtha, Lao PDR
Email: mplong@laotel.com

Mr. Oulayvanh
Socio-economist
EU Microproject
Long District, Luang Namtha, Lao PDR
Email: mplong@laotel.com

Mr. Nilandone Thavonsouk
Socio-economic adviser
EU Microproject
Viengphoukha, Luang Namtha, Lao PDR
Email: mpvpk@laotel.com

Mr. Samlan Phonthiene
NRM Advisor
RDMA/GTZ
Box 100 Muang Sing
Luang Namtha, Lao PDR
Email: samlan@gtrural.org

Mr. Randall Ritzema
Graduate Student Researcher
PO Box 600
Luang Prabang, Lao PDR
Email: rsritzema@ucdavis.edu

Dr. Benjamin Samson
Scientist, Agronomist
Crop and Environmental Sciences Division
Lao-IRRI Project Office, PAFO Compound
Luang Prabang, Lao PDR
Email: b.samson@cgiar.org

Mr. Somsy Khamany
Teacher Agroforestry
Luang Prabang Agriculture and Forestry College
Paksueang, Luang Prabang, Lao PDR

Mr. Vilaphone Phanjasone
Teacher
Luang Prabang Agriculture and Forestry College
Paksueang, Luang Prabang, Lao PDR

Mr. Khamphoui Phonexay
Director
Luang Prabang Agriculture and Forestry College
Paksueang, Luang Prabang, Lao PDR

Mr. Bounkieng Sulinjasak
Teacher Upland Agriculture
Luang Prabang Agriculture and Forestry College
Paksueang, Luang Prabang, Lao PDR

Mr. Matthias Rimarzik
Advisor
DED
Luang Prabang Agriculture and Forestry College
P.O. Box 771
Paksueang, Luang Prabang, Lao PDR
Email: rimarzik@yahoo.com

Mr. Outhai Suokkhy
Students Management
Luang Prabang Agriculture and Forestry College
Paksueang, Luang Prabang, Lao PDR

Mr. Somphong Pradichith
Director
Luang Prabang Provincial Agriculture and
Forestry Office
Luang Prabang, Lao PDR

Mr. Bounhueng Duangphachanh
Provincial Governor
Luang Prabang Provincial Governors Office
Luang Prabang, Lao PDR

Mr. Houmchitsavat Sodarak
Director
Northern Agriculture and Forestry Research
Center/NAFRI
P.O Box: 487
Luang Prabang, Lao PDR
Email: frclpb@laotel.com

Mr. Martin Greijmans
Adviser
SNV/NAFReC/NAFRI
Luang Prabang, Lao PDR
Email: mgreijmans@snvworld.org

Mr. Sianouvong Savathvong
Chief
Forestry Section
PAFO, Luang Prabang
Provincial Forestry Office Mano Area,
Thammikarath Road
Luang Prabang, Lao PDR
Email: sianouv@yahoo.com

Mr. Vixay Chansavang
Souphanouvong University
Luang Prabang, Lao PDR

Mr. Pieter-Jan Bouw
Team Leader
World Vision
Luang Prabang, Lao PDR
Email: Pieter-Jan_Bouw@wvi.org

Mr. Bounkorn Sapsiri
ADP Coordinator
Area Development Program (ADP)
World Vision Lao PDR
Luang Prabang, Lao PDR
Email: Bounkorn_Sapsiri@Worldvision.or

Mr. Khampheng Mounmeuangxam
Program Coordinator
Ngoi Area Development Program
World Vision
Luangparbang, Lao PDR
Email: khampheng_mounheungxap@wvi.org

Mr. Rick Krenzer
Northern Programme Officer
Food-for-Work
World Food Programme
Navan Noi Village, Xai District
Oudomxai, Lao PDR
Email: rick.krenzer@wfp.org

Mr. Patrick Lucas
Community Planning Facilitator
Oudomxay Science Technology &
Environment Office, CUSO Lao PDR
Xay District, Oudomxay, Lao PDR
Email: laocatalyst@yahoo.com

Dr. Adrian Schuhbeck
Programme Coordinator
Community Based Rural Development
Programme/ DED
PO Box 207
Oudomxay, Lao PDR
Email: adrian.schuhbeck@ded.de

Mr. Somsamouth Phongsavath
Deputy Coordinator of OCISP/PAFO
Provincial Agriculture and Forestry Office
Oudomxay
Oudomxay, Lao PDR
Email: somsamouth_ph@yahoo.com

Mr. Annoukhone Nagavong
Watershed Management Project Team Member
Oudomxay Science Technology &
Environment Office (STEa)
Xay District, Oudomxay, Lao PDR
Email: annoukhone@yahoo.com

Mr. Khonsey Xaynganamone
Watershed Management Project Team Leader
Oudomxay Science Technology &
Environment Office (STEa)
Xay District, Oudomxay, Lao PDR
Email: kh.xaynganamone@yahoo.com

Mr. Holger Grages
Project Manager
Integrated Poverty Reduction Project
GAA
P.O. Box 99, Mueang Khoua, Mai District
Phongsaly, Lao PDR
Email: hobuli@gmx.de

Dr. Pengkham Miphouvieng
Project Coordinator
Integrated Poverty Reduction Project
GAA
P.O. Box 99, Mueang Khoua
Mai Distric
Phongsaly, Lao PDR
Email: hobuli@gmx.de

Mr. Basanta Adhikary
Agriculture Advisor
RDMA Sayaboury
GTZ
RDMA-Hongsa district
Sayaboury, Lao PDR
Email: basanta@gtzrural.org

Mr. Ian Davies
Consultant
P O Box : 3933
JICA
Vientiane Capital, Lao PDR
Email: akikoian@gmail.com

Dr. Jutta Krahn
Postbox 3680
Vientiane Capital, Lao PDR
Email: jukrahn@gmx.de

Dr. Joep Slaats
Consultant
#558/01, Unit 35, Ban Phongtongsavath,
Chantabouly District
Vientiane Capital, Lao PDR
Email: Joep.slaats@laopdr.com

Dr. Tin Maung Aye
Project Fellow/ Agronomist
Cassava project
CIAT Asia Office, NAFRI campus
Vientiane Capital, Lao PDR
Email: t.aye@cgiar.org

Dr. Rod Lefroy
Program Coordinator
CIAT in Asia
Vientiane Capital, Lao PDR
Email: r.lefroy@cgiar.org

Dr. Thiphavong Boupcha
CIAT in Asia
P O Box : 783
Vientiane Capital, Lao PDR
Email: t.boupcha@cgiar.org

Dr. Keith Fahrney
Project Coordinator
PRDU project
CIAT Asia Office, NAFRI campus
Vientiane Capital, Lao PDR
Email: k.fahrney@cgiar.org

Mr. Lao Thao
Research Assistant
PRDU project
CIAT Asia Office, NAFRI campus
Vientiane Capital, Lao PDR
Email: k.fahrney@cgiar.org

Mr. John Connell
Project Coordinator-Laos
SADU project
CIAT Asia Office, NAFRI campus
Vientiane Capital, Lao PDR
Email: j.connell@cgiar.org

Mr. Ounkeo Pathammavong
Agroenterprise Development Specialist
SADU project
CIAT Asia Office, NAFRI campus
Vientiane Capital, Lao PDR
Email: o.pathammavong@cgiar.org

Ms. Katja Hinzmann
Advisor
Upland Agriculture Development Center
DED
P.O. Box 2455
Vientiane Capital, Lao PDR
Email: katja.hinzmann@lycos.de

Mr. Vilaphorn Visounnarath
Manager
Environmental Office
Department of Electricity
Nongbone Road, PO BOX 309
Vientiane Capital, Lao PDR
Email: vilaphorn_v@hotmail.com

Mr. Khammanh Sopraseurth
Technical Staff
Electricity Department of Lao PDR (EDL)
Nong Born Road P-O-Box 4708
Vientiane Capital, Lao PDR
Email: k_manh@yahoo.com

Mr. Chantho Milattanahpeng
Chief of Division
Social and Environ. Management Division
Electricity Department of Lao PDR
Nong Bone Road, P.O.Box:4708
Vientiane Capital, Lao PDR
Email: hhpo@laotel.com

Ms. Kanako Kihara
JICA Adviser
Department of Forestry
Thatdam.Rd. P.O.Box 2932
Vientiane Capital, Lao PDR
Email: sasakama@bridge.ocn.ne.jp

Ms. Lisbet Bostrand
1st Secretary
Sida
Embassy of Sweden
Vientiane Capital, Lao PDR
Email: lisbet.bostrand@sida.se

Mr. Florian Rock
Teamleader
Land Policy Development Project
GTZ
P.O. Box 9233
Vientiane Capital, Lao PDR
Email: Florian.Rock@gtz.de

Mr. Phoui Siksidao
Coordinator
RDMA/GTZ
RDMA Office No. 120, Unit 6 Ban Naxay.
Saysetha district
Vientiane Capital, Lao PDR
Email: Phoui.siksidao@gtz.de

Dr. Daniel Benoit
Representative in Laos
IRD
PO Box 5992
Vientiane Capital, Lao PDR
Email: dlbenoit@irdlaos.org

Mr. Alain Pierret
IRD
c/o Ambassade de France - BP 06
Vientiane Capital, Lao PDR
Email: alain.pierret@ird.fr

Mr. Olivier Planchon
IRD
Vientiane Capital, Lao PDR
Email: olivier.planchon@gmail.com

Dr. Bernard Moizo
Senior researcher
IRD/NUOL Project
BP 5992
Vientiane Capital, Lao PDR
Email: BMoizo@laopdr.com

Dr. Gary Jahn
IRRI Representative to Lao PDR
Lao-IRRI Project
IRRI
Vientiane Capital, Lao PDR
Email: gjahn@cgiar.org

Dr. Peter Messerli
Researcher
Lao National Mekong Committee
c/o LNMCS, Lane Xang Avenue
Vientiane Capital, Lao PDR
Email: peter.messerli@cde.unibe.ch

Dr. Silavanh Savathvong
Deputy Director
Department of Forestry
MAF
Vientiane Capital, Lao PDR
Email: sawathvong@yahoo.com

Mrs. Bounchan Khammoungkhoun
Agriculture project officer
Mennonite Central Committee
Vientiane Capital, Lao PDR
Email: mccagr@gmail.com

Dr. Ty Phonmasak
Vice Minister
Ministry of Agriculture and Forestry
Vientiane Capital, Lao PDR

Dr. Phouangparisak Pravongviengkham
Permanent Secretary
Permanent Secretary's Office
Ministry of Agriculture and Forestry
Vientiane capital, Lao PDR
Email: pppravongviengkham@yahoo.com

Mr. Seng Hkum Nhkum
Project Management Advisor
Nam Ngum River Basin Sector Project
Ministry of Agriculture and Forestry
Vientiane Capital, Lao PDR
Email: senghkum@yahoo.com

Mr. Suksavanh Sayarath
Department of Production and Trade
Promotion
Ministry of Handicrafts and Industry
Vientiane Capital, Lao PDR
Email: suksaya@yahoo.com

Mr. Chansamone Sisath
Department of Production and Trade
Promotion
Ministry of Handicrafts and Industry
Vientiane Capital, Lao PDR

Mr. Inthava Sanouvong
Data/information System manager
AIFP-Watershed Management
MRC GTZ Cooperation
Vientiane Capital, Lao PDR
Email: inthava@mrcmekong.org

Mr. Vatthanamixay Chansomphou
Information Management
AIFP-Watershed Management
MRC-GTZ Cooperation
Vientiane Capital, Lao PDR
Email: vatthanamixay@mrcmekong.org

Mr. Christoph Feldkoetter
Advisor Watershed, Information Management
AIFP-Watershed Management
MRC-GTZ Cooperation
Vientiane Capital, Lao PDR
Email: cfeldko@mrcmekong.org

Mr. Phoukhong Phongsa
Country Liaison Officer
AIFP-Watershed Management
MRC-GTZ Cooperation
Vientiane Capital, Lao PDR
Email: phoukhong@mrcmekong.org

Mr. Phonepaseuth Phouliphanh
AIFP National Coordinator
AIFP-Watershed Management
MRC-GTZ Cooperation
Vientiane Capital, Lao PDR
Email: phonepaseuth@lnmc.gov.la

Ms. Nalinthone Vissapra
Information Assistant
AIFP-Watershed Management
MRC-GTZ Cooperation
Unit 18 Ban Sithane Neua, Sikottabong Distric
Vientiane Capital, Lao PDR
Email: nalinthone@mrcmekong.org

Mr. Inpan Southanousin
Deputy Director General
NAFES
Hoay Njang, Vientiane Capital, Lao PDR
Email: NAFES@LaoEx.org

Mr. Andrew Bartlett
Chief Technical Advisor
Laos Extension for Agriculture Project
NAFES
Hoay Njang, Vientiane Capital, Lao PDR
Email: leap@laoexorg

Ms. Andrea Schroeter
Technical Advisor
Laos Extension for Agriculture Project
NAFES
Hoay njang, Vientiane Capital, Lao PDR
Email: andreaschroeter@gmx.de

Mr. Sisavath Homdara
Technician
Planning and Administration
NAFES
Hoay Njang, Vientiane Capital, Lao PDR
Email: h_sisavath@yahoo.com

Mr. Somxay Sisanoh
Deputy Head
Project Coordination and Management
NAFES
Hoay Njang, Vientiane Capital, Lao PDR
Email: somxay@laoex.org

Mr. Bouali Phamieung
Head
Rural Development
NAFES-Forestry Department
Vientiane Capital, Lao PDR
Email: nafes@laoex.org

Dr. Bounthong Bouahom
Director General
NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: bounthong@nafri.org.la

Mr. Soulivanthong Kingkeo
Deputy Director General
NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: soulivanthong.k@nafri.org.la

Mr. Sisongkham Mahathilath
Deputy Head of Administration Division
NAFRI
P.O. Box 7170
Vientiane Capital, Lao PDR
Email: sisongkham.m@nafri.org.la

Mr. Phouthone Sopthilath
Head of International Cooperation Unit
NAFRI
P.O. Box 7170
Vientiane Capital, Lao PDR
Email: phouthone.s@nafri.org.la

Ms. Kesone Keohavong
Administration, Finance and Planning
Division
NAFRI
Vientiane Capital, Lao PDR
Email: kesone.k@nafri.org.la

Mr. Thanoukhom Khennavong
Administration, Finance, Planning and
Cooperation Division
NAFRI
Vientiane Capital, Lao PDR
Email: thanoukhom.k@nafri.org.la

Mr. Khampha Chanthilath
Head of Component
Farming System Research/Extension
Component - LSUAFRP
NAFRI
Vientiane Capital, Lao PDR
Email: khampha@nafri.org.la

Mr. Khamphone Mounlamay
Head of Component
Forestry Research Center - LSUAFRP
NAFRI
Vientiane Capital, Lao PDR
Email: khamphonemou@yahoo.com

Mr. Matthias Plewa
Adviser
Horticulture Research Center
NAFRI
PO Box 2455 Vientiane
Vientiane Capital, Lao PDR
Email: matthias.plewa@gmx.de

Ms. Tonglien Vilyphone
Officer
Horticulture Research Center
NAFRI
Vientiane Capital, Lao PDR

Mr. Khamphay Manivong
Chief of Division
Information Management Division
NAFRI
P.O. Box 7170
Vientiane Capital, Lao PDR
Email: khamphay.m@nafri.org.la

Ms. Khanthamaly Chanthalangsy
Technical
Information Management Division
NAFRI
P.O. Box 7170
Vientiane Capital, Lao PDR
Email: khamthamaly@nafri.org.la

Mr. Sonekham Namlamoun
ICT Technical
Information Management Division
NAFRI
P.O. Box: 7170
Vientiane Capital, Lao PDR
Email: sonekham@nafri.org.la

Mr. Khankham Ouneoudom
Technical
Information Management Division
NAFRI
P.O. Box 7170
Vientiane Capital, Lao PDR
Email: khankham@nafri.org.la

Mr. Duansavanh Phouangkhamso
ICT Technician
Information Management Division
NAFRI
P.O. Box: 7170
Vientiane Capital, Lao PDR
Email: duansavanh@hotmail.com

Mr. Bandith Ramangkoun
Head of Information Service Component
Information Management Division
NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: bandith@nafri.org.la

Mr. Phonepaseuth Vongsipasom
ICT technician
Information Management Division
NAFRI
P.O. Box: 7170
Vientiane Capital, Lao PDR
Email: phonepaseuth@nafri.org.la

Ms. Phetsamone Xoumphonphakdy
Technical
Information Management Division
NAFRI
P.O. Box 7170
Vientiane Capital, Lao PDR
Email: petsamone@nafri.org.la

Mr. Emmanuel Bourdon
Engineer
IRD-IWMI/NAFRI
BP 06
Vientiane Capital, Lao PDR
Email: bourdon@irdlaos.org

Mr. Soullileuth Bousamay
Assistant MSEC Project
IRD-IWMI/NAFRI
P O 06
Vientiane Capital, Lao PDR

Mr. Latsachak Keooudone
Assistant MSEC Project
IRD-IWMI/NAFRI
BP 06
Vientiane Capital, Lao PDR

Mr. Xayyathip Khampaseuth
Assistant MSEC Project
IRD-IWMI/NAFRI
BP06
Vientiane Capital, Lao PDR

Mr. Yann Le Troquer
Technician
IRD-IWMI/NAFRI
BP 06
Vientiane Capital, Lao PDR
Email: yann.le_troquer@irdlaos.org

Mr. Guillaume Lestrelin
Geographer
IRD-IWMI/NAFRI
Vientiane Capital, Lao PDR
Email: guillame.lestrelin@durham.ac.uk

Dr. Olivier Ribolzi
Researcher
IRD-IWMI/NAFRI
Vientiane Capital, Lao PDR
Email: olivier.Ribolzi@irdlaos.org

Mr. Tasaketh Sengkeo
Assistant MSEC Project
IRD-IWMI/NAFRI
BP06
Vientiane Capital, Lao PDR
Email: tsengkeo@yahoo.com

Mr. Jean-Pierre Thiebaut
Engineer
IRD-IWMI/NAFRI
BP 06
Vientiane Capital, Lao PDR
Email: thiebautxird@laopdr.com

Mr. Rudolf van der Helm
MSc student
IRD-IWMI/NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: rudolf.vanderhelm@wur.nl

Dr. Olga Vigiak
post-doc
IWMI-IRD/NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: o.vigiak@cgiar.org

Mr. Carl Mossberg
Programme Management Adviser
LSUAFRP/NAFRI
PO Box 4289
Vientiane Capital, Lao PDR
Email: carl@laotel.com

Ms. Yayoi Fujita
Local Advisor
LSUAFRP - Socio-Economic Unit
NAFRI
Vientiane Capital, Lao PDR
Email: yayoi@nafri.org.la

Mr. Peter Jones
Land Use Adviser
LSUAFRP - Land Management Component
NAFRI
P.O. Box 7170
Vientiane Capital, Lao PDR
Email: prjones@laotel.com

Dr. Paulo Pasicolan
Forest Research Adviser
LSUAFRP- Forest Research Component
NAFRI
PO Box 4298
Vientiane Capital, Lao PDR
Email: paulopasicolan@yahoo.com

Mr. Michael Victor
Information Services Adviser
LSUAFRP- Information Services Component
NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: omichael@loxinfo.co.th

Mr. Erik Pettersson
Associate Expert - Socio-economics
LSUAFRP-Socio-economic Component
NAFRI
PO Box 4298
Vientiane Capital, Lao PDR
Email: eupettersson@gmail.com

Mrs. Bounsay Chantharath
PRONAE/NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: pronae.pcadr@nafri.org.la

Mr. Chanthasone Khamxaykay
PRONAE/NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: khamxaykhay@yahoo.com

Mr. Pascal Lienhard
PRONAE/NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: plienhard@hotmail.com

Mr. Khamkeo Panyasiri
National Program Coordinator
PRONAE/NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: K_panyasiri@yahoo.com

Mr. Thammakham Sosomphou
PRONAE/NAFRI
PO Box 7170
Vientiane Capital, Lao PDR
Email: pronae.pcadr@nafri.org.la

Dr. Florent Tivet
Technical Advisor
PRONAE/NAFRI
Vientiane Capital, Lao PDR
Email: Florent.tivet@cirad.fr

Dr. Linkham Douangsavanh
Head of SEU
Socio-economic Unit, Information Division
NAFRI
Vientiane Capital, Lao PDR
Email: Linkham.d@nafri.org.la

Mr. Kongkeo Phachonephon
Soil Science and Land Classification Center
NAFRI
Vientiane Capital, Lao PDR

Mr. Oloth Sengtaheuanghong
Acting of Director
Soil Science and Land Classification Center
NAFRI
Vientiane Capital, Lao PDR
Email: oloth.s@nafri.org.la

Mr. Khamkone Sayakounmane
Soil Science and Land Classification Center
NAFRI
Vientiane Capital, Lao PDR

Mr. Bounthieng Sengmany
Head of Land Management Component
Soil Science and Land Classification Center
NAFRI
Vientiane Capital, Lao PDR

Mr. Noel Bouathong
Head of Department of Agronomy
Faculty of Agriculture, Nabong campus
NUOL
Vientiane Capital, Lao PDR
Email: noel_bouathong@yahoo.com

Mr. Bounthene Prasiboriboun
Head of Department
Department of Watershed Management and
Land Use Planning, Faculty of Forestry
Faculty of Forestry
NUOL
Vientiane Capital, Lao PDR
Email: bounthene_p@yahoo.com

Mr. Inthong Somphou
Chief of Division of Research Affaires
Division of Research Affaires, Faculty of
Agriculture (FOA), Nabong campus
NUOL
Vientiane Capital, Lao PDR
Email: inthongsomphou@yahoo.com

Mrs. Pem Luangsackda
Lecturer of Soil Science
Faculty of Agriculture, Nabong Campus
NUOL
Vientiane Capital, Lao PDR

Mr. Khamla Phanvilay
Vice Dean
Faculty of Forestry/NUOL
Vientiane Capital, Lao PDR
Email: klphanvilay@hotmail.com

Dr. Sithong Thongmanivong
Head of Research and Post Graduate Division
Faculty of Forestry/NUOL
Vientiane Capital, Lao PDR
Email: sithongth@hotmail.com

Dr. Phouth Simmalamvong
Dean
Faculty of Social Sciences/NUOL
PO Box 7322, Dongdok Campus
Vientiane Capital, Lao PDR
Email: phouth_s@nuol.edu.la

Ms. Viengkham Chantavong
Lecturer of Plant pathology
Laboratory of Plant pathology Analysis,
Faculty of Agriculture (FOA), Nabong campus
NUOL
Vientiane Capital, Lao PDR
Email: vongsana20@hotmail.com

Mr. Bounpanh Senethavisouk
Program Officer
Oxfam
Sisangvone village, Saysetha district
Vientiane Capital, Lao PDR
Email: oxfamsolpo@laopdr.com

Mr. Bounlouay Vongsay
Project Coordinator Assistant/PAFO
Phonsung Sustainable Agriculture Project
Vientiane Capital, Lao PDR
Email: oxfamsolpo@laopdr.com

Ms. Soulivanh Bouakham
Deputy director
Administration Division
Department of Land Development
Prime Minister's Office
Vientiane Capital, Lao PDR
Email: boua990@yahoo.com

Mr. Palikone Thalongsengchanh
Department of Land Development
Prime Minister's Office
Vientiane Capital, Lao PDR

Ms. Barbara Böni
Head
SDC Branch Office Laos
Swiss Agency for Development and
Cooperation (SDC)
192/1 Sibounheuang Road
Vientiane Capital, Lao PDR
Email: barbara.boeni@sdc.net

Mr. Viengkeo Phetnavongxay
Rural Development and Natural Resources
Management Sector Unit
The World Bank
Vientiane Capital, Lao PDR
Email: vphetnavongxay@worldbank.org

Mr. Somebath Vonglatsamee
Deputy Director
Upland Agriculture Development Center
Phonemy village Viangkham District
Vientiane Province, Lao PDR
Email: somebathvonglatsamee@yahoo.com

Nepal

Ms. Elisabeth Kerkhoff
Agroforestry Expert
Natural Resource Management Programme
ICIMOD
GPO Box 3226
Kathmandu, Nepal
Email: ekerkhoff@icimod.org

Dr. Isabelle Providoli
Soil and Water Conservation Specialist
Natural Resource Management Programme
ICIMOD
GPO Box 3226
Kathmandu, Nepal
Email: iprovidoli@icimod.org

Mr. Kamal Prasad Aryal
Student
Swedish Biodiversity Centre (CBM)
ICIMOD
G.P.O. Box 3226
Kathmandu, Nepal
Email: aryal.kamal@gmail.com

The Netherlands

Dr. Stephan Mantel
Project officer Land Resources Decision
Support
ISRIC - World Soil Information
Wageningen University
Box 353 - 6700
AJ WAGENINGEN, Netherlands
Email: Stephan.Mantel@wur.nl

Dr. Geert Sterk
University Lecturer
Erosion and Soil & Water Conservation group
Wageningen University
P.O. Box 47, 6700 AA Wageningen
Gelderland, Netherlands
Email: geert.sterk@wur.nl

Pakistan

Ms. Tabassum Iffat
Lecturer
Department of Geography
University of Peshawar
NWFP, Pakistan
Email: hayatkhattak@yahoo.com

The Philippines

Dr. Delia Catacutan
World Agroforestry Centre
ICRAF/Philippines
Los Banos, Philippines
Email: delia_icraf@yahoo.com

Ms. Maria Teresa de Guzman
Science Research Specialist
Agricultural Resources Management Research
Division
Philippine Council for Agriculture, Forestry
and Natural Resources Research and
Development (PCARRD)
Los Banos , Laguna, Philippines
Email: t.deguzman@pcarrd.dost.gov.ph

Dr. Blesilda Calub
Affiliate Assistant Professor
Integrated Farming Systems and Agricultural
Extension Division Agricultural Systems
Cluster
University of the Philippines Los Banos
Los Banos , Laguna, Philippines
Email: bmcclub@gmail.com

Dr. Sushil Pandey
Economist
Social Sciences Division
IRRI
DAPO Box 77777
Makati City, Philippines
Email: sushil.pandey@cgiar.org

Sweden

Dr. Lill Lundgren
Technical Director
Ramboll Natura
P O Box 4205
Stockholm, Sweden
Email: lill.lundgren@ramboll.se

Thailand

Mr. Satit Sueprasertsuk
Senior Civil Engineer and AIFP Coordinator
Agriculture Irrigation and forestry Programme
180/3 Rama 6 Rd, Soi Phibul wattana Phayathai
Bangkok 10400, Thailand
Email: konbannork@yahoo.com

Mr. Pongchai Dumrongrojwattana
Ph.D. Student
Department of Biology, Faculty of Science
Chulalongkorn University
Bangkok, Thailand
Email: dpongchai@hotmail.com, dpongchai@yahoo.com

Ms. Cecile Barnaud
PhD student
CU-CIRAD
Chulalongkorn University, 254 Phayathai Road,
Bangkok 10330, Thailand
Email: cecilebarnaud@yahoo.fr

Dr. Christophe Le Page
French coordinator
CU-CIRAD, Chulalongkorn University
Phayathai Road, Pathumwan
Bangkok, Thailand
Email: Christophe.l@chula.ac.th

Ms. Amelia O'Brien
Volunteer - Scientific Research Officer
Australian Youth Ambassadors
Faculty of Forestry, Kasetsart University
Bangkok, Thailand
Email: amelia.clare.o@gmail.com

Dr. Yuji Niino
Land Management Officer
Regional Office for Asia and the Pacific/FAO
39 Phra Atit Road
Bangkok, Thailand
Email: Yuji.Niino@fao.org

Mr. Arthorn Boonsaner
Forest Hydrologist
Watershed Research Division
61 Paholyothin Rd., Jatujak
Bangkok, Thailand
Email: Arthorn_40@yahoo.com

Mr. Somchai Chuajin
Department of Agriculture
Office of Agricultural Research and
Development Region 3
Bangkok, Thailand
Email: oard3@yahoo.com

Ms. Ronnakorn Triraganon
Capacity Building Coordinator
Capacity Building Product and Services Unit
RECOFTC
P.O. Box 1111 Chatuchak
Bangkok, Thailand
Email: orot@ku.ac.th

Dr. Christer Holtsberg
Swedish Environmental Secretariat for Asia
(SENSA)
Sida
Swedish Embassy, 140 Sukhumvit Road
Bangkok 10110, Thailand
Email: Christer.Holtsberg@sida.se

Dr. Mira Andersson Ovuka
Programme Officer
SENSA/Sida
Swedish Embassy, 140 Sukhumvit Road
Bangkok 10110, Thailand
Email: mira.andersson.ovuka@sida.se

Mr. Kukiat Soitong
Director
Bureau of Rice Promotion
Department of Agriculture Extension
2143 Benjasirikit Building, Phalyothin Road
Bangkok, 10900, Thailand
Email: ksoitong@doae.go.th

Mr. Sanan Peukrat
Chief of Technical Section
Office of Land Development Region 6
84/1 Mu 6 Sanpong, Maerim
Chiang Mai, Thailand
Email: Sanan@ldd.go.th

Dr. Kanjana Chuenpichai
Soil Surveyor
Office of Land Development, Region 6
164 M.3 Chotana Rd. Maerim
Chiang Mai, Thailand
Email: kanjana99@gmail.com

Dr. Mattiga Panomtaranichagul
Associate Professor
Department of Soil Science, Faculty of
Agriculture
Chiang Mai University
Chiang Mai, Thailand
Email: mattiga@chiangmai.ac.th

Mr. Ulrich Schuler
Researcher
Faculty of Agriculture
Chiang Mai University
Chiang Mai, Thailand
Email: ulrich.schuler@gmx.de

Ms. Chalthon Choochareon
Researcher
The Uplands Program
Chiang Mai University
Chiang Mai, Thailand
Email: choocharoen@yahoo.com

Dr. Nathan Badenoch
Post-doc Researcher
Unit for Social and Environmental Research
Chiang Mai University
P.O. Box 144
Chiang Mai, Thailand
Email: baideanach@gmail.com

Ms. Petra Erbe
The Uplands Program
Hohenheim Office, Faculty of Agriculture,
Chiang Mai, Thailand
Email: petra.erbe@web.de

Mr. Dirk Euler
PhD-student
The Uplands Program
Hohenheim Office, Faculty of Agriculture
Chiang Mai, Thailand
Email: deuler@uni-hohenheim.de

Dr. David Thomas
Senior Policy Analyst
ICRAF
P.O. Box 267, CMU Post Office
Chiang Mai, Thailand
Email: thomas2@loxinfo.co.th

Mr. Monchai Phongsir
Advisor
LSUAFRP-- Farming System Research and
Extension
NAFRI
PO Box 14 Khon Kaen University 40002
Khon Kaen, Thailand
Email: monchai7@hotmail.com

Mr. Thawilkal Wangkahart
Agricultural Scientist
Office of Agricultural Research and
Development Regional 3 (OARD3)
Ministry of Agriculture and Cooperatives
(MOAC)
Khon Kaen 40000, Thailand
Email: kwuthinan@hotmail.com

Dr. Suchint Simaraks
Assoc. Prof.
Faculty of Agriculture
Khon Kaen University
Khon Kaen 400002, Thailand
Email: suchint@kku.ac.th

Mr. Sivapong Nareuban
Senior Researcher
Mae Hong Son Rice Research Center
Pang Ma Pa District
Mae Hong Son, Thailand
Email: sivapong2002@hotmail.com

United Kingdom

Ms. Floriane Clement
PhD student
IRD
NE7 1RU, United Kingdom
Email: Floriane.Clement@ncl.ac.uk

USA

Mr. Michael Dwyer
Graduate student
Energy & Resources Group
University of California at Berkeley
Berkeley, California, USA
Email: mdwyer@berkeley.edu

Vietnam

Mr. Tran Duc Toan
Researcher
National Institute of Soils and Fertilizers
Ha Noi, Viet Nam
Email: toantrantnnh@yahoo.com.vn

Mr. Do Duy Phai
Junior Researcher
Department of Land Use
National Institute of Soils and Fertilizers
Ha Noi, Viet Nam
Email: phaidduy@yahoo.com

Mr. Hung Tran Van
Head of International Cooperation
Hanoi, Viet Nam
Email: tranhungfipi@yahoo.com

Dr. Nguyen Van Thang
Deputy Director
Legume R & D Center
Thanh Tri, Hanoi, Vietnam
Hanoi, Viet Nam
Email: Thanglrdc@fpt.vn

Dr. Nguyen Van Dung
Center for Agricultural Research and
Ecological Studies
Hanoi Agricultural University
Hanoi, Viet Nam
Email: nvdung1@hn.vnn.vn

Dr. Didier Orange
Senior Researcher
IRD
National Institute of Soils and Fertilizers
57 Tran Hung Dao , Hanoi, Viet Nam
Email: d.orange@cgiar.org

Dr. Michel Evéquo
Assistant Country Director
Cooperation Office for the Mekong Region
SDC
44b Ly Thuong Kiet, Hanoi Central Office
Hanoi, Viet Nam
Email: Michel.evequo@sd.net