



Twenty years of working towards a sustainable Southeast Asia

1993–2013

Transforming lives and landscapes with trees

HIGHLIGHTS

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TWENTY YEARS OF WORKING TOWARDS A SUSTAINABLE SOUTHEAST ASIA: 1993–2013

TRANSFORMING LIVES AND LANDSCAPES WITH TREES



Foreword

This year, 2013, the World Agroforestry Centre's Southeast Asia Program (and the Indonesia and Philippine programs) celebrates 20 years of agroforestry research for development.

The anniversary has provided us with an opportunity to reflect on the last two decades of work. In these pages, in particular, we have traced the major research thread from its inception searching for alternatives to slash-and-burn agriculture and restoring degraded *Imperata* grassland to the present expansion of negotiation-support methods that encourage low-emissions development through participatory land-use planning. Our region has also embarked on studies pertaining to resource and land rights over the last couple of decades.

The reflective process has enabled us to more clearly see how our strength in fieldwork with farmers, communities, businesses and governments translates into strength in practical agricultural development technologies and national and international policy recommendations. There is a continuum of evidence, knowledge and of purpose that provides us with the confidence to speak.

We are proud to have been able to contribute to the development goals of the countries we work in and those of our partners, who have been improving the livelihoods and environmental health of the region for decades. These relationships are very important to us, providing our management and research teams not only with the necessary financial support but also collegial collaboration and guidance through the complex and oft-competing demands of natural resources management, economic growth, national and international priorities, environmental sustainability and human and natural wellbeing.

With this anniversary booklet, we hope that you will develop a deeper understanding of the history of our work in the region of the last two decades and the more interesting highlights of the last two years.

A handwritten signature in black ink, appearing to read 'Ujjwal Pradhan', with a horizontal line underneath.

Ujjwal Pradhan PhD
Regional Coordinator
Southeast Asia Regional Program

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WHO WE ARE >

The World Agroforestry Centre Southeast Asia is the region's leading agroforestry research-for-development organization.

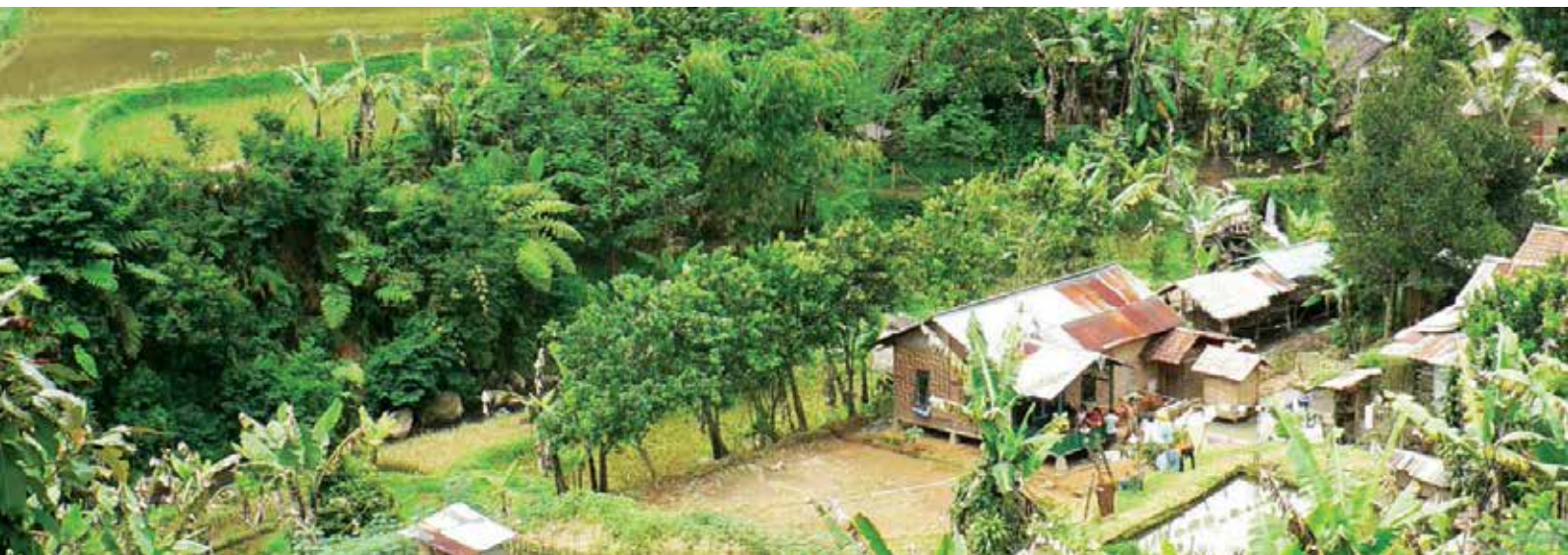
Regionally headquartered in Indonesia since 1993, in 2013 we maintain offices and programs in China, Indonesia, the Philippines, Thailand and Viet Nam, along with active projects in DPR Korea, Lao PDR and Nepal, and contacts in Malaysia, Cambodia, Timor Leste and Myanmar. With a regional staff of around 150, we strive to produce the world's best science on the roles of trees in humanised landscapes, with a particular focus on research that benefits smallholding farmers and people who live on the margins of forests. Our country offices maintain programs specific to their national situation while also crossing regional boundaries to research issues of wider significance.

Our global headquarters is in Nairobi, Kenya, maintaining programs in Africa, the Americas and Asia with around 400 scientific and support staff worldwide. The Centre is one of the fifteen members of the CGIAR, a global partnership that unites organizations engaged in research for a food secure future. The Centre was constituted as the International Centre for Research in Agroforestry (ICRAF), which remains our legal name after we rebranded as the World Agroforestry Centre in 2002.

Our Vision is a rural transformation in the developing world where smallholder households strategically increase their use of trees in agricultural landscapes to improve their food security, nutrition, income, health, shelter, energy resources and environmental sustainability.

Our Mission is to generate science-based knowledge about the diverse roles that trees play in agricultural landscapes and to use our research to advance policies and practices that benefit the poor and the environment.

FROM THEN TO NOW >



From the homegardens observed in Bangladesh and Indonesia; to the millions of hectares of rubber and fruit agroforests of Sumatra and Kalimantan; to the government-fostered taungya systems of Burma, Thailand and Java; and from the tree-cultured swiddens observed from Assam to Mindoro, agroforestry has been woven indelibly into the fabric of land use in Southeast Asia for many generations.

An astounding array of agroforestry systems are observed, evolving in response to market changes, new technical options and the inexorable pressure of more people on the land.

Agroforestry systems were always there, particularly in the uplands. But their potential to solve land-use problems was not recognized by mainstream research and extension institutions and, consequently, they were given little notice. Until recently. But the situation has changed.

Dennis Garrity 1993

The International Centre for Research in Agroforestry (ICRAF) established its regional research program in Southeast Asia in April 1992, according to a report¹ written by the first regional research coordinator, Dr Dennis Garrity, who was appointed in July 1992, assuming his post on 1 November. Other scientists soon joined him in at his post in Bogor, Indonesia: Retno Winahyu, Meine van Noordwijk, Subekti Rahayu, Pratiknyo Purnomosidhi, Thomas P. Tomich, Betha Lusiana, Suyanto and Suseno Budidarsono,

while Genevieve Michon and Hubert de Foresta were seconded to the team. The Philippine country office, which began operations at the same time, was home to Agustin Mercado and Glo Acaylar. Soon after, David Thomas established the Thailand program.

Bogor was chosen as the site of the regional headquarters because of Indonesia's long and rich history of agroforestry systems and the proximity of sister organizations such as the newly created

¹ Garrity DP. 1993. *ICRAF Southeast Asia: implementing the vision*. Bogor, Indonesia: International Centre for Research in Agroforestry Southeast Asia Regional Research Program. Available from http://worldagroforestrycentre.org/regions/southeast_asia/publications?do=view_pub_detail&pub_no=RP0018-04.

Center for International Forestry Research, the Asia-Pacific Agroforestry Network (APAN) of the Food and Agriculture Organization of the United Nations and the Institut Pertanian Bogor.

Three events had particular significance in the development of the guiding principles of the regional research program. The first occurred in August 1992, when the new Southeast Asia regional program team of scientists joined Indonesian colleagues from forestry and agricultural research institutions to select sites for research under the international Alternatives to Slash and Burn (ASB) project, which was initiated at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 (known as the Earth Summit). The second was an international workshop on ASB research methodology, which the Southeast Asia program hosted in Bogor in February–March 1993. And the third was an international training course on land-use systems' research methodology for the humid tropics of Asia, co-hosted by the Southeast Asia program in Bogor together with APAN. These events brought together scientists from across the region and the rest of the world to examine the key issues that would help shape the research agenda for Southeast Asia.

To complete the sequence of founding events, the then director-generals of ICRAF and the Government of Indonesia's Forestry Research and Development Agency signed an agreement that formally began what is now the World Agroforestry Centre's Southeast Asia Program.

The program's mandate was to conduct strategic research on key hypotheses and to develop and disseminate more effective research methods. Those imperatives remain the same to this day. It was the young scientific team's stated intention to 'identify and concentrate on the most important problems in agroforestry and provide strategic leadership in developing the research base to solve them'. They saw their research bounded by two themes: 1) the development of alternatives to slash-and-burn agriculture; and 2) the rehabilitation of degraded lands.

Looking around the region, they noted that the landscape ecology of much of Southeast Asia followed a broadly similar pattern along a decreasing elevational gradient, which they depicted in a simple graphic.

They argued that, depending on the watershed size, geomorphology and human settlement patterns, the various zones might be juxtaposed or one or more might be missing but the pattern repeated itself sufficiently to serve as a model that could be used to help clarify research needs.

In this picture, they claimed that 'agroforestry is anticipated to have a major impact on the lowland rice and coastal ecosystems in the future', but they prioritised three other ecosystems: 1) the forest margins; 2) grasslands; and 3) hilly farmlands.

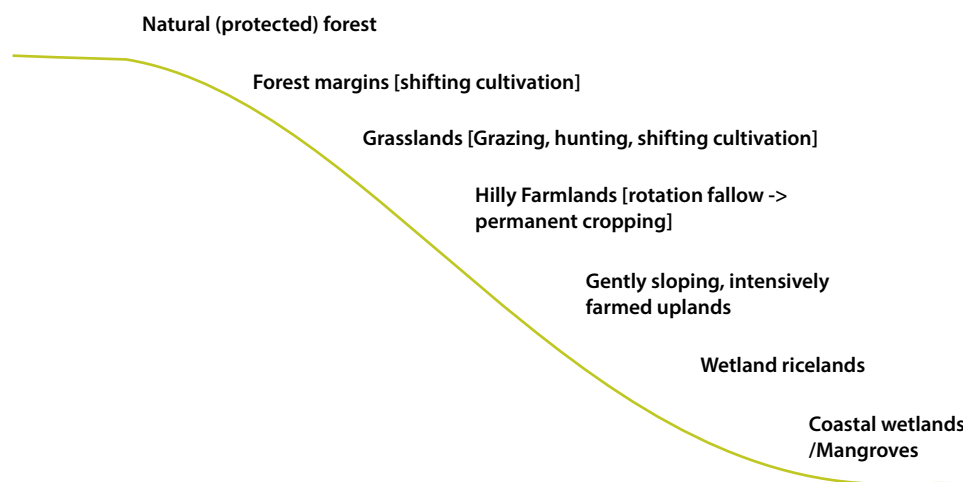


Figure 1. Land-use pattern in a typical Southeast Asian watershed. Source: Garrity 1993



The research thread in Southeast Asia



The original hypotheses

The Southeast Asia program first set about testing hypotheses applicable to each of the three ecosystem zones.

On the forest margins, the hypothesis was that complex agroforests provided a superior alternative for small-scale farmers to either food-crop systems or monocultural plantations of perennials. As an alternative to slash and burn, complex agroforests increased production sustainability, increased biodiversity, reduced production risks and increased returns to labour compared to continuous food crops or monocultural plantations.

The second hypothesis stated that rehabilitating *Imperata* grasslands with small-scale agroforestry systems would be superior to plantation reforestation in terms of production, equitability and participation.

For hilly farmlands, the team hypothesised that there were several pathways to sustainable farming. Among these, contour hedgerow systems initiated through natural vegetative strips provided distinct advantages as a superior, least-cost foundation upon which to build agroforestry-based, conservation farming.

Alternatives to Slash and Burn

Much of the work to test these hypotheses, in the first years at sites in Indonesia and the Philippines and later in Thailand, was carried out under the auspices of the Alternatives to Slash and Burn² international research project, which introduced its own complementary hypothesis—that intensifying land use as an alternative to slash and burn can reduce deforestation and reduce poverty—based on the Borlaug Hypothesis³. Around the same time, an *Imperata* grassland project⁴ began in collaboration

2 The research network continues to this day, rebranded as the ASB Partnership for the Tropical Forest Margins: <http://www.asb.cgiar.org/>.

3 Norman Borlaug was an American agronomist, humanitarian and Nobel laureate who has been called 'the father of the Green Revolution'. Borlaug continually advocated increasing crop yields as a means to curb deforestation. The large role he played in both increasing yields and promoting this view has led to this idea being called the 'Borlaug hypothesis': increasing the productivity of agriculture on the best farmland can help control deforestation by reducing the demand for new farmland. Source: http://en.wikipedia.org/wiki/Norman_Borlaug.

4 Garrity DP, ed. 1997. *Agroforestry innovations for Imperata grassland rehabilitation*. London: Kluwer Academic Publishers.
Garrity DP. 1996. Agroforestry innovations for *Imperata* grassland rehabilitation: workshop recommendations. *Agroforestry Systems* 36(1–3):263–274.
Santoso D, Adiningsih S, Mutert E, Fairhurst T, van Noordwijk M. 1997. Soil fertility management for reclamation of *Imperata* grasslands by smallholder agroforestry. *Agroforestry Systems* 36(1–3):181–202.
Tomich TP, Kuusipalo J, Menz K, Byron N. 1997. *Imperata* economics and policy. *Agroforestry Systems* 36(1–3):233–261.

with the Australian Centre for International Agricultural Research and soon after investigations began into policies concerning tenure and land uses, supported by the Asian Development Bank and the Ford Foundation.

These projects produced a large number of publications⁵, including international journal articles, working papers, policy briefs, information booklets and books for a range of audiences from farmers through national policy makers to international scientific bodies that advised world governments. The results provided plenty of evidence to support the three original hypotheses of the program and also to reject the Borlaug Hypothesis as too simplistic.

While our interest in the technology of agroforestry has continued and deepened, our relationship with the Alternatives to Slash and Burn program helped deploy our expertise into wider spheres of interest dealing with climate change (currently articulated as reducing emissions from deforestation and forest

degradation (REDD)), food security, biodiversity conservation, watershed protection and related matters that were also attracting considerable global attention. We combined global interests with a strong 'from the bottom upwards' perspective anchored in rights and resources access as key constraints to agroforestation.

One output from research conducted from 1996 through to 2000 was the now widely regarded ASB Matrix⁶. It had become clear to our research team that efforts to develop alternative land-uses and policies to curb deforestation were futile without careful consideration of the objectives of farmers and policy makers at various levels. If alternative systems and technologies were not profitable and socially acceptable for smallholders then there was little likelihood they would be adopted. Similarly, weak markets and other institutions could thwart adoption of change by smallholders.

ASB Summary Matrix: Forest Margins of Sumatra						
Land-use	Global environment		Agronomic sustainability	National policymakers' concerns		Adoptability by smallholders
	Carbon sequestration	Biodiversity	Plot-level production sustainability	Potential profitability (at social prices)	Employment	Production Incentives (at private prices)
Description	Aboveground, Time-averaged (tonnes/ha)	Aboveground, Plant species/standard plot	Overall rating	Return to land (US\$/ha)	Average labour input (days/ha/yr)	Return to labour (US\$/day)
Natural forest	306	120	1	0	0	0
Community-based forest management	136	100	1	11	0.2	4.77
Commercial logging	93	90	0.5	1080	31	0.78
Rubber agroforest	89	90	0.5	506	111	2.86
Oil palm mono culture	54	45	0.5	1653	108	4.74
Uoland rice/bush fallow rotation	7	45	0.5	(117)	25	1.23
Continuous cassava degrading to <i>Imperata</i>	2	15	0	28	98	1.78

Figure 2. Example of an ASB matrix for the forest margins of Sumatra. Source: <http://www.asb.cgiar.org/content/poverty-policy-and-deforestation#sthash.UeyHuz5v.dpuf>

5 Van Noordwijk M, Tomich T, Winahyu R, Murdiyarso D, Suyanto, Partoharjono S, Fagi A. 1995. *Alternatives to slash and burn in Indonesia: summary report of phase 1*. ASB Indonesia report no. 4. Nairobi: Alternatives to Slash and Burn; Bogor, Indonesia: International Centre for Research in Agroforestry. Available from <http://www.asb.cgiar.org/content/alternatives-slash-and-burn-indonesia-summary-report-phase-1>.

6 <http://www.asb.cgiar.org/content/poverty-policy-and-deforestation#sthash.UeyHuz5v.dpuf>
Clark WC, Tomich TP, van Noordwijk M, Guston D, Catacutan D, Dickson NM, McNie E. 2011. Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.0900231108



Southeast Asia Network for Agroforestry Education (SEANAFE)

In 1994, a number of the leading universities in Southeast Asia met in Bogor and signed a joint declaration calling for greater cooperation and sharing of curriculum designs and teaching materials. It took a while before such activities could be funded but in April 1999 the Southeast Asia Network for Agroforestry Education⁷ (SEANAFE) was born, hosted by the Centre, co-founded by 33 educational institutions and supported by the Swedish International Development Cooperation Agency. The network's vision was, and remains, one of empowered individuals and communities in Southeast Asia who can manage their natural resources and the environment for sustainable livelihoods. SEANAFE sees its mission as developing human resources for agroforestry and integrated natural resource management through collaboration among educational institutions. The network's members consist of universities and technical colleges in Indonesia, Laos, the Philippines, Thailand and Viet Nam and collaboration with China and Malaysia is increasing. Membership now numbers 78 and some national networks have invited agricultural extension

or advisory organizations to join as associate members. SEANAFE has reviewed and developed agroforestry curricula, supported development of teaching materials, trained agroforestry teaching staff, acted as a policy advocate through agroforestry workshops and studies and provided many research opportunities in agroforestry for undergraduate and graduate students.

Landscapes and watershed management

While the focus of the ASB Matrix was on a comparison of land-use systems, meanwhile, the ASB team in Thailand's analyses pointed to a dominance of landscape-level interactions, specifically through watershed management and the perceived roles of forests as unique providers of the related ecosystem services.

This identification led to a project in Thailand and Indonesia, supported by the Australian Centre for International Agricultural Research, that explored how agroforestry could maintain quantity, quality and regularity of water flows in catchments at the larger scale of a basin. This study supported a 'negotiation approach' to resolving conflicts with farmers on the margins of tropical forests.

⁷ <http://www.seanafe.org/html/>
<http://www.worldagroforestry.org/downloads/Publications/PDFS/B10837.PDF>



Rewarding Upland Poor for Environmental Services (RUPES)

Together, the ASB analyses showed that agroforests and other tree-based systems maintained critical ecosystem services but that economic pressures lead to a shift to monocultures with considerable loss of carbon, biodiversity and watershed integrity. This sparked our interest in economic instruments and incentives to reward upland poor for the environmental services they provided⁸.

The International Fund for Agricultural Development agreed to support the RUPES⁹ project in two phases. RUPES in its first phase (2002–07) brought together a consortium of partners to test working models of best practices for successful environmental transfer agreements adapted to the Asian context. The project was a combination of action research at a number of sites in Asia and intra-regional studies on the environmental

services of biodiversity conservation, watershed protection, carbon sequestration and landscape beauty, and the interactions between the stakeholders, reward mechanisms and institutional and policy arrangements. Phase 2 (2008–12) was designed to follow up on the lessons learned in RUPES 1 in Indonesia, the Philippines, Viet Nam, Nepal, India and China. The ultimate target group for RUPES 2 continued to be indigenous forest dwellers and smallholding farmers in less productive environments that were vulnerable to environmental degradation and climate change. Research focussed on national policies and the 'buyer' and 'broker' part of the rewards for environmental services' value chain to promote long-term sustainability of benefits.

Trees in Multi-use Landscapes in Southeast Asia (TUL-SEA)

The watershed projects had provided many replicable studies, but site-specific, cost-effective tools were needed to expand the research throughout Southeast Asia. And so, to help support negotiations around land-use change in the region, a suite of technical 'tools' and methodologies were developed as part of the Trees in Multi-use Landscapes in Southeast Asia project (2007–2010), which was conducted by the Centre in partnership with the German Federal Ministry for Economic Cooperation and Development and the University

8 Tomich TP, van Noordwijk M, Thomas DE. 2004. Environmental services and land-use change in Southeast Asia: from recognition to regulation or reward? *Agriculture, Ecosystems and Environment* 104:229–244

Van Noordwijk M, Leimona B, Jindal R, Villamor G B, Vardhan M, Namirembe S, Catacutan D, Kerr J, Minang PA, Tomich TP. 2012. Payments for Environmental Services: evolution towards efficient and fair incentives for multifunctional landscapes. *Annual Review of Environmental Resources* 37:389–420.

9 Phase 1 was called 'Rewarding Upland Poor for Environmental Services' and phase 2 'Rewards for, Use of, and Shared Investment in Pro-Poor Environmental Services'.



of Hohenheim, Germany. The 'toolbox' was designed to support negotiations around integrated natural resources management and as such contained 'tools' like Rapid Land Tenure Assessment¹⁰ (a methodology to help resolve land tenure disputes); Forest, Agroforest, Low-value Landscape or Wasteland¹¹ (a computer model that creates various scenarios for 'transforming your agroforested landscapes into places worth living and fighting for'); Participatory Landscape Analysis¹² (a way of capturing local knowledge about an ecosystem); Water, Nutrient and Light Capture in Agroforestry Systems¹³ (a computer model that represents tree, soil and crop interactions in a range of agroforestry systems); and a Quick Biodiversity Survey¹⁴ (a series of activities that uses animal groups such as dung beetles or bats and plants to produce a summary of biodiversity in an area in about six weeks total, including field work). The toolkit, consists now of more than 25 methods and computer software. It is constantly being used and revised throughout Southeast Asia

and other parts of the world and is proving to be an extremely valuable collection of approaches for gathering important data quickly and efficiently and feeding that information to people involved in negotiations over land uses, including farmers, NGOs, governments and businesses.

Reducing Emissions from All Land Uses (REALU)

Meanwhile, the international community was debating, which it continues to do, a new global climate deal, which looked then like it would probably include a mechanism for reducing emissions from deforestation and forest degradation, including conservation (REDD+). We saw that while REDD+ could be a valid and viable mechanism for mitigating climate change, it only addressed a part of the total emissions from land-use change: the millions of trees growing outside 'forests' would be excluded. REDD+ would be much more effective if constructed as part of a comprehensive architecture addressing all land uses in developing countries. A broad-based approach to reducing emissions from all land uses (REALU) might lead to greater reduction of emissions and more benefits for local people.

Our team of by-now experienced climate scientists with much evidence from the field, could see that more attention was needed on the interactions between forest carbon stocks, other carbon stocks affected by land use, the major drivers of land use and forest change, and the livelihoods of the hundreds of millions of people whose actions shaped those changes. Alone, REDD+ would likely be hampered by methodological problems of leakage, unclear definition of 'forest', measurement methodology and equity issues between, and within, developed and developing countries with different agro-ecosystems.

So, between 2009 and 2013, the REALU project (in phases 1 and 2), which is a partnership with the Norwegian Agency for Development Co-operation, has set out to develop through action research a set of approaches, methodologies and national capacities to implement effective, landscape-based strategies for REDD+ within a context of rural sustainable development, national sovereignty, respect for community and indigenous rights, and the integrity of a global greenhouse gas accounting system. The project has been focusing on research activities at sites in Indonesia, Cameroon, Peru, Viet

- 10 Galudra G, Pasya G, Sirait MT. 2008. *Rapid Land Tenure Assessment (RaTA): a tool for identifying the nature of land tenure conflicts*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from http://sea/publicationdo=view_pub_detail&pub_no=LE0108-08-10.
- 11 Suyanto DA, Mulia R. 2008. *Forest, Agroforest, Low-value Landscape or Wasteland (FALLOW) model: a simple tool to help you illuminate future options on development strategies to transform your rural agroforested landscapes into places worth living in and worth fighting for*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from http://sea/publicationdo=view_pub_detail&pub_no=LE0107-08-10.
- 12 Hoang MH. 2008. *Participatory Landscape Analysis (PaLA)*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from http://sea/publicationdo=view_pub_detail&pub_no=LE0093-08-10.
- 13 Van Noordwijk M, Lusiana B, Mulia R. 2004. *A model of Water, Nutrient and Light Capture in Agroforestry Systems*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from http://sea/publicationdo=view_pub_detail&pub_no=PO0009-04-10.
- 14 Nurhariyanto , Prasetyo PN, Jihad , Joshi L, Martini E. 2008. *Quick Biodiversity Survey (QBS) guideline for Rapid Agro-Biodiversity Appraisal (RABA)*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from http://sea/publicationdo=view_pub_detail&pub_no=LE0105-08-10.

Nam and Nepal. The project's key findings to date have been threefold.

1. Compared to schemes still under discussion for mitigation of forest-based emissions, REALU along with a full accounting scheme for agriculture, forestry and other land uses (AFOLU) will be more
 - a. effective in bringing major 'leakage' concerns into the accounting rules and allow increased land-use intensity outside forests as a contribution to net reduction of emissions;
 - b. efficient by providing many cost-effective options for reducing emissions, including tropical peatland and smallholders' agroforests; and
 - c. equitable by applying the same accounting rules for Annex 1 and non-Annex 1 countries and embracing low-forest-cover countries on a proportional basis while rewarding the rural poor.
2. The absence of a globally agreed definition of 'forest' will impede implementation of any REDD scheme.
3. Trees outside forests (woody vegetation outside of institutionally defined 'forest') and peatland contain large amounts of carbon that are excluded from mitigation discussions.

Land-Use Planning for Low-Emissions Development Strategies (LUWES)

Bringing us into the present of this 20-year history of critical engagement with a complex range of land uses, interest groups and political dynamics to address global issues of climate change, food security and poverty in the Southeast Asian context is the newly developed methodology known as Land-Use Planning for Low-Emissions Development Strategies (LUWES).

LUWES is a platform for developing a decision-making process that involves everyone with an interest in a landscape—farmers, governments, NGOs, businesses—to establish land-use plans that reduce greenhouse gas emissions while simultaneously maintaining economic growth.

Part of the LUWES platform simulates emissions-reduction scenarios within specific zones of a

landscape, or across an entire landscape, in order to produce forecasts for these and their associated opportunity costs. LUWES has also been designed to recognize the impact of land-use allocation policies and distribution on tenure and livelihoods. It accommodates the integration process between multiple modalities to reduce land-based emissions (such as REDD+, locally appropriate mitigation actions, the voluntary carbon market) at the planning stage across a common landscape.

LUWES is a set of principles, steps, and tools (including a Java-based software, Abacus SP) to help people negotiate the development of land-use plans. Tools are included from the TUL-SEA project, such as the Rapid Land Tenure Assessment mentioned above, Rapid Carbon Stock Appraisal and REDD/REALU Site Feasibility Appraisal.

Currently, LUWES is being deployed in several major projects in Indonesia, supported by the Danish International Development Agency, Margaret A. Cargill Foundation, European Union and the German Federal Environment Ministry (BMU) and training is taking place throughout Southeast Asia and in other parts of the world. We hope that LUWES can contribute to the achievement of sustainable landscapes that support local development while also helping to mitigate climate change.



And the future?

The reform of the CGIAR, a global research partnership for a food-secure future, of which the Centre is one of the 15 members, is leading to wider-ranging collaborations between the Centre, other CGIAR centres and national and international research institutions, in addition to our existing partnerships with governments, NGOs and communities.

We expect these partnerships and collaborations to continue and become more multifaceted and sophisticated as we confront the enormous challenge of uncovering ways to feed the world's increasing population and maintain a sustainable environment.

However, we are buoyed by the evidence and feel confident that agroforestry will play an ever-greater role in balancing economic growth, a secure food supply and a sustainable environment.

INTRODUCTION TO THE HIGHLIGHTS OF 2011–12 >



Six hundred million people occupy Southeast Asia, inhabiting 11 countries. Around a fifth of these live on the island of Java in Indonesia. Population growth overall is about 2% a year. Economically, the countries of the region range from the 'poorest of the poor' (Cambodia, Lao PDR, Myanmar) through 'poor to lower middle class' (Indonesia, the Philippines, Viet Nam) and 'middle' (Malaysia, Thailand) to 'rich' (Singapore, Brunei). In Southeast Asia, the World Agroforestry Centre has program offices in Indonesia, the Philippines, Thailand and Viet Nam along with active projects in DPR Korea, Lao PDR and Nepal, and contacts in Malaysia, Cambodia, Timor Leste and Myanmar.

We also maintain a program in China, the most populous nation on Earth, with offices in Kunming and Beijing. The China program is headquarters for our recently established East Asia Node of the Southeast Asia Regional Program. The Node's sphere of interest extends from the DPR Korea and Mongolia in the north through Yunnan and the

Mekong River in the south to the Tibetan Plateau in the west, home to a population of around 1.5 billion.

According to the United Nations¹⁵, the whole region faces enormous environmental challenges such as high pollution levels, extensive deforestation, declining soil quality and water shortages. Population growth is fuelling the absorption of arable land by expanding cities and encroachment on forests by agricultural areas. While China and Viet Nam have recently been able to claim more reforestation than deforestation, the quality of the reforestation in the former nation has been questioned by the head of our China country office¹⁶. Each country has its own set of challenges and priorities. The World Agroforestry Centre has not only been conducting research-for-development projects that directly benefit citizens in specific countries but also carrying out region-wide projects to help understand the area in its totality and better equip governments and nongovernmental organizations for meeting the challenges ahead.

15 <http://www.un.org/popin/fao/eastasia.htm>

16 Xu J. 2011. China's new forests aren't as green as they seem. *Nature* 477: 371

How can we adapt to a changing climate?

The most pressing matter of the last two years was climate change, the likely effects and possible strategies for adapting to the predicted extreme variations in weather.



To help make the case for a greater focus on trees and smallholders as part of not only adapting to, but also mitigating, climate change, we published the 133-page book, *How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes*¹⁷. To get its message across at the highest levels, we distributed it to delegates to the Seventeenth Conference of Parties of the United Nations Framework Convention on Climate Change in Durban, South Africa, in December 2011, as well as to universities, research institutes and other bodies throughout the world. The book's main focus is on the potential for 'environmental services rewards schemes' to have a major impact on conserving forests, improving smallholding farmers' livelihoods and reducing the effects of climate change, especially on poor people. Such schemes usually involve upland people being paid or rewarded in other ways for not clearing or converting forests but rather maintaining and enhancing them, in order to protect the quality of water, store carbon, maintain biodiversity or landscape beauty or some other kind of 'service'

that the environment provides to humans. The book draws on extensive research we have been carrying out throughout Southeast Asia.

Our other research related to climate change ranged widely. For example, one of our teams investigated how to maintain and, indeed, enhance the productivity and value of smallholders' agroforestry systems by better management of trees' genetic resources¹⁸, which is not only important for ensuring adaptability but also security of food supply. Another team developed a simpler method of measuring carbon stocks in different land-use systems¹⁹, making it easier for governments and communities to understand emissions from their land uses. As part of our continuing groundbreaking work in environmental services' research related to climate change and biodiversity conservation, we established the principles for fairness and efficiency (payments, compensation or co-investment)^{20,21}. The important task of how to monitor, report and validate nationally appropriate agricultural mitigation plans²² was also investigated. And a discussion about how to include more climate knowledge in national agroforestry plans was published in SciDev.Net²³.

17 Van Noordwijk M, Hoang MH, Neufeldt H, Oborn I, Yatich T, eds. 2011. *How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes*. Nairobi: World Agroforestry Centre (ICRAF). Available from <http://bit.ly/zgdRli>.

18 Dawson IK, Vinceti B, Weber JC, Neufeldt H, Russell J, Lengkeek AG, Kalinganire A, Kindt R, Lillesø JB, Roshetko JM, Jamnadass R. 2011. Climate change and tree genetic resource management: maintaining and enhancing the productivity and value of smallholder tropical agroforestry landscapes: a review. *Agroforestry Systems* 81(1): 67–78. Available from <http://bit.ly/yCO740>.

19 Hairiah K, Dewi S, Agus F, Velarde SJ, Ekadinata A, Rahayu S, van Noordwijk M. 2011. *Measuring carbon stocks across land use systems: a manual*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/tNlxPQ>.

20 Van Noordwijk M, Leimona B. 2011. *Principles for fairness and efficiency in enhancing environmental services in Asia. Payments, compensation or co-investment?* Policy Brief. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/xJHTBr>.

21 Pasha R, Asmawan T, Leimona B, Setiawan E, Wijaya CI. 2012. *Commoditized or co-invested environmental services?* Working paper 148. Bogor, Indonesia: World Agroforestry Centre Southeast Asia Regional Program. Available from http://worldagroforestrycentre.org/regions/southeast_asia/publications?do=view_pub_detail&pub_no=WP0160-12.

22 Wilkes A, Shiping W, Tennigkeit T, Feng J. 2011. *Agricultural monitoring and evaluation systems: what can we learn for the MRV of agricultural NAMAs?* Working Paper 126. Bogor, Indonesia: World Agroforestry Centre (ICRAF) China. Available from <http://bit.ly/AzdyRk>.

23 Roshetko JM, Lasco RD. 2012. Let's add climate knowledge to agroforestry plans. *SciDev.Net* 1 Oct. Available from <http://www.scidev.net/en/south-east-asia/opinions/let-s-add-climate-knowledge-to-agroforestry-plans-1.html>.

COUNTRY HIGHLIGHTS 2011–12 >

China and East Asia Node

The research thread in China and East Asia

The World Agroforestry Centre's China program was established in 2002 by Horst Weyerhaeuser and is currently under the direction of Prof Jianchu Xu. Hosted by Kunming Institute of Botany, Chinese Academy of Sciences, the Centre established its first joint laboratory with a Chinese partner—the Centre for Mountain Ecosystem Studies—in Kunming in 2004. Officially registered in Beijing in 2006, the Centre's operates under an agreement with the Ministry of Agriculture and the Chinese Academy of Agricultural Sciences.

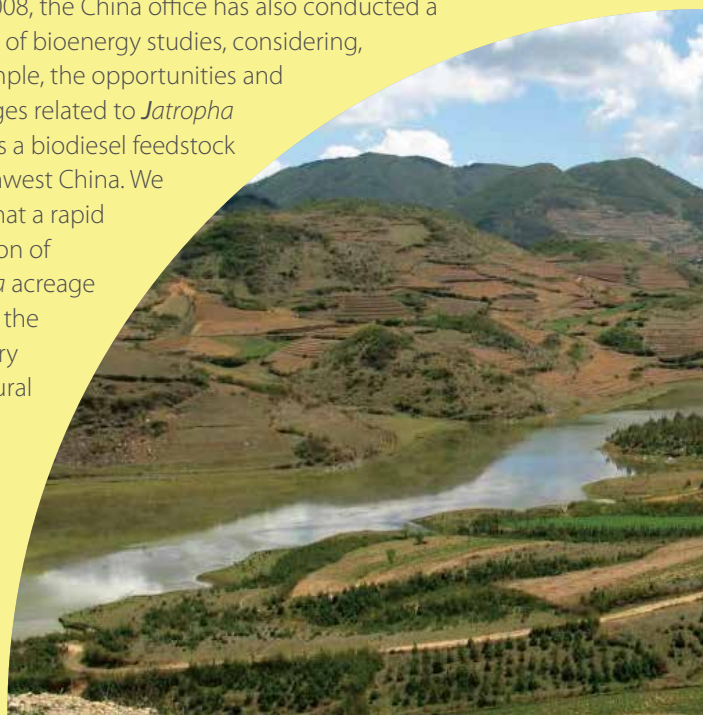
During its first five years, the China program developed partnerships with both national and local research institutes, government agencies, and non-governmental organizations. In 2013, the Centre now employs 35 staff, with a liaison office in Beijing and its main research facility in Kunming. The Beijing office works to link science to development of policies for natural resources management, in collaboration with Chinese scientists, CGIAR centres and Government policy-makers. In partnership with the Kunming Institute of Botany, the Kunming office incorporates scientific understanding into field practices, aiming to improve the multifunctional aspects of agriculture in collaboration with farmers and technicians. The mountainous ecosystems of Southwest China are the focus of the majority of studies owing to the region's unique biological and cultural diversity.

Some of our research has focused on the conflict between rural livelihoods and forest conservation, for example, in two Government programs: Sloping Land Conversion Program or 'Grain for Green

Program' and the Natural Forest Protection Program. These two programs have their origins in the central Government's recent focus on forest conservation and expanding tree cover on sloping farmland. This was a direct response to flooding along the Yangtze and Song rivers in 1998.

In 2005, we explored the economic and environmental impacts of both programs' implementation in Yunnan and policy support for planning at different levels of governance. For the natural forests program, we participated in a series of field studies on China's timber trade with the Asia-Pacific region, focusing on the environmental and livelihood aspects of Yunnan's trade with Myanmar. Subsequent research has focused on the China-Africa forest-product trade. Although the respective Government-led schemes are beginning to address timber legality concerns, our scientists have suggested new sustainability certification is essential to ensure improved sourcing by Chinese and other international companies along the value chains.

Since 2008, the China office has also conducted a number of bioenergy studies, considering, for example, the opportunities and challenges related to *Jatropha curcas* as a biodiesel feedstock in Southwest China. We found that a rapid expansion of *Jatropha* acreage without the necessary silvicultural



infrastructure to support it would likely leave governments with high subsidy costs and jeopardize the long-term viability of China's biofuel industry. By linking bioenergy with sustainable forest management, our scientists found that conversion of existing forests into short rotation species for timber, rather than energy, is more profitable than any other scenario. This highlights the need for regulatory innovations to balance incentives for timber production with conservation goals.

Policy research alone is, in most cases, not an effective means of promoting policy change in China. In a country where the opportunity costs of waiting, good planning, and evaluation are high, often the most persuasive argument for a change in policy is to offer practical alternatives. Based on this principle, a significant portion of the China team's work in the past ten years has consisted of action-oriented, field-based, technical support to build the capacity of communities and government agencies in Yunnan. Our work on edible wild mushroom management exemplifies this commitment. The integration of trees, vegetation and fungi have the potential to provide a much-needed alternative income for rural households and, simultaneously,

build community resilience to climatic variability. The China team's technical support has focused on four main areas: 1) geo-informatic systems for land-use planning and decision-support; 2) agroforestry for restoration and agricultural diversification; 3) tree domestication for income generation; and, 4) the integration of trees into farming landscapes and mountain ecosystems as a way to mitigate future climate vulnerability.

The establishment of the East Asia Node in 2011 has encouraged the team to take a more regional approach to policy-oriented research. Our success in DPR Korea demonstrates how agroforestry can be a progressive approach to restoring landscapes and providing food security to highland communities. The Making the Mekong Connected project, supported by BMZ and GIZ, has promoted 'green rubber' as an alternative to monoculture not only in China but also in other riparian countries. More recently, the Building Effective Water Governance project, supported by the International Development Research Centre, is creating a regional platform for highland-lowland links for good environmental governance in the Himalayan region.

China and East Asia Node highlights of 2011–12

In keeping with the rest of the 'awakened dragon', the Centre's China office has been growing quickly and producing important research findings even beyond the borders of China, hence, we formed the East Asia Node, which will serve as the base for research programs throughout East Asia, a region that, as it grows economically, is also increasingly challenged to feed one-third of the world's population while maintaining a healthy environment.

As China also becomes increasingly influential in international affairs, it is important to understand the unique characteristics of Chinese

environmental values and policy processes. This is especially true given the rate and scale of China's environmental impacts on natural ecosystems from local to international levels.

Conservation with 'Chinese characteristics'

According to research carried out by senior scientists at the China office, Chinese conservation values, policies and practices are not well-integrated. Jianchu Xu and Ed Grumbine identified four systemic barriers to conservation in China that contribute to this poor integration: 1) weak rule of law; 2) unclear land tenure; 3) top-down government authority; and 4) disconnection between scientific research and management implementation²⁴.

24 Grumbine RE, Xu JC. 2011. Creating a 'Conservation with Chinese Characteristics'. *Biological Conservation* 144(5): 1347–1355. Available from <http://bit.ly/ze4yQi>.

To advance China toward an environmentally secure future, the researchers suggested that combining traditional Chinese environmental values with contemporary science and international conservation practices would help to create a 'conservation with Chinese characteristics'. They don't argue that traditional values should replace modern science and management, rather that, given the cultural and political conditions in China today, using traditional values to frame contemporary environmental science and ecosystem-based management might create stronger societal support for conservation.

Mekong hydropower

The Mekong River is the longest watercourse in Southeast Asia and it is facing many challenges if it is continue to help feed the more than 300 million people who rely on it.

Although China has an extensive hydropower program underway on the Upper Mekong, as yet there are no dams on the river's lower mainstream. However, as many as 12 additional projects, which would generate substantial energy and wealth, especially for Cambodia and Laos, are currently in the proposal stage for the Lower Mekong.

The cumulative effects of these hydropower projects, if built, together with existing Chinese dams, will transform the Mekong by altering natural flow patterns and disrupting fisheries and other ecosystem services, to the detriment of the millions of people who depend on the river for their livelihoods.

Our research team found that proposals for new dam construction are driven by several factors, including changing human demographics and development needs, energy and food security concerns, economic cooperation, and climate change. The team linked these social, ecological, economic and political forces to continuing regional governance issues and made recommendations on how to improve the quality of decisions about Mekong hydropower in its complex, transboundary setting²⁵.

25 Grumbine R E, Dore J, Xu JC. 2012. Mekong hydropower: drivers of change and governance challenges. *Frontiers in Ecology and the Environment* 10(2): 91–98. Available from <http://v-c-s.org/methodologies/methodology-sustainable-grassland-management-smg>.

Rangeland carbon

In a world-first, Andreas Wilkes of the China and East Asia Node collaborated with several national and international organizations to establish the first Methodology for Sustainable Grassland Management under the Verified Carbon Standard²⁶. The methodology was based on a project in China that introduced better grassland management practices, such as improving the rotation of grazing animals between summer and winter pastures, limiting the timing and number of grazing animals on degraded pastures, and restoration of severely degraded lands by replanting with perennial grasses and ensuring appropriate, long-term management. For Andreas, it was a major outcome from many years of work on carbon storage in China's rangelands²⁷.

Climate change on the 'roof of the world'

In 2011, the East Asia Node also published the findings from significant research projects that examined the impact of climate change on water resources and local livelihoods in the Asian highlands and on agriculture and adaptation in China²⁸. The uplands of Asia, from the Hindu Kush through to the montane systems of mainland Southeast Asia, are sources of water for as much as one-third of the world's population and our study directly addressed the impacts of climate change on this population.

- 26 Verified Carbon Standard. 2011. *Methodology for Sustainable Grassland Management (SGM)*. Washington DC: Verified Carbon Standard. Available from <http://bit.ly/zgSSAN>.
- 27 Tennigkeit T, Wilkes A. 2008. *Carbon finance in rangelands: an assessment of potential in communal rangelands*. Kunming, China: World Agroforestry Centre (ICRAF) China. Available from <http://www.worldagroforestry.org/downloads/publications/PDFS/WP15892.PDF>.
- 28 Xu JC. 2011. Climate change in the Asian highlands: socio-economic implications for the Mekong Region. In: Lazarus K, Badenoch N, Dao N, Resurreccion BP, eds. *Water rights and social justice in the Mekong Region*. London: Earthscan. p. 197–216.
- Xu JC. 2011. The impact of climate change on water resources and local livelihood in the Asian highlands. In: Rayanakorn K, ed. *Climate change challenges in the Mekong Region*. Chiang Mai, Thailand: World Agroforestry Centre (ICRAF) China. p. 9–33.
- Zhang L, Yi H, Renfu L, Wang J, Xu JC. 2011. The impact of climate change on agriculture and adaptation in China. In: Rayanakorn K, ed. *Climate change challenges in the Mekong Region*. Chiang Mai, Thailand: World Agroforestry Centre (ICRAF) China. p. 77–109.

Oil from rubber seeds

Other research was also groundbreaking. A small project with potentially far-reaching impact was carried out on the oil from the seeds of rubber trees²⁹. Rubber is one of the most widespread tree crops throughout Asia with recent significant expansion in the Mekong region. While it is the latex that is sought after, the seeds are also high in oil that could be used as bio-diesel, except that they are high in acidity that prohibits their efficient use. However, the study showed that if the temperature within the stored piles of seeds, the humidity and mildew infections were all controlled and kept to a minimum, as well as the storage time of the seeds and the rubber-seed oil itself, then the acidity could be reduced so that the oil became usable. Will we eventually see rubber-tired vehicles that are also rubber fuelled?

The agroforestry of mushrooms

Jianchu Xu and colleagues also examined the management of wild mushrooms³⁰, one of the many non-timber forest products in Yunnan province and a potentially huge source of income for local farmers given the voracious domestic market for edible fungi. Little research had been done that illustrated an interdisciplinary approach to management of wild mushrooms and the empirical case studies that were necessary for developing practical management methods were even rarer. During the project the researchers developed a sustainable management strategy that greatly contributed to raising the income of farmers. They also found that their approach was highly relevant to policy decentralization and reform related to incorporating indigenous knowledge and local participation in forest management.

- 29 Zhu Y, Xu JC, Mortimer PE. 2011. The influence of seed and oil storage on the acid levels of rubber seed oil derived from *Hevea brasiliensis* grown in Xishuangbanna, China. *Energy* 36(8): 5403–5408. Available from <http://bit.ly/z7U4iD>.
- 30 He J, Zhou Z, Yang H, Xu JC. 2011. Integrative management of commercialized wild mushroom: a case study of *Thelephora ganbajun* in Yunnan, Southwest China. *Environmental Management* 48(1): 98–108. Available from <http://bit.ly/yunQFq>.
- Yang XQ, Gayantha LKP, Eike L, Yang XF, He J, Liu PG, Xu JC. 2012. Looking below the ground: prediction of *Tuber indicum* habitat using the weight of evidence method. *Ecological Modelling* 247:27–39.
- Mortimer PE, Karunaratna SC, Li QH, Heng G, Yang XQ, Yang XF, He J, Ye L, Guo JY, Li HL, Sysouphanthong P, Zhou DQ, Xu JC, Hyde KD. 2012. Prized edible Asian mushrooms: ecology, conservation and sustainability. *Fungal Diversity* 56(1):31–47.

Patterns of fertilizer use and the implications for agricultural and environmental policy

Balancing the need to increase crop yields with the need to reduce the environmental impacts of fertilizers poses major policy, regulatory and agricultural advisory service challenges for China. A growing number of studies have demonstrated the potential for improving the efficiency of fertilizer use in China but it is not yet clear how to achieve these efficiency improvements on a larger scale. The empirical foundation for fertilizer policy in China is still weak, particularly in inland provinces. Our team examined patterns of fertilizer use in Yunnan Province, an inland and ecologically important province in Southwest China, drawing on two household surveys³¹. The team found that fertilizer application rates in the surveyed areas were highly heterogeneous, among crops, households and regions. Managing this diversity poses the largest challenge to fertilizer policy in Yunnan and, by extension, in China. None of the factors that were examined were robust predictors of the intensity of fertilizer use though in one survey there was a strong inverse relationship between farm size and fertilizer intensity. The lack of clearer signals in the survey data, a consequence of heterogeneity in cropping patterns, agroecosystems, and local economies, underscores the importance of locally tailored approaches to fertilizer regulation in China and of a strong, service-oriented agricultural advisory system oriented around sustainable agriculture.

Growing agroforests to repair land and improve livelihoods in DPR Korea

In another unique project, the Centre has been working in the Democratic People's Republic of Korea in partnership with the Swiss Development Cooperation agency to establish participatory agroforestry on sloping land³². More than 60% of DPR Korea's population live in urban areas and only

- 31 Li YJ, Kahrl F, Pan JJ, Roland-Holst D, Su YF, Wilkes A, Xu JC. 2012. Fertilizer use patterns in Yunnan Province, China: Implications for agricultural and environmental policy. *Agricultural Systems* 110:78–89.
- 32 Xu JC, van Noordwijk M, He J, Kim GJ. 2012. Participatory agroforestry development for restoring degraded sloping land in DPR Korea. *Agroforestry Systems* 85(2):1–303.
- Xu JC, Mercado A, He J, Dawson I. 2013. *Agroforestry guides for field practitioners in sloping land management, DPR Korea*. Kunming, China: World Agroforestry Centre (ICRAF) China.

15% of the land is suitable for cultivation. Most land is either too mountainous or subject to harsh weather that make it unfit for intensive cropping. The agricultural sector has been in decline since the early 1990s owing to disruption of trade with the former socialist bloc after 1989 and climate-induced disasters such as floods and droughts. Whatsmore, from 1994 to 2009 yields on roughly the same area of land, on average, decreased by 30%. As food availability declined and the centralized food distribution system became deficient, people turned to the slopes where productivity is inherently even lower but whatever can be grown goes directly to the household and not the system. Forests were cleared, the slopes were degraded and nutrients on this marginal land were further depleted.

To try and reverse these trends, a 'sloping land management' partnership was initiated in the early 2000s with the aim of providing food, fodder and other products and to restore degraded land through innovative agroforestry systems managed by the residents themselves. Now, approximately 600 ha in North Hwanghae province are under sustainable, participatory management. In 2008 and 2009, national workshops promoting agroforestry and development of a national strategy for ecosystem restoration, respectively, were held in Pyongyang with the consequence that agroforestry continues to be established throughout the nation, with technical support provided by the Centre's China and East Asia Node scientists.



Indonesia

The research thread in Indonesia

While much of the history of the Centre's research in Indonesia is tied closely to the major projects described in the From Then Until Now section above, particularly in the early days with the Alternatives to Slash and Burn program and the *Imperata* research, an important aspect of the work in the archipelago has been the domestication of 'wild' trees given that the forests of Indonesia host mega-diverse flora and the islands are one of the most fertile regions on the planet.

However, most smallholders' agroforestry systems in Southeast Asia, and Indonesia is no exception, are characterized by limited management and planning. The types of trees that make up the systems are often the result of opportunity or chance and the quantity and quality of products are often below the system's potential.

Accordingly, the prime focus of agroforestry tree domestication in Indonesia has been the development of germplasm (seeds and seedlings) for farmers' groups and community organizations. These bodies play an important role in collecting and sharing tree seeds but, like local commercial seed dealers, are usually not familiar with proper seed collection techniques.

Through training and field tests, the Centre in Indonesia created technically sound and farmer-friendly guidelines for collecting tree seeds and building nurseries. This led to the establishment of local enterprises, which was followed up with capacity-building in nursery management and vegetative propagation skills. The result: hundreds of local nurseries and a set of manuals that farmers who weren't part of the original research projects could use to build their own.

Indonesia highlights of 2011–12

The Indonesia office is the Centre's largest, with more than 70 scientific and support staff, reflecting the nation's strategic importance in agroforestry, agriculture, forestry and climate-change research. The research conducted through the office ranges widely, for example, from the management of rubber agroforests through study of the habitats of orangutan in Sumatra to establishing the where and when of Indonesia's emissions of greenhouse gases and how to plan to reduce them.

Low-emissions development planning

Land-Use Planning for Low Emission Development Strategy (LUWES)³³ is a platform for developing a multiple stakeholder decision-making process to establish land-use plans for sustainable development, which can reduce greenhouse

gas emissions from land-based activity while simultaneously maintaining economic growth.

The platform—which is a suite of methods, tools and activities—was developed over several years and projects as part of our response to the Government of Indonesia's commitment to reduce greenhouse gas emissions by as much as 41% by 2020. LUWES has been designed to simulate scenarios that reduce emissions within specific zones of a landscape, or across an entire landscape, in order to produce forecasts of reductions and their associated opportunity costs. It also takes into consideration the impact tenure and livelihoods of land-use allocation policies. The platform integrates multiple modalities, such as REDD+, locally appropriate mitigation actions, and the voluntary carbon market, at the planning stage across a common landscape. It provides a set of principles, steps, and tools (including Abacus SP, a Java-based software) to help people with an interest in a landscape negotiate the development of land-use plans.

33 Dewi S, Ekadinata A, Galudra G, Agung P, Johana F. 2011. *LUWES: Land use planning for Low Emission Development Strategy*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from http://worldagroforestry.org/our_products/publications/details?node=53675.



L UWES has been incorporated into several major projects starting in 2013 that are designed to help local governments in Indonesia refine their land-use plans to not only reduce emissions but also establish sustainable landscapes. Staff of the Centre and other interested organizations in Viet Nam and Peru have also been trained in the method, with more planned around the world, reflecting the relevance of the LUWES platform to global efforts to reduce emissions.

National greenhouse gas emissions maps

Another substantial and significant product was mapping the nation's greenhouse gas emissions from land-use and land-cover changes over 15 years³⁴. This had never been done before. The research team used a specially devised method for the purpose. Known as Analysis of Land Use and Cover Trajectory, the method combined the existing comprehensive but unverified National Forest Inventory database with satellite imagery and verification at selected sites to identify the quantity and quality of the changes in the types of vegetation that covered the land from 1990 to 2005. The results showed where, when and how much emissions were released from changes to land use and land cover over the period. The team provided advice to the Government of Indonesia on how to incorporate the data and method into a national carbon accounting system, which is essential for meeting the Government's ambitious emissions reduction targets.

Is it profitable to pursue activities that emit greenhouse gases?

Also as part of the nation's preparations for

meeting its commitment to reduce emissions from deforestation and forest degradation, the Centre's Indonesia office studied other crucial matters such as the abatement or 'opportunity' cost curves that related past emissions to the economic gains they allowed³⁵. The research team assessed the feasibility of implementing REDD mechanisms in five pilot areas, analysing the costs to farmers and other stakeholders of reducing emissions in Papua, Gorontalo, South Kalimantan provinces and Pasuruan district in East Java. Three types of data were compiled: 1) carbon-stock change estimations from land use, land-use changes and forestry; 2) drivers of land-use and land-cover changes; and 3) a profitability analysis of land-use systems in Indonesia. The results showed that some of the greenhouse gas emissions in the past only provided a small amount of economic benefit and that the potential for reducing emissions was obvious.

Making oil palm 'carbon efficient'

Establishment of oil palm plantations is one of the most important drivers of land conversion in Indonesia. Increasing the carbon efficiency of these plantations and integrating them into land-use planning for low-emissions development will substantially contribute to reducing emissions while maintaining economic growth at the local level and eventually at the national level.

Oil palm covers around 8 million hectares or approximately 5% of the nation's land area. Indonesia is the world's biggest exporter of palm oil. The commodity has been the centre of controversy mostly because of the conversion of natural forests into oil palm plantations.

To answer the question, 'Is oil palm a carbon-efficient land use?', we studied 23 oil palm plantations in Indonesia by using an opportunity-cost analysis, which estimates the cost of forgone opportunities³⁶.

The opportunity cost of land-use change is defined as the amount of financial gain per ton of carbon dioxide equivalent (CO₂eq) emitted from a particular

34 Ekadinata A, Widayati A, Dewi S, Rachman S, van Noordwijk M. 2011. *Indonesia's land-use and land-cover changes and their trajectories (1990, 2000 and 2005)*. ALLREDDI Brief 1. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/zkbn9N>.
Harja D, Dewi S, Heryawan F, van Noordwijk M. 2011. *Forest carbon-stock estimates based on National Forest Inventory data*. ALLREDDI Brief 2. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/xCG2Xz>.
Ekadinata A, Dewi S. 2011. *Estimating losses in aboveground carbon stock from land-use and land-cover changes in Indonesia (1990, 2000, 2005)*. ALLREDDI Brief 3. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/xFZlzM>.
Dewi S, Suyanto S, van Noordwijk M. 2011. *Institutionalising emissions reduction as part of sustainable development planning at national and sub-national levels in Indonesia*. ALLREDDI Brief 4. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/wkIlsj>.

35 Van Noordwijk M, Dewi S, Suyanto S, Minang PA, White D, Robiglio V, Hoang MH, Ekadinata A, Mulia R, Harja D. 2011. *Abatement cost curves relating past greenhouse gas emissions to the economic gains they allowed*. Project Report. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/AkaT0k>.
36 Dewi S, Ekadinata A, Rahmanulloh A, Khasanah N, Rahayu S, van Noordwijk M, Budidarsono S. 2012. *The carbon efficiency of oil palm plantations: an opportunity cost analysis*. Technical Brief 28: palm oil series. Bogor, Indonesia: World Agroforestry Centre Southeast Asia Program.



change in land use, such as removing a forest and replacing it with an oil palm plantation. The higher the financial gain (for example, in USD) per ton CO₂eq emitted, the higher the opportunity cost. A higher opportunity cost implies a higher cost of abating the emissions caused by the land-use change.

We wanted to know whether emissions always corresponded with real financial gain. That is, was it worth it converting a forest into a plantation? We found that the carbon efficiency varied within and between plantations (from less than USD 5 to greater than USD 20 per ton of CO₂eq). The opportunity costs were calculated for each change of land use for each zone (mineral and peat soils). The quantity of emissions associated with a particular level of opportunity cost were also quantified.

This analysis provided the first approximation of carbon efficiency and abatement costs and was a step towards making general comparisons across sectors (for example, energy and waste) that produce greenhouse gases and have carbon on international carbon markets.

Policies and/or best practices that encourage the production of oil palm as part of low-emissions development should ideally devise a clear indicator linking land use and carbon efficiency. This would show the financial gain from each unit

of greenhouse gas emissions occurring during the development and cultivation of oil palm in plantations. Developing an indicator that is focused on the plantation is an effective way to show the links between emissions, drivers and actors, as it defines an operational scale attributable to a single actor rather than isolating emissions from any particular unit of commodity.

Furthermore, to contribute to the sustainability of the broader landscape, ecosystem services that aren't just about climate regulation should also be promoted (biodiversity maintenance and watershed protection, for example). Landscape configurations, such as promoting habitat corridors, riparian areas and forest patch mosaics, should also be considered, rather than the current common practice of uniform, monocultural landscapes.

In comparison with emissions savings that address the concerns of customers about the 'greenness' of a specific product, carbon efficiency addresses the local and national concerns of producers about wider issues of landscape sustainability. This makes maintaining carbon efficiency less restrictive than just attaining emissions savings because it recognizes the need for a balance between planned development for economic growth, local sustainability and global responsibility.

Can 'green' rubber help save Indonesia's old rubber agroforests?

Our studies have shown that although most of the complex rubber agroforests have disappeared in Malaysia and Thailand, around 2 million hectares are still thriving in Indonesia³⁷. Much of these have a physiognomy and functioning that are close to those of natural forests. However, if left neglected they will soon be converted to agriculture and industrial plantations. And since little primary forest is left in the country, maintaining these forests is the only option to support high forest diversity across the archipelago.

37 Villamor GB. 2012. Flexibility of multi-agent system models for rubber agroforest landscapes and social response to emerging reward mechanisms for ecosystem services in Sumatra, Indonesia. Thesis. Bonn, Germany: Zentrum für Entwicklungsforschung, University of Bonn.

Villamor GB, Bao Le Q, Vlek PL, van Noordwijk M. 2012. Modelling human-landscape system dynamics to support reward mechanisms for agro-biodiversity conservation. In: Seppelt R, Voinov A, Lange S, Bankamp D, eds. *Proceedings of the 2012 International Environmental Modelling and Software Society*. Leipzig, Germany: International Environmental Modelling and Software Society.



But the problem is that in the absence of specific incentives, there is no reason why smallholders—who manage the vast majority of old rubber agroforests—should agree to forego the benefits of more profitable land uses for the sake of biodiversity conservation.

Eco-certification or eco-labelling of rubber agroforests has been explored by the World Agroforestry Centre for the past decade as a mechanism for conserving biodiversity habitats and furthering economic development in rubber-growing areas.

This kind of scheme guarantees that the production practices used to generate a product meet a set of eco-standards, or that the raw materials of the product are produced in biodiverse systems, and verifies that producers have used management practices that conserve environmental services.

Thus, selling eco-labelled rubber latex at a price higher (a 'price premium') than the average, 'farmgate' price would increase farmers' economic returns from rubber agroforests. Clean and dry 'green' rubber currently sells for around USD 3 per kilogram, which is twice the farmgate price for 'non-green' rubber. Though there is no substantial market yet for certified rubber products, some interest has been shown by companies and negotiations are underway.

The constraints include standards that could be very difficult for farmers to achieve; no factories that as yet are willing to receive eco-certified rubber; potential conflict with government policy that promotes oil palm companies (no government policy supports conserving rubber agroforests); and the market for eco-certified rubber is still underdeveloped.

Overcoming these challenges will take more research and a concerted effort by many different players if the biodiversity of these agroforests is to be preserved and the livelihoods of local farmers improved.

Is the environment a commodity, an opportunity or a co-investment?

Based on action research in Asia in the Rewards For, Use of, and Shared Investment in Pro-poor Environmental Services (RUPES 2) project since 2002, Beria Leimona, Meine van Noordwijk and team established three paradigms for identifying different types of environmental services' schemes: 1) commoditised environmental services; 2) compensation for opportunities skipped; and 3) co-investment in (environmental) stewardship³⁸. The primary difference between the three is the way in which conditions of service are achieved. The third approach has the greatest opportunity to support people's aspirations to escape from poverty because the first two presuppose property rights that the rural poor often do not have. Co-investment requires and reinforces trust after initial conflicts over the consequences of resource use on environmental services have been clarified and a realistic joint appraisal has been reached.

Orangutan habitat and the cost of preservation

Also in Sumatra, our researchers looked at orangutan habitat and the economics of sustainable forest management³⁹. They conducted an 'opportunity

38 Van Noordwijk M, Leimona B. 2010. Principles for fairness and efficiency in enhancing environmental services in Asia: payments, compensation, or co-investment? *Ecology and Society* 15(4): 17. Available from <http://www.ecologyandsociety.org/vol15/iss4/art17>.

Pasha R, Asmawan T, Leimona B, Setiawan E, Wijaya CI. 2012. *Commoditized or co-invested environmental services? Working paper 148*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. DOI 10.5716/ WP12051.PDF.

39 Wich S, Riswan, Jenson J, Refisch J, Nellemann C, eds. 2011. *Orangutans and the economics of sustainable forest management in Sumatra*. Nairobi: United Nations Environment Programme Great Apes Survival Programme; Berg am Irchel, Switzerland: PanEco; Medan, Indonesia: Yayasan Ekosistem Leuseur; Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program; Arendal, Norway: United Nations Environment Programme Global Resource Information Database (GRID) Arendal. Available from <http://bit.ly/w0kXCQ>.

cost' analysis of the Tripa swamp and Batang Toru mountain forests where orangutan live to see if there were alternatives to the most profitable land use (oil palm) that was driving the conversion of undisturbed forest, the orangutan habitat. The research team found that in order to make preserving the forests a profitable venture, a carbon market price of approximately USD 10 per tonne of carbon dioxide equivalent would be needed, which is well within the range of voluntary carbon market prices that have been achieved so far by 'reducing emissions from deforestation and degradation' (REDD) projects, that is, USD 9.43–17.00.

Intensification of 'aren' or sugar palm (*Arenga pinnata* (Wurmb) Merr.), which is a multipurpose tree that provides livelihoods for local people and food for other creatures in the landscape, was also considered⁴⁰. Its domestication is still limited in the area surrounding the habitat of the Sumatran orangutan. The team found that the value of aren for local people's livelihoods and conservation could be enhanced by increasing its stocking density. There was also scope for improving market access and the share of benefits received by farmers.

Role-play research

Despite the serious intent, research can also employ more 'fun' aspects, such as role-play games. Grace Villamor and her colleagues used questionnaires and role-playing games to assess the perceptions and behaviours of rubber agroforestry farmers operating under existing conservation agreements as part of research to establish reward schemes for agro-biodiversity⁴¹.

To our knowledge, this was the first attempt to apply such a combination of methods to explore perceptions of payments for environmental services.

In the game, all financial bids by external agents to secure an oil palm foothold in the village were rejected despite indications of declining income among the villagers. Agents promoting an eco-

certification scheme in the game had success. The responses obtained in the game could assist in the actual rollout of such a scheme without creating unrealistic expectations of its financial benefits. However, co-investment schemes that require higher levels of trust and clarity of performance measures would have to address the potential discrepancy.

Results of the study that included the role play game revealed a strong conservation belief system and social norms in the village, with indications that individual interest in converting old rubber agroforests to oil palm, with consequent private gain and loss of local social agro-biodiversity benefits, was suppressed in the social context of a role-playing game.

Do locals agree with the international experts?

Putting all of their experience and knowledge together, the Indonesia office team compiled a number of important publications to compare local Indonesian perspectives on REDD with international ones and how they were represented in qualitative scenario models⁴².

They noted that the international REDD debate had been focusing on 1) the scope of efforts to reduce emissions; 2) the financial incentives and associated mechanisms; and 3) safeguards to try and include local perspectives and biodiversity benefits. However, for local people living on the margins of tropical forests, the team found that the REDD debate was just another complication in an already complex relationship that they have with governments and forest authorities. Could they make use of their national government's interest in REDD to improve their own lives? Or would the implementation of any REDD scheme actually hinder them in their struggle for access to the forests they have been living with for generations?

Through a series of studies of different situations in Indonesia, the team discovered that conflicts over land can be aggravated by REDD but that the Government's 'village forest' agreements could be a promising solution. Deeper analysis revealed the

40 Martini E, Roshetko JM, van Noordwijk M, Rahmanulloh A, Mulyoutami E, Joshi L, Budidarsono S. 2012. Sugarpalm (*Arenga pinnata*) for livelihoods and biodiversity conservation in the orangutan habitat of Batang Toru, North Sumatra, Indonesia: mixed prospects for domestication. *Agroforestry Systems* 86 (3): 401–417. DOI 10.1007/s10457-011-9441-0.

41 Villamor GB, van Noordwijk M. 2011. Social role-play games vs individual perceptions of conservation and PES agreements for maintaining rubber agroforests in Jambi (Sumatra), Indonesia. *Ecology and Society* 16(3): 27. Available from <http://dx.doi.org/10.5751/ES-04339-160327>.

42 Van Noordwijk M, Galudra G, Akiefnawati R, Villamor GB, Purnomo H, Suyanto S. 2011. *Local perspectives on REDD in comparison with those at the international negotiation tables and their representation in quantitative scenario models*. Project Report. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/y6BCtK>.

importance of the local social context in land-use decisions and that so far the complexities of interactions between all the different players at varying levels of decision making had yet to be fully understood by the players themselves. To try and deal with this, the team suggested models that can describe natural, social, human, financial and physical capital vertically as well as horizontally. In this way, policy makers and, indeed, all players in a landscape can see the opportunities and constraints that affect each one, which provides a good base to build understanding and agreement upon.

Vegetables amongst the trees

Most smallholding farmers in Indonesia cultivate both annual and perennial crops on farms of limited size, frequently 1 hectare or less. Traditionally, these systems evolved to produce agricultural and tree products for home consumption, with the surplus being sold locally. The development of infrastructure and market economies has opened commercial opportunities for smallholding farmers.

However, many smallholders still face challenges related to crop production and marketing: landholdings do not reflect economies of scale; suboptimal management practices produce commodities that do not meet market specifications; and farmers have limited understanding of market information and marketing channels. Additionally, farmers lack access to professional assistance that could enable them to enhance their production and marketing capacity.

Working with communities in West Java, we implemented a number of studies to identify how vegetable production could be intensified in smallholders' agroforestry systems where additional land for agricultural expansion did not exist⁴³. Baseline studies and rapid market appraisal were conducted to identify existing conditions and possible opportunities. Focus-group discussions were held to identify smallholders and traders' interest in expanding smallholding vegetable production and marketing. Understory vegetable

production trials were conducted under three light intensity levels representative of common agroforestry systems. We also carried out farmers' exchange visits to provide exposure and intensive capacity building to smallholders regarding market-oriented production of select vegetable commodities. A consumer preference study was also implemented to inform smallholders and traders of market prospects. We found that opportunities do exist for smallholders to intensify production and marketing of vegetables in their existing agroforestry systems. However, to take full advantage of those opportunities, smallholders would require technical, marketing and material assistance.

More and better teak

Teak is among the most valuable timbers in Indonesia with international and domestic demand generally exceeding supply. As in other teak-producing countries, the decline of plantation production has created opportunities for smallholding producers.

Approximately 1.5 million households on the island of Java grow teak, managing 444 000 hectares of mixed cropping systems, mainly on degraded land. These families are independent growers providing raw material for the thriving teak furniture industry. The viability and profitability of smallholding teak production systems are threatened by poor silvicultural management that yields small quantities of low-value timber. Smallholders are aware of this shortcoming but have difficulty adapting better silvicultural management owing to a lack of capital and limited ability to wait through the duration of a rotation before needing returns. Additionally, most smallholders produce teak with an array of other crops to meet short- and medium-term livelihoods' needs.

Working in communities in Yogyakarta, we conducted a number of studies⁴⁴ to identify

43 Roshetko JM, Manurung GS, Kurniawan I, Dahlia L, Susila A. 2012. Intensifying vegetable production in smallholder agroforestry systems of West Java. *Acta Horticultura* 958:59–66.
Susila AD, Purwoko BS, Roshetko JM, Palada MC, Kartika JG, Dahlia L, Wijaya K, Rahmanulloh A, Raimadoya M, Koesoemaningtyas T, Puspitawati H, Prasetyo T, Budidarsono S, Kurniawan I, Reyes M, Suthumchai W, Kunta K, Sombatpanit S, eds. 2012. *Vegetable-agroforestry systems in Indonesia*. Special Publication 6c. Tokyo: World Association of Soil and Water Conservation; Nairobi: World Agroforestry Centre (ICRAF).

44 Roshetko JM, Astho A, Rohadi D, Widyani N, Manurung GS, Fauzi A, Sumardamto P. 2012. Smallholder teak systems on Java, Indonesia: income for families, timber for industry. In: Meyer SR, ed. *IUFRO 2012 Small-Scale Forestry Conference: Science for Solutions*. 24–27 September, University of Massachusetts, Amherst. Vienna: International Union of Forest Research Organizations. p. 162–167. Available from http://iufrossf2012.files.wordpress.com/2012/10/iufro_3-08-00_proceedings_2012.pdf.
Narendra BH, Roshetko JM, Tata HL, Mulyoutami E. 2012. Prioritizing underutilized tree species for domestication in smallholder systems of West Java. *Small-scale Forestry*. DOI 10.1007/s11842-012-9227-x.
Perdana A, Roshetko JM, Kurniawan I. 2012. Forces of competition: smallholding teak producers in Indonesia. *International Forestry Review* 14 (2):238–248.

solutions that enable farmers to mitigate the threats mentioned above and improve the benefits to their families (income) and society (quality timber supply). A baseline study, teak system inventory and management survey were conducted to identify existing conditions and practices. Participatory silvicultural trials were conducted on farms to identify management options appropriate for smallholders' conditions. Based on our research findings, guidelines for improved smallholding teak production were developed and evaluated with farmers and are now being institutionalised.

Supporting clear forestland tenure

In May 2013, the constitutional court of Indonesia resolved a major ambiguity in Article 1 of the 1999 Forestry Law, ruling that customary community forests were not State forests. This landmark decision made a clear distinction between customary forests belonging to traditional communities that were controlled indirectly by the State, and State forests that were under direct control through the Ministry of Forestry. The implementation rules will now have to be promulgated by the districts.

The decision supports the Centre's many years of analysis of strategies to enhance livelihoods and curb deforestation. We, along with our close partners the ASB Partnership for the Tropical Forest Margins, the Rights and Resources Initiative (RRI) and International Land Coalition (ILC) recognized that Government policy needed to ensure rights to community ownership of forests if these twin goals were to be achieved. Since 1998, we worked with the Government and AMAN, the indigenous people's organization, to seek a clear resolution of the conflicting tenure of forest land in Indonesia⁴⁵.

Community forest governance has been recognized as a policy option other than 'command-and-control' models and privatization schemes. Since 1998, Indonesia has developed a range of community-based forest management schemes as complementary strategies to decentralize forest governance, such as community forestry (*hutan kemasyarakatan*), village forest (*hutan desa*), people's plantation forest (*hutan tanaman rakyat*) and customary forest (*hutan adat*). Despite this, it remains doubtful whether local communities can sustain forest management without support from external parties.

In July 2011, in Lombok, the World Agroforestry Centre, along with the Ministry of Forestry, ITTO, RRI and civil society institutions, organized the International Conference on Forest Tenure: Governance and Enterprise, Experience and Opportunities in Asia in a Changing Context. We were actively engaged in both the program and steering committees as well as in presenting ways forward in tenure reforms. This landmark conference highlighted persistent land conflicts and tenure insecurity in forest areas and the process of gazettelement for ascertaining claims. Thanks to the attention brought by the conference, there has been greater focus on resolving land and forest conflicts, promoting community rights, and designating what is State forest and what is not. The Civil Society Road Map to forest tenure reforms was prepared and the World Agroforestry Centre has been engaged in multistakeholder dialogues on how to ensure these transitions, information gaps on forest tenure and customary rights, and participatory land-use planning and visioning.

Since 1993, the World Agroforestry Centre's Indonesia program has engaged with government authorities and NGOs to develop policies and build capacity towards successful, sustained, community forest management. Our synthesis work suggests that successful management depends on institutional arrangements that 1) establish local residents' rulemaking autonomy; 2) facilitate the flow of external financial and institutional assistance for monitoring and enforcement of local rules; and 3) buffer residents and their respective local institutions from more powerful and, at times, corrupt actors involved in forest exploitation.

We have been able to demonstrate how well-managed village forest agreements can conserve biodiversity, improve local communities' livelihoods, recognize land rights and local and indigenous communities' roles in the provision of environmental services, all of which can be incorporated into local land-use planning. Based on our synthesis work mentioned above, four associated solutions and preferred scenarios are being implemented to support this objective: 1) creating innovative agroforestry systems; 2) securing community-based management and tenure; 3) strengthening local community institutions in land management; and 4) integrating environmental services provided by village forests into governments land-use plans.

⁴⁵ See <http://www.asb.cgiar.org/story/category/indonesia-upholds-indigenous-people%E2%80%99s-rights-forest>

The Philippines

The research thread in the Philippines

The Philippine program started its field research in 1993 in Claveria, Misamis Oriental, which became the centre for development of on-farm technology that was then extrapolated to other sites in the country. The focus of the work in Claveria was, and remains, on various conservation farming research. This eventually became the foundation of the Landcare⁴⁶ program in 1996 that has been widely adopted in collaboration with the Australian Centre for International Agricultural Research. More than 450 self-governing groups are now operating; over 10 000 farm households have adopted contour buffer strips; and more than 400 community and household nurseries have produced more than 1.2 million seedlings⁴⁷. These led us to conduct various field studies on the potential of intercropping systems using timber trees and hedgerows, in smallholders' agroforestry systems, to help improve degraded soils⁴⁸.

In the last two decades, community-based forest management has become an important lynchpin of the Philippine Government's program to address upland poverty and forest land rehabilitation and community-based forest management has been declared the national strategy. There are more than 6 million hectares under some form of community management, affecting around 4.4 million people. The main technology component of the strategy is agroforestry. The Centre has been responding

by developing agroforestry systems, soil and water conservation technologies and policies that lead to rehabilitation of *Imperata* grasslands and stabilization of upland farms.

The Philippine team also worked on developing a negotiation-support process with partners in the Manupali watershed in Central Bukidnon. The work focused on the buffer zone of the Mt Kitanglad Range Nature Park in the upper reaches of the Manupali watershed in central Mindanao and was aimed at developing the elements of a workable social contract between buffer-zone communities and non-local stakeholders concerned with resource protection. The Centre and its partners have developed tools and approaches to improve the integration of biodiversity conservation and agroforestry development through the active involvement of communities.

Our initial work in the buffer zone of the Park focused on determining an appropriate mix of timber and fruit-tree species of interest to farmers and testing diffusion strategies to incorporate them into farming systems. We introduced germplasm of a range of species followed by a series of experiments that evaluated the available commercial species for comparative performance by elevation. We also experimented with three types of smallholding nursery systems. These activities have resulted in a major acceleration of smallholders' tree production in the buffer zone. We also refined an indigenous practice called natural vegetative strips. They were exceptionally effective in soil conservation with minimal maintenance and had immediate potential to help farmers in the buffer zone intensify land-use and increase profitability while sustaining land resources⁴⁹. Their widespread adoption by thousands of farmers is now backstopping the institutional innovations and provides pragmatic alternatives to encroachment in the Park.

The Centre's Philippine program was one of the main organizers of the first-ever climate-change adaptation national conference, held in Albay in

46 <http://www.landcarephilippines.org>

47 Mercado Jr AR, Garrity DP, Patindol M. 2001. The Landcare experience in the Philippines: technical and institutional innovations for conservation farming. In: Franzel S, Denning GL, Cooper P, eds. *Development in Practice*. Vol. 12. Boca Raton, FL, USA: Routledge, Taylor and Francis Group. p. 495–508.

Franzel S, Denning GL, Lilleso JPB, Mercado AR. 2004. Scaling up the impacts of agroforestry: Lessons from three sites in Africa and Asia. *Agroforestry Systems* 61–62(1–3):329–344.

Mercado Jr AR. 2007. Landcare. In: Critchley W, Wach T, eds. *WOCAT 2007. Where the land is greener: case studies and analysis of soil and water conservation initiatives worldwide*. Bern, Switzerland: World Overview of Conservation Approaches and Technologies. p. 133–136.

48 Mercado Jr AR. 2007. *Potential of timber-based hedgerow intercropping for smallholder agroforestry on degraded soils in the humid tropics of Southeast Asia*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Research Program.

49 Mercado Jr AR, Rondall J. 2007. Natural vegetative filter strips. In: Critchley W, Wach T, eds. *WOCAT 2007. Where the land is greener: case studies and analysis of soil and water conservation initiatives worldwide*. Bern, Switzerland: World Overview of Conservation Approaches and Technologies. p. 129–132.

October 2007. It was also one of the chief organizers of the International Biodiversity and Climate Change conference in March 2008. On the ground, the team has implemented climate-change adaptation projects in watershed and protected areas of Luzon and Mindanao and provided technical assistance to the Department of Environment and Natural Resources and other government agencies such as the National Economic and Development Authority through projects like the Philippine Climate Change Adaptation Project, supported by the World Bank, and the Adaptation to Climate Change and

Conservation of Biodiversity project supported by Deutsche Gesellschaft für Internationale Zusammenarbeit.

The Centre is also a pioneer in the Philippines in exploring climate-change mitigation through carbon sequestration by trees and forests. It has assisted organizations such as the Kalahan Foundation, World Bank and Conservation International in developing forestry projects for the carbon market.

Philippine highlights of 2011–12

The Philippines is one of the most disaster-prone nations on Earth, with an average of 20 typhoons a year with accompanying flooding, landslides and loss of life, all of which are likely to be exacerbated with increasing climate variability and intensity.

The Centre's Philippine program is headed by Dr Rodel D. Lasco, who is also the lead author for the Asia chapter of the Intergovernmental Panel on Climate Change's *Fifth Assessment Report*.

This confluence of circumstances has resulted in the Centre leading scientific efforts to support the Government's national plan for dealing with climate change, especially in relation to impacts on smallholding farmers and how these can be mitigated while encouraging adaptation through international schemes such as voluntary carbon markets and REDD.

Carbon forestry

The Philippines is in the early stage of developing REDD+ projects and there are several challenges, such as lack of funds and expertise, passive participation of the Government, and conflicting interests with local government plans.

To help understand these issues better, the Centre's team assessed five pioneering REDD+ projects⁵⁰. The assessment concluded that external financial

and technical support, local participation, free and prior informed consent, training of participants, sustainability, national laws and policies, biodiversity conservation and safeguards were crucial in REDD+ development in the country. Further, partnerships with local funding institutions would be helpful to ensure sustainability and the legal framework of REDD+ should be strengthened by national laws and policies to enhance the links of local communities with various government and non-governmental agencies for REDD+ financing and collaboration.

The five sites each had different characteristics but all were the focus of reforestation and agroforestation projects that were designed to attract external buyers for the carbon credits they built up through their extensive tree planting, as well as provide direct benefits from the trees themselves⁵¹.

50 Lasco RD, Mallari NAD, Pulhin FB, Florece AM, Rico ELB, Baliton RS, Urquiola JP. 2013. Lessons from early REDD+ experiences in the Philippines. *International Journal of Forestry Research*. Available from <http://dx.doi.org/10.1155/2013/769575>.

51 Lasco RD, Habito CMD, Delno RJP, Pulhin FB, Concepción RN. 2011. *Climate change adaptation for smallholder farmers in Southeast Asia*. Los Baños, Philippines: World Agroforestry Centre (ICRAF) Philippines. Available from <http://bit.ly/wFftDQ>.

Lasco RD, Pulhin FB, Bugayong FA, Mendoza MD. 2011. An assessment of potential benefits to small holders of REDD+ components in the Philippines. *Annals of Tropical Research* 33: 31–48.

Lopez RC, Abasolo E, Lasco RD. 2011. *Carbon-forestry projects in the Philippines: potential and challenges: the Ikalahan Ancestral Domain forest-carbon development*. Working Paper 133. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/x6alf2>.

Lopez RC, Herrera MN, Lasco RD. 2011. *Carbon-forestry projects in the Philippines: potential and challenges: the Quirino forest-carbon development project in Sierra Madre Biodiversity Corridor*. Working Paper 132. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/yo2Mjm>.



In addition, the team estimated that reducing the rate of forest degradation by 5–15 % annually, while doubling the rate of reforestation to a modest 1.5% annually, could reduce carbon emissions by up to about 60 million tons by 2030. This is equivalent to USD 97–417 million of mean carbon credits annually (at USD 5 per ton). They concluded that REDD+ carbon credits could be a significant source of financing for forestry projects in developing countries like the Philippines⁵².

Lopez RC, Ibañez JC, Lasco RD. 2011. *Carbon forestry projects in the Philippines: potential and challenges: the case of the Arakan Forest Corridor forest carbon project*. Working Paper 130. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/yX3Q6f>.

Lopez RC, Mirasol FS, Lasco RD. 2011. *Carbon-forestry projects in the Philippines: potential and challenges: the case of Mt Kitanglad Range forest-carbon development project*. Working Paper 129. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/z3Sd8Q>.

Lopez RC, Moya LO, Lasco RD. 2011. *Carbon-forestry projects in the Philippines: potential and challenges: the Laguna Lake Development Authority's forest-carbon development project*. Working Paper 131. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Available from <http://bit.ly/x0iqco>.

- 52 Lasco R, Veridiano RK, Habito MC, Pulhin FB. 2012. Reducing emissions from deforestation and forest degradation plus (REDD+) in the Philippines: will it make a difference in financing forest development? *Mitigation and Adaptation Strategies for Global Change*. Available from <http://>

Climate change, biodiversity, sustainable agriculture and a threatened species database

As well, several key projects were implemented that focused on biodiversity, environmental economics and sustainable agriculture. One project integrates climate change issues into biodiversity planning and management. During its first year, a floral diversity assessment of the Ikalahan Ancestral Domain and an analysis of existing local products, processes and markets were conducted.

Additionally, the country's first georeferenced database⁵³ of threatened forest tree species was released. Georeferencing, or putting on a map, the exact locations of where species occur is a prerequisite for many branches of science, such as modelling the distribution of species and analysing the correlation of species with ecosystems. Georeferencing also helps to track plant species and prioritize scarce resources for conservation.

Because of the importance of georeferencing and also the shortage of its deployment (more than 90% of the billion or more occurrence records found in biological specimens worldwide are not georeferenced), we developed a method to georeference occurrences of threatened forest tree species in the Philippines.

The Philippines is a tropical country hosting a high concentration of diverse plant species, ranking fifth in the world, and housing 5% of the world's flora. Yet, ironically, it is also a leading global biodiversity hotspot of threatened forest trees owing to anthropogenic habitat alteration.

The Department of Environment and Natural Resources' administrative order DAO 2007-01, which constitutes the official country listing of threatened plants, lists 174 vulnerable species, 101 critically endangered, 187 endangered and 64 other threatened species in the Philippines. The International Union for Conservation of Nature's *Red List* of threatened plant species also provides an annually updated listing. Forest tree species are particularly threatened mainly because of demand for their timber.

worldagroforestry.org/forestryvoluntarycarbon/index.php?q=library/1111.

- 53 Lawrence RT, Torres AM, Pulhin FB, Lasco RD. 2011. *Georeferenced database of threatened forest tree species in the Philippines, Version 1.0*. Available from <http://bit.ly/zJTL2s>.

To help address this, we used locality descriptions that were initially narrowed down in a geographic information system using administrative maps and then further confined using two criteria: 1) elevation; and 2) surface-cover information from remotely sensed images.

The result was a georeferenced database of 2067 occurrence records of 47 threatened forest species on a national scale, each with a unique location per species and enough metadata directing the database user to the source of occurrence data, based on locality descriptions, established species' elevation range requirements, recent surface cover, and administrative and protected area boundaries.

The database can be used as a tool in determining priority species for collection of specimens or germplasm, for taxonomic identification and historical mapping. It also serves as an integral component in spatially modelling the distribution of tree species and forest formations in the past and in possible future scenarios.

Interconnected forests and coasts

The second major project—From Reef to Ridge: An Ecosystem-based Approach to Biodiversity Conservation and Development in the Philippines (USAID)⁵⁴—examines ecosystem-based approaches to biodiversity conservation, focusing on the interconnection of forest and coastal ecosystems, to improve the awareness and capacity of major stakeholders in dealing with the problem of soil erosion and sedimentation, as well as promote agroforestry as an approach to reduce sedimentation while at the same time improving biodiversity and farmers' livelihoods. Preparatory activities—such as water sampling, stakeholder analysis, focus groups, watershed management and agroforestry training—were carried out for Layawan watershed, including modeling using the Map Window Soil and Water Assessment Tool to estimate material transfers in the watershed. The team also used the Precis Regional Climate Model to derive weather data. 'Willingness to pay,' 'willingness to participate' and opportunity cost surveys were implemented for the design of an environmental rewards' scheme. Initial results showed positive

willingness to pay by domestic water users, positive willingness to participate by upland farmers, and low opportunity costs by upland farmers owing to tenurial issues.

Vegetables in agroforests

A lot of vegetables consumed in the Philippines are produced in mountainous areas within watersheds. Integrating trees in intensive vegetable production systems is feasible and offers good prospects, however, adoption is not easy, especially on steeply sloping farms. Aside from technical gaps, the viability of growing vegetables as part of an agroforest is constrained by several factors, including farmers' inability to invest, inadequate institutional structures to facilitate information flow, and lack of market and price support.

In Lantapan, which is the vegetable basket of northern Mindanao, we assessed with smallholding farmers how they integrated trees on vegetable farms, conducted field experiments and evaluated different indigenous and commercial vegetables planted amidst *Eucalyptus* trees. We found that there were certain tree-vegetable combinations that provided mutual benefits, increasing vegetable yields by up to 40%⁵⁵. Using drip irrigation, plastic barriers between trees and vegetable roots and planting shade-loving vegetables near trees were approaches that could minimize competition for water, nutrients and light. Integrating valuable trees into the system was also found to be crucial. Vermicomposting was also proven to be promising as a gender-responsive technology for female farmers⁵⁶. Working with a women's group, compost

55 Mercado Jr AR, Duque C, Palada MC, Reyes MR. 2012. Vegetable-Agroforestry (VAF) System: understanding vegetable-tree interaction as a key to successful vegetable farming in the uplands of Southeast Asia. In: Catacutan DC, Mercado Jr AR, Choing-Javier ME, Ella VB, Espaldon MVO, Rola AC, Duque-Piñon C, Saludadez JA, Penaso AM, Nguyen MR, Pailagao CT, Bagares IB, Alibuyog NR, Midmore D, Reyes MR, Suthumchai W, Kunta K, Sombatpanit S, eds. *Vegetable agroforestry systems in the Philippines*. Special Edition No. 6b. Beijing: World Association of Soil and Water Conservation; Nairobi: World Agroforestry Centre.

56 Chiong-Javier ME, Piñon CD, Mercado Jr AR, Reyes MR. 2012. *Holding their own: smallholder production, marketing and gender issues in Philippine agroforestry*. Manila: Social Development Research Center, De La Salle University. Catacutan D, Mercado Jr AR, Chiong-Javier ME, Ella VB, Espaldon MVO, Rola AC, Palada MC, Piñon CD, Saludadez J, Penaso AM, Nguyen MR, Pailagao CT, Bagares IB, Alibuyog NR, Midmore D, Reyes MR, Cajilig R, Suthumchai W, Kunta K, Sombatpanit S, eds. 2012. *Vegetable-agroforestry systems in the Philippines*. Special Publication no. 6b Bangkok: World Association of Soil and Water Conservation; Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Program.

54 <http://www.worldagroforestry.org/sea/ph/node/122>

with worms was quickly identified as an easily managed, small-scale venture with low capital investment that produced many beneficial returns.

We also found that Philippine Government policy is generally supportive to vegetables and agroforestry but the benefits to smallholders remained limited. National policies are often slow in addressing the diverse and immediate needs of farmers and so we analysed local policies. In response, the local government initiated a pro-smallholder, incentive-based policy to reward farmers who practised agroforestry and to further stimulate investment in, and adoption of, sustainable farming practices.

Rewards for environmental services

Complementing the other projects was the second phase of the RUPES project, which developed payment schemes for watershed services and carbon sequestration. RUPES 2 supported the publication of working papers and documentation on the carbon forestry projects mentioned above, a booklet titled, *Training on negotiation skills for power balance in RES schemes*, three brochures⁵⁷—*Current watershed functioning of Manupali*, *RUPES in Lantapan* and *Voices of water users in Manupali watershed*—and, with the Food and Agriculture Organization of the United Nations' Regional Asia Pacific Office, co-funded a community-based voluntary carbon market in Kalahan. In Lantapan, thanks to RUPES' facilitation the National Power Corporation committed to fund rehabilitation, reforestation and protection of the Alanib sub-watershed in Manupali watershed. And through our collaboration with the Department of Environment and Natural Resources, the Philippine branch of Holcim Ltd, a Swiss-based global company supplying cement and aggregates, agreed to pay for the establishment of 500 hectares



of agroforests and another 500 hectares for 'rainforestation' in the next five years in the Mt Kitanglad area.

Integrating trees in conservation agriculture in the uplands

Conservation agriculture with trees is a farming system that can help smallholders to restore eroded and impoverished soils in the uplands and, consequently, increase yields and incomes. There are four main principles which determine the success of the system. First is to disturb soil as little as possible. Second, cover the soil with organic matter that is compatible with crops. Third, rotate and diversify crops and use leguminous and cover crops and trees that can replenish soil fertility. Finally, use locally available resources for pest, water and soil-nutrient management, such as compost, leachates and rainwater harvesting. Researcher- and farmer-managed on-farm experiments⁵⁸ in Mindanao are looking at several conservation agriculture treatments to identify promising production systems that can dramatically improve

57 Rewards for, Use of, and Shared Investment in Pro-poor Environmental Services project. 2011. *Negotiation skills for power balance in rewards for environmental services (RES) schemes*. Los Baños, Philippines: World Agroforestry Centre (ICRAF) Philippines; Rome: International Fund for Agricultural Development.

Rewards for, Use of, and Shared Investment in Pro-poor Environmental Services project. 2011. *Current watershed functioning of Manupali*. Los Baños, Philippines: World Agroforestry Centre (ICRAF) Philippines; Rome: International Fund for Agricultural Development.

Rewards for, Use of, and Shared Investment in Pro-poor Environmental Services project. 2010. *Voices of water users in Manupali watershed*. Los Baños, Philippines: World Agroforestry Centre (ICRAF) Philippines; Rome: International Fund for Agricultural Development.

Rewards for, Use of, and Shared Investment in Pro-poor Environmental Services project. 2009. *RUPES in Lantapan*. Los Baños, Philippines: World Agroforestry Centre (ICRAF) Philippines; Rome: International Fund for Agricultural Development.

58 Mercado Jr AR, Reyes MR, Ella V, Boulakia S. 2012. Conservation agriculture research in the Philippines. In: Mulvaney MJ, Reyes MR, Chand-Halbrendt C, Boulakia S, Jumpa K, Sukvibool C, Sombatpanit S, eds. *Conservation agriculture in Southeast Asia and beyond*. Special Publication no. 7. Bangkok: World Association of Soil and Water Conservation.



soil conditions and crop yields while keeping labour requirements to a minimum. Initial results show that, indeed, conservation agriculture with trees can provide new options to better care for the land and simultaneously increase food production.

Rubber agroforestry

Philippines contributes only about 1% of global natural rubber output. It is ranked lowest among Southeast Asian rubber-producing countries and produces less than half of its natural rubber requirements. By 2025, the country needs 1.2 million hectares devoted to rubber to meet accelerating demand. Rubber trees are mainly grown on Mindanao where soils and climate are favourable.

We have been researching the best ways to combine rubber trees with other crops in order to provide farmers with short-, medium- and long-term economic benefits, help bind the soil and reduce erosion and landslides while buffering risks and improving environmental sustainability. We have tested bananas, fodder grasses, legumes and fruit trees along with maize, upland rice, vegetables and perennials like cacao and coffee. These are grown in integrated, multi-storey, hedgerow, intercrop systems. Our work has involved identifying appropriate rubber clones along elevation transects; supporting household and community budwood

gardens and nurseries⁵⁹; integration of other cash perennials and building farmers' capacity in the various facets of rubber-growing technology.

Evaluating watersheds for sustainable agriculture

A project on sustainable use of sloping agricultural land was also initiated in 2011⁶⁰. Sloping land comprises an estimated 45% of the total land area in the Philippines and directly supports around 30% of the population. The project will determine watershed characterisation by analysing the suitability of land for agricultural development and planning land uses to achieve multifunctional watersheds. This will form the basis for a new phase of improved management for both productivity and sustainability.

59 Mercado Jr AR, Edralin I, Harrison S. 2011. Technical and financial aspects of clonally propagated rubber planting stock for rubber agroforestry in Mindanao. In: Harrison SR, Bosch A, Gregorio NO, Herbohn JL. *Proceedings of end-of-project workshop: ASEM/2006/091 Enhancing tree seedling supply via economic and policy changes in the Philippines nursery sector*. 19–20 June 2010, Leyte, Philippines. Canberra: Australian Centre for International Agricultural Research. p. 163–170.

60 'Watershed evaluation for sustainable use of sloping agricultural land in the Southern Philippines'. Australian Centre for International Agricultural Research.

Thailand

The research thread in Thailand

The Centre's first mainland Southeast Asia program was established in Chiang Mai province in northern Thailand in partnership with the Kingdom of Thailand's Royal Forest Department and Chiang Mai University. Field research began in 1996 at the ASB program's benchmark site in Mae Chaem, a major upper tributary sub-basin of the ecologically, economically and culturally important Ping River Basin. This was the first ASB site with a research strategy based on nested levels of mountain watersheds, spatially explicit data and GIS technologies, as well as the first where the range of agroforestry practices included sequential agroforestry in the form of short-to-long-cycle rotational forest-fallow systems. Initial research focused on characterizing, assessing and understanding these diverse types of agroforests and links with mountain ethnic minority livelihoods and cultures, building the ASB matrix and our spatial database, and on the effects of changing government policies. Funding partnerships were with the Ford Foundation, Asian Development Bank and ASB.

Two major lines of further collaborative research on managing and assessing impacts of change in the Mae Chaem agroforestry landscapes began in 2000 as a result of the initial research findings. Research on local management of watershed landscapes focused

on developing and testing science-based tools useful in efforts by mountain minority communities and emerging local watershed management networks to better manage their agroforestry landscapes and to negotiate more equitable outcomes in growing land-use conflicts with State agencies and downstream communities. Effective science-based tools ranged from participatory mapping of villagers' own land-use categories and boundaries using GIS technologies through to local monitoring of watershed functions based on systematic measurement of key biophysical indicators. The primary funding partnership for this work was with the Rockefeller Foundation.

The second line of research focused on the key impacts of change in agroforestry landscapes, with particular emphasis on nested levels of hydrological modeling and comparison with parallel work in Indonesia (with support from the Australian Centre for International Agricultural Research and the World Bank), on assessments of child health and nutrition in mountain minority communities under various levels of stress (in partnership with the International Development Research Centre), and on impacts on small mammal biodiversity (supported by the Government of Sweden).

The next phase of research in Thailand began with expanding the reach of the team's findings and collaborative approach to larger scales and similar areas in North Thailand and the region. After 2004,



research results led to collaboration with Thailand's Office of Natural Resources and Environmental Policy and Planning in developing and testing participatory models for river basin and sub-basin management in the Ping River Basin in partnership with the World Bank. The Rockefeller Foundation provided further support for analyses of livelihoods and land uses in the Upper Ping Basin and we expanded collaboration with the RUPES project through research on alternative livelihoods based on ecotourism for mountain minority communities in areas being annexed into protected areas, as well as with the TUL-SEA project in testing rapid assessment technical tools and methodologies in areas with livelihoods increasingly linked with ecotourism.

The Thailand program's links with neighbouring countries began in 1997 with hosting a World Resources Institute resource governance project in Thailand, Viet Nam, Lao PDR, Cambodia and China. The team then became part of the SEANAFE support system and provided various types of exchange and focused collaboration with projects conducted by colleagues in Viet Nam, China and Lao PDR.

With further support from the Rockefeller Foundation and a project conducted in collaboration with the East-West Center funded by the US National Science Foundation, we expanded our GIS database to cover the mainland Southeast Asia region and conducted research on resources and market access for poor people in mountain areas of the Mekong region together with colleagues in China, Viet Nam and Lao PDR.

After years of political instability and change in Thailand's institutions and policy, a 2009 agreement with Chiang Mai University based the Thailand program within the Knowledge Support Center for the Greater Mekong sub-region with a mandate for region-wide collaboration in research on issues linked with natural resources management, environmental services and climate change, especially in the context of rapidly changing livelihoods, economic conditions and policies.

Thailand highlights of 2011–12

The Centre's role in the Knowledge Support Centre for the Greater Mekong sub-region, in partnership with Chiang Mai University, is to facilitate collaboration and sharing of information about natural resources management throughout the Mekong region. A web site and brochure have been created and more activities are being planned and developed as researchers and partners increase their collaboration. The Knowledge Support Centre aims to contribute significantly to the complex and often poorly understood Mekong region, which is a matter of increasing urgency as all countries that lie within its scope are undergoing rapid change. In building and conducting its collaborative programs, the Knowledge Support Centre is able to draw directly on the expertise not only of the Thailand office and its colleagues but also that of the China and East Asia Node, which is also carrying out research in the Mekong region.

In addition to contributing to regional analyses building on previous collaborative research in

the region⁶¹, the Thailand program also began, or continued, a number of important projects in 2011–12. Research has sought to address issues in three major subject areas, discussed below.

Promoting sustainable and natural resources management and conservation

Based on their expertise, the Thailand team was invited to collaborate in a project in Thailand's Mae Hong Son province located between Chiang Mai and the border with Myanmar.

Natural resources management problems in Mae Hong Son province are neither new nor unique compared to other areas of North Thailand. As elsewhere, major issues include biophysical and legal constraints, among others. However, the situation in the province makes some issues even more pronounced owing to the greater burden of biophysical constraints than are found in

61 Sturgeon J, Menzies N, Lagerquist Y, Thomas D, Ekasingh B, Lebel L, Phanvilay K, Thongmanivong S. 2013. enclosing ethnic minorities and forests in the golden economic quadrangle. *Development and Change* 44(1):53–79.

other provinces. Local, national and international agencies and non-governmental bodies have been attempting solutions for a long time, the results of which have, in practice, been less effective and sustainable than desired.

The Promoting Sustainable Natural Resource Management and Conservation in Mae Hong Son Province project was a multi-partner research study led by Chiang Mai University's Science and Social Science faculties and the World Agroforestry Centre Thailand's Knowledge Support Centre for the Greater Mekong Sub-region, in collaboration with the Mae Hong Son Provincial Office of Natural Resources and the Environment. The project investigated the current state of management of natural resources and developed participatory and sustainable action plans in selected pilot villages, in a funding partnership with the Food and Agriculture Organization of the United Nations.

The team concluded that participatory land-use demarcation with multiple land-use options and local bylaws was a viable and sustainable combination for natural resources management and conservation. This will help local planners and communities to improve community livelihoods while also protecting the environment.

Additional related research includes a new project supported by the CGIAR research program on policies, institutions and markets, with the title, Dynamics and Land Tenure and Property Rights under the State's Conservation of Protected Forest and Agricultural Commercialization in Mae Ram Watershed, Chiang Mai Province.

To help further strengthen technical knowledge in related areas, the CGIAR research program on forests, trees and agroforestry is also providing support for further research through three related projects: 1) Trees, Skills and Knowledge for Facilitating Forest Restoration and Agroforestry in Northern Thailand; 2) Rubber Area Assessment with Object-based Classification of Landsat-7 ETM Data; and 3) Database Development for Spatial and Temporal Distribution of Biomass in Northern Thailand.

Poverty, sacred groves and local knowledge

Research findings of significance to the management of natural resources in the region, related to poverty, changing livelihoods and local knowledge, were also published through

the TUL-SEA project⁶². In particular, the project's work in Chiang Mai's Mae Win sub-district helped clarify the links between people's changing livelihoods, poverty and the natural environment.

Communities in the sub-district were faced with numerous external forces that put strong pressure on them to change their traditional livelihoods, first, into commercial crops and then, more recently, into craft production and ecotourism-related services. These rural communities appeared to retain their common perception of a mutually shared poverty but notions of relative differences and perceived inequities also seemed to be emerging. Even where progress seemed the most impressive, parents were investing heavily in education for their children and were uncertain whether the new generation would carry on with the livelihoods they had been building or if they would move elsewhere where the future might be brighter.

To help better understand additional elements of traditional local knowledge related to natural resources management, the Thailand team also undertook a small, but nonetheless interesting study of sacred forest groves⁶³. Sacred groves are part of local Thai culture and have played a critical role in conserving biodiversity. The research team found that these sites were considered cultural treasures that had been tended under traditional stewardship for many years and that their preservation was seen to be crucial. Local laws and customs often limited human activity in these forests: hunting, grazing and logging might be prohibited or restricted and villagers took care not to damage the natural environment.

In accordance with the perceived importance of local knowledge by key institutions in Thailand, as well as the need for middle-income countries to help provide direct funding support for research programs, the Thailand team is undertaking two more projects on related topics. The first project seeks to build on local knowledge in developing a 'creative economy' and is being conducted in

62 Prabudhanitisarn S, Photaporn M. 2011. *Land-use change from complex causes and negative impacts to potential solutions in Mae Wang watershed, Mae Win sub-district, Mae Wang, Chiang Mai, Thailand*. Online. Trees in Multi-Use Landscapes in Southeast Asia project report. Available from <http://bit.ly/Aej5RW>.

63 Wangpakattanawong P, Junsongduang A, Ratnamhin A. 2011. *Roles and importance of sacred groves in biodiversity conservation in Chiang Mai*. Online. Trees in Multi-Use Landscapes in Southeast Asia project report. Available from <http://bit.ly/Aej5RW>.

collaboration with Chiang Mai University's Faculty of Social Sciences, in a funding partnership with the Government's Office of Chiang Mai Province. The second project seeks to assess ecological knowledge related to forest-fallow shifting cultivation, particularly in relation to biodiversity and carbon sequestration in forest restoration projects, in a funding partnership with the Thailand Research Fund.

Market-based incentives for maintaining biodiversity in protected forest land

This line of research began by questioning how concepts and mechanisms of paying for environmental services might be useful for management of Doi Inthanon National Park. Although Thailand was seen as not poor enough to qualify for support under the first phase of the RUPES project, the second phase was able to allocate a small amount of funding from its partner, the International Fund for Agricultural Development, to explore a context not studied at other sites.

The study found that under conditions such as those in North Thailand it was possible for community-based eco-tourism to act as a market-based mechanism for rewarding upland communities. The communities were located in, and adjacent to, a protected national park and the mechanism was

designed to help maintain environmental services provided by the park. Biodiversity was seen by the State and conservationists as most important. The critical factors of assessment, valuation and monitoring were all effectively dealt with by economic market mechanisms, thereby, bypassing many of the problems found in more conventional arrangements.

Sufficient levels of economic and indirect rewards were required for continued engagement by local communities, while a sufficient quality of cultural and environmental conditions and ecotourism services were required for continued purchase by park visitors. An additional level of social and environmental engagement was also required to maintain the improved image of local communities engaging in eco-tourism without further strong negative attacks from government or conservation interests.

Both national park officials and local communities agreed that these arrangements effectively avoided the many problems with government programs and appeared to be succeeding where others had failed. These findings suggest that more strongly market-based approaches would be worth further exploration and testing elsewhere.



Group meeting with Mae Hong Son Governor and staff, UNJP representative, Land Development Department officer and CMU-KSC-GMS staff on promoting sustainable and natural resources management and conservation project, Feb. 2012.

Viet Nam

The research thread in Viet Nam

The World Agroforestry Centre began work in Viet Nam in the late 1990s with the Agroforestry Capacity Building project in collaboration with the Agricultural Science Institute (now the Academy of Agricultural Sciences) and the Swedish International Development Cooperation Agency.

From 2002 to 2005, Dr Hoang Minh Ha, the sole Centre scientist at the time, was hosted by the Institute of Soils and Fertilizers, the Ministry of Agriculture and Rural Development and the Rural Development Network to implement a project called, Sustainable Land-Use Practices for the Uplands of Viet Nam and Laos: Science and Local Knowledge for Food Security.

We established the Viet Nam Network for Agroforestry Education in 2002.

In 2004–05, the Viet Nam office implemented the RUPES 1 project in collaboration with the Forest Science Institute of Viet Nam, Hue University of Agriculture and Forestry, Nong Lam University, WWF, International Union for the Conservation of Nature, Winrock International and the Rural Development Network.

This was followed by another project, Comparative Analysis of Market and Resource Access of the Poor in Upland Zones of the Greater Mekong Region, in 2006–07.

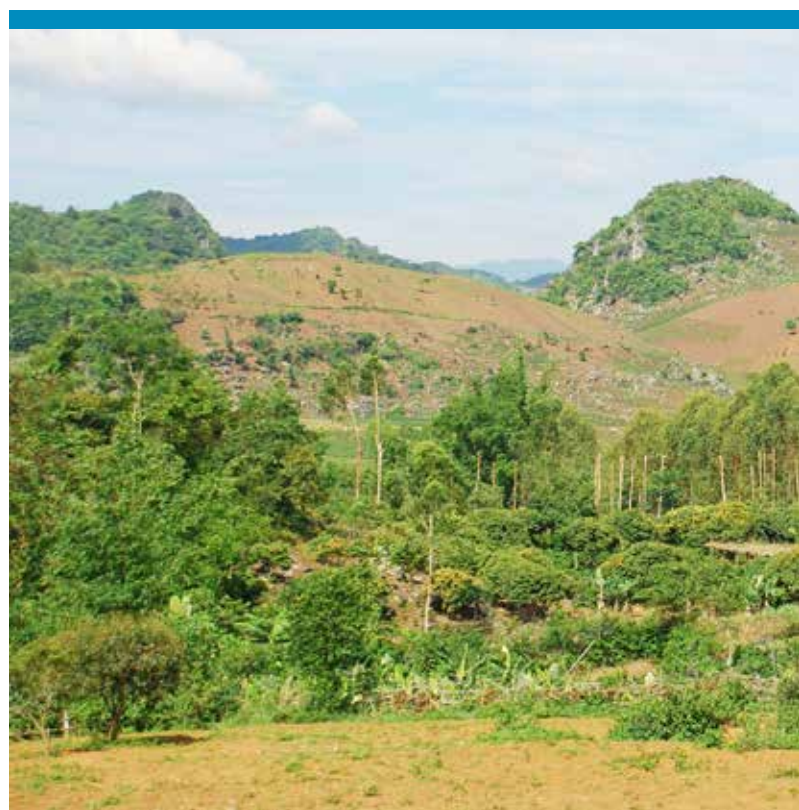
In 2007, a permit was granted by the Union for Friendship Organizations that recognised our work and allowed us to operate as an international NGO. This paved the way for the establishment of our first independent office in Cau Giay district. And we began implementing two major projects: Trees in Multi-use Landscapes in Southeast Asia and Harmonizing Poverty Reduction and Environmental Goals in Policies and Planning for Sustainable Development. The latter was managed by the Ministry of Natural Resources and the Environment in cooperation with the Center for International Forestry Research, Carl Bro Viet Nam, Centre for Agricultural Forestry Research and Development at Hue University of Agriculture and Forestry and the Viet Nam Environment and Sustainable Development Institute). These projects were followed by RUPES 2 and Reducing Emissions

from All Land Uses projects and, most recently, the Agroforestry for Livelihoods of Smallholder Farmers in Northwest Viet Nam project, which began in late 2011.

The Centre's Viet Nam program has witnessed the country's transition into an emerging economy, which has brought both opportunities and challenges to agroforestry research and development. Past successes in reforestation programs have placed the country in an excellent position to advance efforts to address drivers of deforestation and degradation. Today, Viet Nam is at the frontier of global REDD efforts and the Centre in Viet Nam is one of the Government's leading partners in developing climate-smart and low-emissions development strategies and incentives for forest environmental services.

The Government's focus on REDD and climate-smart agriculture has marked a new era where more robust agroforestry research is expected. Agroforestry has now been recognized as a key pillar in protecting Viet Nam against extreme weather events and variable climate, as can be witnessed in the revitalization of the previously defunct Agroforestry Research Unit at the Academy of Forest Sciences.

Today, our partners have re-affirmed the need for more agroforestry research in Viet Nam and have recognized the role that the Centre has to play in helping Viet Nam grow a green economy.



Viet Nam highlights of 2011–12

Rapid growth has been the salient feature of the Centre's Viet Nam office, in keeping with the importance of the advice provided by our scientists to the Government, particularly to the Ministry of Agriculture and Rural Development and the Ministry of Natural Resources and Environment⁶⁴.

The Centre is the one of the nation's most important institutions for research related to climate change and adaptation, particularly in the area of payments for environmental services, contributing significantly to the Government's major schemes in the uplands of north and northwest Viet Nam⁶⁵.

Climate change

As part of this work, the Viet Nam office organized a national workshop on climate change adaptation in Hanoi in collaboration with the Ministry of Natural Resources and the Environment and the Ministry of Agriculture and Rural Development, two of the office's closest partners. The workshop featured the launch of two books by special guests Dr Meine van Noordwijk, the Centre's Chief Science Advisor, and Professor Nguyen Ba Ngai, deputy director of VNFORD. The first book, *Tools for use in integrated natural resources management and payment for environmental services in Vietnam*⁶⁶, is an adaptation for Viet Nam of the tools developed as part of the TUL-SEA project for training trainers in payments for environmental services. The second was the Viet Nam launch of *How trees and people can co-adapt*⁶⁷. The workshop also shared lessons from several projects across the country and identified research areas and an urgent need for building local capacity to prepare provincial adaptation plans for extreme events and climate change.

Staff of the Viet Nam office also contributed to major global studies on climate change and food security. The team identified which of the world's cereal producing regions were likely to become vulnerable to climate change during the 21st century by identifying those regions that would be 1) exposed to climatic stress; and 2) have a limited capacity to adapt⁶⁸. First, the team used a global hydrological model to identify regions likely to be exposed to drought. Second, they used agricultural, meteorological and socio-economic data to develop models of adaptive capacity and run those models to show where adaptive capacity was likely

64 Nguyen TH, Catacutan D. 2012. *History of agroforestry research and development in Viet Nam: analysis of research opportunities and gaps*. Working paper 153. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. DOI: 10.5716/WP12052.PDF. Available from <http://www.worldagroforestrycentre.org/sea/Publications/files/workingpaper/WP0161-12.PDF>.

65 Simelton E, Hoang MH. 2011. *Climate-change resilient agroforestry systems for livelihood improvement of smallholders in Vietnam*. Paper presented at the Food and Fertilizer Technology Center for the Asia and Pacific Region and Philippines Council for Agriculture, Aquatic and Natural Resources Research and Development international workshop, Sustainable Farming Strategies for Increased Resilience of Asian Sloping Land Agroecosystems amid Climate Change. Manila. October. Hanoi: World Agroforestry Centre (ICRAF) Viet Nam.

66 Hoang MH, Quan NH, eds. 2011. *Tools for use in integrated natural resources management (INRM) and payment for environmental services in Vietnam (TULViet)*. Hanoi: World Agroforestry Centre (ICRAF) Viet Nam. Available from <http://bit.ly/zN6ctC>.

67 Van Noordwijk M, Hoang MH, Neufeldt H, Oborn I, Yatich T, eds. 2011. *How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes*. Nairobi: World Agroforestry Centre (ICRAF). Available from <http://bit.ly/yxADmr>.

68 Fraser, EDG, Simelton, E, Termansen M, Gosling, SN, South A. 2012. 'Vulnerability hotspots': integrating socio-economic and hydrological models to identify where cereal production may decline in the future due to climate change induced drought. *Agricultural and Forest Meteorology* 170:195–205. Available from http://worldagroforestrycentre.org/regions/southeast_asia/publications?do=view_pub_detail&pub_no=JA0448-12.



to decline by the 2050s and 2080s relative to the baseline period of 1990–2005. Third, they contrasted the hydrological and adaptive capacity model outputs to identify ‘vulnerability hotspots’ for wheat and maize (a vulnerability hotspot was defined as a region that the models projected would be likely to experience both a decline in adaptive capacity and in available soil moisture). Results from the hydrological model projected significant drying in many parts of the world over the course of the 21st century. Results from the adaptive capacity models showed that regions with the lowest overall adaptive capacity for wheat included much of western Russia, northern India, southeastern South America and southeastern Africa. For maize, regions with the lowest adaptive capacity included the northeastern USA, southeastern South America, southeastern Africa and central/northern India. When taken together, the study identified five wheat- and three maize-growing regions likely to be both exposed to worse droughts and have a reduced capacity to adapt. For wheat, these were southeastern USA, southeastern South America, the northeastern Mediterranean and parts of central Asia. For maize, the analysis suggested that vulnerability hotspots were southeastern South America, parts of southern Africa and the northeastern Mediterranean.

During the course of the research, the team found that much work on climate change and food security focused on modelling crop and weather interactions but these models generally did not account for the ways in which socio-economic factors influenced how harvests were affected by weather. To address this gap⁶⁹, the researchers used a quantitative harvest vulnerability index based on annual soil moisture and grain production data as the dependent variable in a Linear Mixed Effects model with national scale socio-economic data as independent variables for the period 1990–2005. The results showed that rice, wheat and maize production in middle-income countries were especially vulnerable to droughts. By contrast,

harvests in countries with higher investments in agriculture (for example, higher amounts of fertilizer use) were less so. In terms of differences between the world’s major grain crops, factors that made rice and wheat crops vulnerable to drought were quite consistent, while those of maize crops varied considerably depending on the region. This was most likely due to maize being produced under very different conditions worldwide. One recommendation for reducing drought vulnerability risks was to coordinate development and adaptation policies, including institutional support that enabled farmers to take action to adapt rather than simply wait and react.

Low-emissions development planning is possible in Viet Nam

Viet Nam is undergoing rapid economic and population growth with accompanying dramatic land-use and policy changes. The Government has initiated major policy reforms to boost the economy through agricultural expansion, modernization and diversification, revamping governance, and recovering lost forests through forest conservation and reforestation programs. The country opened its doors for international trade to achieve its targeted double-digit economic growth. But the Government has been challenged by the trade-offs between economic and environmental goals.

To assist with reconciling the seemingly competing demands of sustaining the environment while increasing food supply and economic growth, the Viet Nam team carried out research that found that low-emissions development was possible in the country, building on past and present work, such as REDD+ preparations⁷⁰.

The team concluded that a range of activities was possible and should be considered by the Government, such as long-term, forest land-use planning and forest conservation programs; restoration of protection forest through natural regeneration or assisted regeneration through agroforestry; expansion of reforestation only in

69 Simelton E, Fraser EDG, Termansen M, Benton TG, Gosling SN, South A, Arnell NW, Challinor AJ, Dougill AJ, Forster PM. 2012. The socioeconomics of food crop production and climate change vulnerability: a global scale quantitative analysis of how grain crops are sensitive to drought. *Food Security* 4(2):163–179.

70 Catacutan DC, Hoang TL, Khasanah N, Nguyen MP, Dano MN, Mulia R. 2012. *Land-use Analysis For Low Emissions Development Strategies (LEDS) in Viet Nam*. Technical Report. Hanoi: World Agroforestry Centre Viet Nam.

degraded areas; long-term agricultural land-use planning; promotion of appropriate agroforestry systems and practices in shifting cultivation and upland areas; promotion of agroforestry practices in industrial tree/perennial tree crop plantations, especially at the early stage of plantations; a nuanced approach in designing interventions to ensure that trade-offs are well understood and managed by all involved; and new or additional incentives that stimulate farmers' interest and investment in climate-smart agricultural or emissions-reduction practices.

Bundling environmental services

Of considerable importance for any future REDD scheme was the research carried out by the Centre on a viable incentive system that contains rewards, payments and livelihood options—'bundling' payments for ecosystem services or 'co-investment'—being developed in Ba Be district, Bac Kan province⁷¹.

With forest cover of 56.6% and a poverty rate of 36.6%, Bac Kan is among the most heavily forested and poorest provinces of Viet Nam, making it a potential site for pioneering REDD+ schemes in the country. Rather than focus on one type of environmental service, such as watershed functions, the 'bundling' approach combines water, landscape beauty and carbon storage to produce optimal benefits for the environment, the local residents who manage it and other people who use it. The team found that the clear links (water and landscape beauty) between upstream environmental services providers and downstream users was being used for investment negotiation. Thirty thousand paying visitors come to Ba Be National Park annually. Part of the entrance fee and some of the services provided to tourists can be used for protecting upstream forest and encouraging agroforestry.

How can benefits be shared?

Directly related to this work was a study into how benefits from any future REDD scheme could be distributed through the national and local levels to ensure equity and transparency⁷². The Government of Viet Nam is currently coordinating the design of a comprehensive benefit-distribution system, with the ambition to convert certified net emissions reductions into REDD+ revenue and distribute it to local partners in a transparent, equitable and cost-effective manner. A pilot scheme is underway in Bac Kan province. The results of the study showed that an appropriate benefit-sharing system for REDD+ revenues can be developed in such a way that meets international regulations as well as national and sub-national circumstances, particularly for the environmental services' providers who directly protect forests. Viet Nam's payments for forest environmental services' and conservation schemes (where conservation and rural development are integrated) serve as a base for the development of a REDD+ benefit-distribution system. Experience drawn from Viet Nam, in general, and in Bac Kan, in particular, can be replicated and directly contribute to reducing global carbon emissions.

Agroforests for smallholders in the mountains of northwestern Viet Nam

About 3.4 million people (4% of Vietnam's population) live in the five northwestern provinces in culturally diverse communities made up of 30 ethnic groups. The rugged mountainous landscape is subject to degradation of agro-ecosystems and forest destruction and fragmentation, which threatens environmental sustainability and food security. Agroforestry offers an integrated approach that can secure the livelihoods of rural households while curbing land degradation and deforestation.

Through the Agroforestry for Livelihoods of Smallholders in Northwestern Viet Nam project⁷³,

71 Hoang MH, Dinh NL, Hoang VG, Nguyen VN. 2011. *Bundling of payments/rewards for environmental services: a viable incentive system under development in the uplands of Northern Vietnam*. Hanoi: World Agroforestry Centre (ICRAF) Viet Nam. Hoang MH, Do TH. 2011. Assessing the potential for, and designing, a 'Payment for Environmental Services' scheme in Bac Kan province, Vietnam. Report to the International Fund for Agricultural Development. Hanoi: World Agroforestry Centre (ICRAF) Viet Nam. Available from <http://bit.ly/yzpB08>.

72 Hoang MH, Do TH, Pham MT, Van Noordwijk M, Minang PA. 2011. Benefit distribution across scales to reduce emissions from deforestation and forest degradation (REDD+) in Vietnam. *Land Use Policy* 31:48–60.

73 Hoang TL, Simelton E, Ha VT, Vu DT, Nguyen TH, Nguyen VC, Phung QT. 2013. *Diagnosis of farming systems in the Agroforestry for Livelihoods of Smallholder farmers in Northwestern Viet Nam project*. Working paper 161. Available from http://sea/publicationdo=view_pub_detail&pub_no=WP0169-13-10.



the Viet Nam team have been working with the Australian Centre for International Agricultural Research and several Government agencies and universities to develop the best agroforestry systems for the varying social and biophysical conditions in three provinces of the mountainous Northwest. The project involves on-station experiments to improve tree germplasm (selection, propagation and cultivation) and designing improved agroforestry technologies; 16 on-farm agroforestry trials, representing 10 different agroforestry systems; and a minimum of three farmers' demonstration trials for each agroforestry system (or its component species) in each of the three provinces taking part in the project.

The project is expected to provide new insights about how smallholders make decisions related to tree planting and adopting new production systems; an increase in the research capacity of Government and university staff; increased incomes for smallholders; reduced risks to producers' livelihoods; empowerment of marginalised people; reforestation; reduced fragmentation of landscapes; reduction of soil erosion; water and agro-biodiversity conservation; improved watershed management; carbon sequestration; and conservation of indigenous species.

Finlayson R. 2012. *Which agroforestry will improve a H'mong farmer's life?* Online. Nairobi: World Agroforestry Centre (ICRAF). Available from <http://blog.worldagroforestry.org/index.php/2013/03/14/1738/>.

Finlayson R. 2012. *Creating complex agroforestry systems in Northwest Viet Nam.* Online. Nairobi: World Agroforestry Centre (ICRAF). Available from <http://blog.worldagroforestry.org/index.php/2013/03/26/creating-complex-agroforestry-systems-in-northwest-viet-nam/>.

Bui HN. 2012. *'Seeds of growth' begin to germinate on Vietnam uplands.* Online. Nairobi: World Agroforestry Centre (ICRAF). Available from <http://www.worldagroforestry.org/newsroom/highlights/%E2%80%9Cseeds-growth%E2%80%9D-begin-germinate-vietnam-uplands>.

DONORS AND PROJECTS, SOUTHEAST ASIA >

2011–13

Australian Agency for International Development	Sustainable livelihoods options and carbon rights as a basis for efficient and fair emissions reduction in the central Kalimantan Ex-Mega Rice Project
	Identifying research to enhance livelihoods and food security from agroforestry and community forestry systems in Nepal
Australian Centre for International Agricultural Research	Watershed evaluation for sustainable use of sloping agricultural land in the Southern Philippines
Bridgestone Japan	Toward a biodiverse rubber estate: quick biodiversity survey of Bridgestone Sumatra Rubber Estate, North Sumatra, Indonesia
Canadian International Development Agency	Agroforestry and forestry in Sulawesi: linking knowledge with action
Center for International Forestry Research	Collaborative activities and projects in Viet Nam
Climate and Land Use Alliance	Develop and establish effective low-carbon development strategy planning and mechanisms at sub-national level to reduce land-use emissions and increase carbon stocks
Commonwealth Scientific and Industrial Research Organization	Exploring Mekong futures 2009–2012
Deutsche Gesellschaft für Internationale Zusammenarbeit	Making the Mekong connected: development of carbon market and conservation financing mechanisms for multifunctional landscape bio-corridors in the Upper Mekong
European Union	Impacts of reducing emission from deforestation and forest degradation and enhancing carbon stocks (IREDD)
	Accountability and local-level initiatives to reduce emissions from deforestation and degradation in Indonesia (ALREDDI)
	Reducing emissions from deforestation and degradation through alternative land uses in rainforests of the tropics (REDD-ALERT)
European Union and Ford Foundation	Participatory land-use planning to promote sustainable palm oil production in West Kalimantan
Food and Agriculture Organization of the United Nations	Project design document and contribute to the drafting of a carbon accounting methodology
	Linking communities in Southeast Asia to forestry-related voluntary carbon markets

Ford Foundation	Expand community-based natural resources management and environmental services management links with reduction of poverty, markets, gender mainstreaming and ecosystem integrity on Lombok island
	Support for applied research on the feasibility of sustainable biofuels production for oil palm in West Kalimantan
Indonesian Palm Oil Commission	Reducing greenhouse gas emissions associated with oil palm in Indonesia
International Food Policy Research Institute	Low emissions development strategy, Viet Nam
International Fund for Agricultural Development	Rewards for, use of, and shared investment in pro-poor environmental services (RUPES 2)
Margaret A. Cargill Foundation	Protecting biodiversity through improved community forest management
Norwegian Agency for Development Cooperation	Reducing emissions from all land uses (REALU)
Roundtable on Sustainable Palm Oil	Contracted member of scientific panel of greenhouse gas working group
Swedish University of Agricultural Sciences	Agroforestry for improving food security and simultaneous leverage on climate-change adaptation and mitigation
Swiss Agency for Development and Cooperation	Democratic People's Republic of Korea: sustainability and institutionalization of sloping land management
	Climate-smart rural development
United Nations Environment Programme through PanEco	Human livelihoods, ecosystem services and the habitat of the Sumatran orangutan: rapid assessment in Batang Toru and Tripa
United States Agency for International Development	From ridge to reef: an ecosystem based approach to biodiversity conservation and development in the Philippines
	Study and assessment of potential payments for environmental services schemes in Bac Kan province, Viet Nam
	Mainstreaming climate change in biodiversity planning and conservation in the Philippines

Twenty years of partnerships

GOVERNMENT

Agroforestry Technology Research Agency Ciamis,
Ministry of Forestry, Republic of Indonesia

Badan Planologi (Center for Forest Inventory and
Mapping - Forest Planning Agency)

Baoshan Forestry Bureau, China

Bukidnon Environment and Natural Resources Office,
Philippines

Bureau of Agricultural Research, Philippines

Centre Research and Development of Land and
Agroclimate (Puslitbangtanak), Republic of Indonesia

Centres for Disease Control and Prevention, China

Chinese Academy of Agricultural Sciences

Chinese Academy of Sciences

Department of Agrarian Reform, Western Mindanao
Community Initiatives Project (DAR-WNCIP), Philippines

Department of Environment and Natural Resources,
Philippines

Department of Foreign Affairs Republic of Indonesia

Direktorat Bina Perhutanan Sosial-Ditjen Rehabilitasi
Lanan Dan Perhutanan Sosial (DBPS), Indonesia

Doi Inthanon National Park, Chiang Mai

Ecosystems Research and Development Bureau,
Philippines

Forest Management Bureau, Philippines

Forestry Research and Development Agency (FORDA),
Republic of Indonesia

Forestry Research Institute Yogyakarta, Ministry of
Forestry, Republic of Indonesia

Gaoligongshan Nature Reserve, China

Indonesia Center for Environmental Law (ICEL)

Indonesian Agency for Agricultural Research and
Development (IARRD)

Indonesian Agroclimate and Hydrology Research
Institute (IAHRI)

Indonesian Center for Animal Research and
Development (ICARD)

Indonesian Centre for Agricultural Land Resources
Research and Development (ICALRD)

Indonesian Coffee and Cacao (ICCRI)

Indonesian Institute of Sciences (LIPI)

Indonesian Research Institute for Estate Crops (Lembaga
Riset Perkebunan Indonesia)

Indonesian Rubber Research Institute (IRRI)

Indonesian Soil Research Institute (ISRI)

Induk Koperasi Peningkatan Teknologi dan
Kesejahteraan Masyarakat Pertanian Kehutanan
(INKOPTEK TANHUN)

Institute of Policy and Strategy for Agriculture and Rural
Development, Viet Nam

Kunming Institute of Botany, China

Mae Chaem District Office, Chiang Mai

Mae Hong Son Provincial Office, Thailand

Ministry of Agriculture and Cooperatives (Land
Development Department), Thailand

Ministry of Agriculture and Rural Development, Viet
Nam

Ministry of Agriculture, Republic of Indonesia

Ministry of Education and Training, Viet Nam

Ministry of Forestry, Republic of Indonesia

Ministry of Interior (Department of Provincial
Administration), Thailand

Ministry of Natural Resource and Environment, Viet Nam

Ministry of Natural Resources and Environment
(Department of National Parks, wildlife and Plant
Conservation and Royal Forest Department), Thailand

Ministry of Research and Technology, Republic of
Indonesia

Ministry of the Environment, Republic of Indonesia

Mt Kitanglad Range Natural Park, Philippines

National Agriculture and Forestry Research Institute
(NAFRI), Lao PDR, Thailand

National Development Planning Agency (BAPPENAS),
Republic of Indonesia

Northern Agriculture and Forestry Research Centre,
Thailand

Northern Mindanao Community Initiatives & Resource
(NAFReC), Lao PDR, Thailand

Management Project (NMCIREMP), Department of
Agrarian Reform, Philippines

Nujiang Forestry Bureau, China

Papua provincial and districts government, Republic of
Indonesia

Philippine Council for Agriculture, Forestry and Natural
Resources Research and Development

Provincial Development Planning Agency (BAPPEDA),
 Republic of Indonesia
 Rencana Aksi Nasional penurunan Gas Rumah Kaca
 (RAN-GRK), Indonesia
 Tambon Administrative Offices (TAOs), Thailand
 Tambon Administrative Organizations for Mae Chaem
 District, Thailand
 Thailand Research Fund

Viet Nam Agricultural Academy of Science, Viet Nam
 Yuanmou Agriculture Bureau, China
 Yuanmou County, Yunnan, China
 Yunnan Academy of Forestry Sciences, China
 Yunnan Academy of Social Sciences, China
 Yunnan Forestry Department, China

UNIVERSITIES

Asian Institute of Technology
 Benguet State University
 Bogor Agricultural University (Institut Pertanian Bogor)
 Brawijaya University
 Central Mindanao University
 Central Queensland University
 Central Visayas State College of Agriculture, Forestry and
 Technology
 Centre Universitario
 Chiang Mai University
 College for Management in Agriculture and Rural
 Development
 Cornell University
 De La Salle University
 Dingle Agriculture and Technical College
 Don Mariano Marcos Memorial State University
 East-West Centre, University of Hawaii
 Gajah Mada University
 Gorontalo State University
 Hanoi Agriculture University
 Hasanuddin University
 Ho Chi Minh City University of Agriculture and Forestry
 Hohenheim University
 Hue University of Agriculture and Forestry
 Hue University of Economics
 Isabela State University
 Jakarta State University (UNJ)
 Kasetsart University
 Khon Kaen University
 King Mongkut Institute of Technology Ladkrang

Lambung Mangkurat University
 Lampung University
 Leyte State University
 Maejo University
 Mataram University
 Misamis Oriental State College of Agriculture and
 Technology
 Mulawarman University
 North Carolina A&T State University
 Prince of Songkla University
 Queensland Horticulture Institute
 Southwest Forestry College
 Syiah Kuala University
 Tadulako University
 Tay Nguyen University
 Thai Nguyen University of Agriculture and Forestry
 Thu Duc Agri-Forestry University
 Ubon Rachathani University
 University of Queensland
 University of the Philippines Los Baños
 University of the Philippines Los Baños Foundation
 University of the Philippines, Open University
 University of Western Sydney, Hawkesbury Campus
 Vietnam Forestry University
 Yale School of Forestry and Environmental Studies
 Yunnan Forestry Vocational Centre
 Yunnan Normal University
 Yunnan University

NON-GOVERNMENTAL ORGANIZATIONS

Aliansi Masyarakat Adat Nusantara (AMAN)	Lembaga Penelitian, Pendidikan dan Penerangan Ekonomi dan Sosial
Aliansi Masyarakat Peduli Hutan dan Lahan (AMPHAL)	Lembaga Pengembangan Masyarakat Pedesaan (LPMP)
Association for Community and Ecologically Based Legal Reform (HuMA)	Lembaga Pengkajian, Pendidikan dan Pelatihan Lingkungan Hidup
AYO Indonesia	Lembaga Pengkajian Sumberdaya & Pembangunan (LPPSP)
Bangwita Flores	LPB Persada
Birdlife International Indonesia Program	Mae Chaem Environment Lovers
Catholic Relief Services Philippine Program	Mae Chaem Watershed Network Committee
Center for Biodiversity and Indigenous Knowledge	Mae Ping Watershed Conservation Project
Center for Climate Risk and Opportunity Management in Southeast Asia and Pacific (CCROM-SEAP)	Mitra Tani Mandiri
Center for Community Development Studies	NUSRA
CERDAS	Operation Wallecea Trust (OWT)
Claveria Land Care Association	Papua Low Carbon Development Task Force (PLCD - TF)
Community-Based Forest Management	Partnership for Governance Reform
Conservation International Indonesia	Partnerships for Community Development
Danish Natural History Museum, Zoological Department	Perkumpulan Qbar
Ecological and Community Based Law Reform Association (HUMA)	Pesticide Eco-Alternatives Center
Forest Watch Indonesia	Philippine Watershed Management Coalition
Forum Komunikasi Kelompok Tani HKM Lampung Barat (FKKt HKm)	Project for Upper Northern Watershed Management by People Organization
Gabungan Perusahaan Karet Indonesia (Rubber Association of Indonesia)	PSW PSP3
Indonesia Center for Environmental Law (ICEL)	Pusat Studi & Pengembangan Sumber Daya Manusia (PSPSDM)
Indonesian Institute for Forest and Environment (RMI)	Pusat Studi Pembangunan-Nusa Tenggara Barat (PSP-NTB)
Indonesian Tropical Institute (LATIN)	Rekonvasi Bhumi
Kaliandra Sejati Foundation	Resources Environmental and Economics Center
KANOPI	Rubber Association of Indonesia (GAPKINDO)
KAPWA Upliftment	Samdhana Institute
Kelompok Kerja Relawan Pengelolaan Sumberdaya Alam & Lingkungan (KKR-PSDAL)	School of Natural and Rural Systems Management
Kelompok Swadaya Masyarakat Sistem Hutan Kerakyatan (SHK) Lestari	Sierra Madre Biodiversity Corridor Program, Conservation International Philippines
Keluarga Pecinta Alam dan Lingkungan Hidup (WATALA)	South-East Asian Regional Center for Graduate Study and Research in Agriculture
Komunitas Konservasi Indonesia (WARSI)	The Indonesian Institute for Forest and Environment (RMI)
Konsepsi	The Indonesian Tropical Institute (LATIN)
Konsorsium Konservasi Hutan Lampung (K2HL)	The Philippines
Laguna Lake Development Authority	Tim Kerja Pemulihan Dieng (TKPD)
Landcare Foundation of the Philippines	Upland Development Program in Southern Mindanao, Project Management Office
Lembaga ARuPA, Yogyakarta	
Lembaga Ekolabeling Indonesia	

USC Satu Nama
 VESDI Hanoi
 VESDI Nha Trang
 VESDI Rurbifarm
 Viet Nam Agricultural Science Institute
 Viet Nam and Climatic Research Unit, School of
 Environmental Sciences
 Visayas State University Western Mindanao, Community
 Initiatives Project
 Wahana Lingkungan Hidup Indonesia (WALHI)
 Lampung
 Wahana Tani Mandiri (WTM), Flores
 Wana Tirta Lestari (WATIRI)
 Wetlands Indonesia
 Wildlife Conservation Society Indonesia Program
 Working Group on Agrarian Reform Study
 Working Group Tenure
 Yayasan Wana Mandhira (YAWAMA)
 Yayasan Bela Banua Talino
 Yayasan Bimbingan Mandiri (YABIMA)

Yayasan Danau Singkarak
 Yayasan Gita Buana (YGB)
 Yayasan Konservasi dan Pemberdayaan Masyarakat
 Papua (YKPM)
 Yayasan Lingkungan Hidup Papua (YALI)
 Yayasan Mitra Samya (YMS)
 Yayasan Mitra Tani Mandiri (YMTM)
 Yayasan Nurani Desa (YND)
 Yayasan Padi Indonesia
 Yayasan Pengembangan Masyarakat (Yapemas)
 Yayasan Pusat Studi Pembangunan NTB
 Yayasan Putra Desa (YPD)
 Yayasan Satu Daun
 Yayasan Sumberdaya dan Lingkungan untuk Pelestarian
 Pembangunan (YSLPP)
 Yayasan Tananua Sumba (YTS)
 Yayasan Tananua Timor (YTT)
 Yayasan Walda

INTERNATIONAL PARTNERS

Agencia Espanola de Cooperacion Internacional
 Asian Development Bank (ADB)
 Austraining Nusantara
 Australian Agency for International Development
 (AusAID)
 Australian Center for International Agricultural Research
 (ACIAR)
 Australian Embassy
 Biodiversity Conservation Program
 Both Ends
 Bridgestone Foundation
 Canadian International Development Agency (CIDA)
 CARE International Viet Nam
 CARE, Raks Thai Foundation
 CarlBro Viet Nam
 Center for International Forestry Research (CIFOR)
 Centre for International Cooperation in Agricultural
 Research for Development (CIRAD)
 CIP-ESEAP
 Climate and Land Use Alliance
 Common Fund for Commodities (CFC)
 Conservation International (CI)

Consortium for Study and Development Participation
 (KONSEPSI)
 Danida Forest Seed Centre
 Danish International Development Agency (DANIDA)
 Danish Ministry of Foreign Affairs
 Darwin Initiative Ford Foundation
 David-Lucille Packard Foundation
 Department for International Development (DFID)
 Deutsche Gesellschaft fur Internationale
 Zusammenarbeit GmbH (GIZ-Paklim)
 Deutsche Gesellschaft fur Technische Zusammenarbeit
 (GTZ)
 Development Alternatives Inc.
 Development Cooperation Section - Environment and
 Forestry Division
 Economy and Environment Program for Southeast Asia
 (EEPSEA)
 Ernst Basler and Partner Ltd.
 European Comission
 Facility Small Grants Programme
 Federal Ministry for the Environment, Nature
 Conservation and Nuclear Safety (BMU)

Food and Agriculture Organization
 Ford Foundation
 Forest Trends
 Genesys Foundation Inc.
 Georg-August-University, Gottingen
 Global Institute for Tomorrow
 Harvard University
 Heifer International China
 HK Logistic Pty Ltd
 Indonesia Palm Oil Commission
 Indonesian Palm Oil Beareu
 International Center for Integrated Mountain Development
 International Food Policy Research Institute
 International Foundation for Science (IFS)
 International Fund for Agricultural Development (IFAD)
 International Institute for Environment and Development (IIED)
 International Land Coalition
 International Plant Genetic Resources Institute (IPGRI)
 International Plant Genetic Resources Institute APO
 International Potato Center, Regional Office for East, Southeast Asia and the Pacific
 International Rice Research Institute (IRRI)
 International START Secretariat
 International Union for the Conservation of Nature
 Kalahan Educational Foundation
 Leuseur International Foundation
 Margareth A. Cargil Foundation (MAC)
 Millennium Challenge Corporation - Abt Associates Inc.
 MISEREOR
 NORAD
 North Caroline State University
 Orangutan Conservation Services Program (OCSP)
 Organic Food Development Center
 Organic Services GmbH
 PanEco Foundation
 Participatory Research, Organization of Communities, and Education Towards Struggle for Self-Reliance, Bohol
 Philippine Business for Social Progress

RDSM Consulting Pty Ltd
 Regional Community Forestry Training Center
 Rights and Resources Group
 Rights and Resources Initiative
 Rockefeller Foundation
 Roundtable on Sustainable Palm Oil
 Royal Danish Embassy
 Royal Forest Department
 Rural Development Network
 Sino-German Center for Research Promotion
 Spanish Agency for International Cooperation (AECI)
 Swedish International Development Cooperation Agency (SIDA)
 The Food and Agriculture Organization of the United Nations
 The Macaulay Land Use Research Institute
 The Nature Conservancy
 The Norwegian Agency for Development Cooperation
 The World Conservation Union (IUCN)
 UK Department of Environment and Rural Affairs
 United Nation Development Programme (UNDP)
 United Nations Office for Project Services, Asia Office
 United States Agency for International Development (USAID)
 University of California, Berkeley
 University of Copenhagen
 Upland Development Programme in Southern Mindanao
 USDA Forest Service, Office of International Programs
 Vietnam Network on Agroforestry Education
 Waseda Environment Research Institute
 Wetlands International
 William J. Clinton Foundation
 Winrock International
 World Association of Soil and Water Conservation
 World Bank
 World Fish
 World Resources Institute
 World Wide Fund

KEY STAFF, SOUTHEAST ASIA >



Ujjwal Pradhan

Regional coordinator

Joined in 2008. Country of origin: Nepal

Dr Pradhan is based in Bogor, West Java, Indonesia. He is responsible for leading scientific teams, mobilising resources, building partnerships, conducting research, reporting and managerial supervision for Indonesia, the Philippines, Thailand, Viet Nam and China. Dr Pradhan has a PhD in development sociology from Cornell University. His dissertation focussed on property rights and state intervention in hill irrigation systems in Nepal. He is on the board of trustees of the Center for People and Forests.



Meine van Noordwijk

Chief science advisor

Joined in 1993. Country of origin: Netherlands

Dr van Noordwijk guides the global integration of the Centre's science and co-leads our global research program on environmental services. He also participates in a number of bilateral projects. His PhD dissertation at Wageningen University, The Netherlands, focussed on roots, plant production and nutrient-use efficiency.



Ceres Pasamba

Management Services Leader

Joined in 2011. Country of origin: The Philippines.

Ms Pasamba oversees the provision of services in the areas of finance and budget, human resources, general administration, information technology and publishing, contracts and project development support; coordination of the national teams in Indonesia, the Philippines, Thailand, China and Viet Nam; and liaises with headquarters in Nairobi. She holds a degree in business administration and accountancy from the University of the Philippines at Diliman and is a member of the Philippine Institute of Certified Public Accountants.



Robert Finlayson

Regional Communications Specialist

Joined in 2010. Country of origin: Australia

Mr Finlayson provides communications support to the Centre's Southeast Asia region, including resource mobilization. He has an MA in Writing from Edith Cowan University, Australia.

China and East Asia Node



Jianchu Xu

China and East Asia Node coordinator

Joined in 2007. Country of origin: China

Dr Xu is the principle scientist and Node coordinator, based in Kunming, as well as visiting professor at Kunming Institute of Botany, Chinese Academy of Science. He gained his PhD from China Agricultural University in environmental sciences and watershed management. He is responsible for all aspects of the Centre's operations in China and East Asian countries.



Su Yufang

Social Scientist

Joined in 2001. Country of origin: China

Ms Su is the East Asia Node's program coordinator, based in Kunming, as well as deputy director at the Center for Mountain Ecosystem Studies. She is responsible for both research and administrative work, whilst also completing her PhD research at Mae Fah Luang University, Thailand. Her research concentrates on climate-change adaptation, forest tenure and governance.



Dietrich Schmidt-Vogt

Geographer

Joined in 2009. Country of origin: Germany

Dr Schmidt-Vogt is a Center for International Migration Integrated Expert at the Centre of Mountain Ecosystem Studies, a research centre jointly managed by the World Agroforestry Centre and the Chinese Academy of Sciences, and is a professor at the Kunming Institute of Botany. He obtained his doctoral and postdoctoral degrees at Heidelberg University, Germany. His research interests include forest-farming interactions, land-use change, biodiversity conservation and integrated land-use systems. He is currently involved in various projects centering on the Mekong region and in developing research collaborations with Myanmar.

Indonesia



Sonya Dewi

Landscape Ecologist

Joined in 2005. Country of origin: Indonesia

Dr Dewi gained her PhD from the Australian National University on Theoretical Ecology. Her interests are in quantification of ecosystem services and landscape governance.



Suyanto

Natural Resources Economist

Joined in 1994. Country of origin: Indonesia

Dr Suyanto has a range of skills in socio-economics, natural resources economics, econometrics and institutional analysis. He conducted a study on the evolution of indigenous land tenure and tree resources management in the buffer zone of Kerinci Seblat National Park in Sumatra for his PhD dissertation in 1999 at Tokyo Metropolitan University. Dr Suyanto leads the economic and policy unit of the Indonesia office and also leads or co-leads several projects, including the Participatory Monitoring by Civil Society of Land-use Planning for Low-emissions Development Strategies project in Papua.



James M. Roshetko

Leader, Trees and Markets Unit, Southeast Asia

Joined in 1997. Country of origin: USA

Dr Roshetko leads the agroforestry tree domestication and marketing work for the Centre's Southeast Asia program from the Bogor, Indonesia, office. He participates in a number of the Centre's global research interests, including agroforestry germplasm supply systems, smallholders' timber production systems, smallholders' marketing, and agroforestry extension. His dissertation at the University of Copenhagen focused on smallholders' agroforestry systems for enhancement of livelihoods and carbon storage.



Beria Leimona

Ecosystem services specialist

Joined in 2002. Country of origin: Indonesia

Dr Leimona contributes to action research and policy formulation of pro-poor rewards for environmental services initiatives in Asia. She is a member of the Ecosystem Services Partnership and the Environment and Economics Programme for Southeast Asia network. She holds a PhD in Environmental Systems Analysis from Wageningen University, The Netherlands.



Betha Lusiana

Ecological Modeller

Joined in 1994. Country of origin: Indonesia

Ms Lusiana develops various tools and research methods, in particular, simulation models and rapid approaches to assess the impact of changes in tree cover on ecosystem services. She is currently a PhD candidate at Hohenheim University, Germany, in Agriculture and Natural Resources Management.



Atiek Widayati

Geospatial analyst

Joined in 2001. Country of origin: Indonesia

Dr Widayati's main areas of work are on land-use and -cover changes, tree-cover transitions and a nested landscape approach for low-emissions development strategies. She coordinates related projects in Indonesia. She leads geospatial work for a wide range of studies of climate-change mitigation and integrated landscape management. Dr Widayati also develops tools and methods for assessing drivers of land-use changes and vulnerability to environmental changes and hazards. She obtained her PhD from the University of Northumbria at Newcastle, UK, and has previously worked for organizations on global-change studies and forest conservation.

The Philippines



Rodel D. Lasco

Philippine coordinator

Joined in 2006. Country of origin: The Philippines

Dr Lasco is responsible for assuring the quality, integration, planning and implementation of all our activities in the Philippines. Dr Lasco holds a PhD in Forestry in Silviculture and Environmental Studies from the University of the Philippines at Los Baños. He is also the coordinating lead author for Chapter 24, Asia, of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change and a member of the National Academy of Science and Technology of The Philippines.



Agustin R Mercado Jr

Research manager for Mindanao

Joined in 1994. Country of origin: The Philippines

Dr Mercado is an agroforester and leads the Centre's vital research work in the Southern Philippines. His research focuses on conservation-oriented agroforestry systems for sloping land and Landcare. He holds a PhD in Agricultural Science, focusing on nutrient cycling in agroforestry systems, from Hohenheim University, Germany.



Florencia Pulhin

Climate-change specialist

Joined in 2004. Country of origin: The Philippines

Dr Pulhin holds a PhD in Forestry with specialization in the fields of Climate Change, Silviculture, Forest Influences and Environmental Forestry. Her research interests include carbon sequestration of the forest ecosystem, greenhouse gas inventories and climate-change adaptation. She led the recent Mainstreaming Climate Change in Biodiversity Planning and Conservation in the Philippines project and currently leads the Biodiversity and Watersheds Improved for Stronger Economy and Ecosystem Resilience project, funded by USAID.



Craig Jamieson

Bioenergy specialist

Joined in 2012. Country of origin: UK

Dr Jamieson is an international bioenergy specialist whose work has taken him to 20 countries on four continents. His specialist field is integrated food and energy systems.

Thailand



Prasit Wangpakattananawong

Thailand representative

Joined in 2011. Country of origin: Thailand.

Dr Wangpakattananawong represents the World Agroforestry Centre in Thailand. He is responsible for furthering the relationship with Chiang Mai University and maintaining the office and program in Thailand. Dr Wangpakattananawong holds a PhD in forest sciences from the University of British Columbia, Canada.

Viet Nam



Delia Catacutan

Viet Nam coordinator

Joined in 1998. Country of origin: The Philippines.

Dr Catacutan's first role with the Centre was as natural resources management specialist in the Philippines, where she conducted research into policy and institutional issues and played a pioneering role in the development of Landcare. In 2009, Dr Catacutan moved to the Centre's headquarters in Kenya after completing a post-doctoral fellowship with the sustainability science program at Harvard University's Center for International Development. She obtained her PhD in Natural and Rural Systems Management from the University of Queensland, Australia. Dr Catacutan took up the position of Viet Nam coordinator in January 2012.



Yurdi Yasmi

Agroforestry system scientist

Joined in 2013. Country of origin: Indonesia

Dr Yasmi is based in Hanoi, Viet Nam, and co-coordinates the Humid Tropics Action Area Central Mekong. He is an agroforestry systems scientist and manager of the Agroforestry for Livelihoods of Smallholder Farmers in Northwestern Viet Nam project. He holds a PhD from Wageningen University, the Netherlands, in natural resources conflict management. He has served on a number of international advisory boards related to global forest policy and governance, such as the World Bank, International Union of Forestry Research Organizations and the International Tropical Timber Organization.



Hoang Thi Lua

Field coordinator, AFLI project

Joined in 2011. Country of origin: Viet Nam

Dr Hoang is the field co-ordinator of the Agroforestry for Smallholders' Livelihoods in Northwestern Viet Nam project. She holds a doctorate in Agriculture and Horticulture Science from Germany and has more than ten years' experience in different projects in the fields of forestry, poverty reduction and sustainable natural resources management. Her current research focuses on agroforestry systems and marketing of agroforestry products.



Elisabeth Simelton

Climate-change specialist

Joined in 2010. Country of origin: Sweden

Dr Simelton started as a post-doctoral fellow while also acting as the interim country coordinator and manager of the Agroforestry for Livelihoods of Smallholder Farmers in Northwestern Viet Nam project in 2011. Her current research areas span food security, multifunctional land uses and climate change to agricultural extension. She obtained her PhD in Geography, on Human and Climate Change Impacts on Wheat Productions in China, from the University of Gothenburg, Sweden.

Research

Dennis P Garrity	Betha Lusiana Supriana *	Edilbert Campomanes
Meine van Noordwijk *	Bo Tengas	Edith Tejada
Ujjwal Pradhan *	Bruno JP Verbist	Edralin Don Emmanuel
Abi Ismarrahman	Bryan Lee Eslao	Eduardo Queblatin
Agus Ruhiyana	Bubung Angkawijaya	Eduardo Sabio
Agustin Arcenas	Budi	Efrian Muharrom
Agustin Mercado Jr. *	C Joel Misery Tukan	Elisabeth Fransina *
Ahmad Kusworo	Caroline Piñon *	Elisabeth Simelton *
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Andrew Willson	Damrong Pipatwattanukul	Fakhri Muhammad Dzakwan
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Arga Pandiwijaya *	Degi Harja Asmara *	Florante Sabejon
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Asep Nuranjani	Desi Suyamto	Fred Stolle
Asep Suryadi *	Diah Wulandari *	Gamal Pasya
Asma Sembiring	Didik Suprayogo	Gamma Galudra Triana Rusvi *
Asngari	Din Islami	Gede Wibawa
Asri Kusumawati	Dina Andriyana Indra Utami *	Genevieve Michon
Atiek Widayati *	Dinah Q Tabbada	Geramil Cordero *
Aubrey Chagas	Dinna Tazkiana *	Gerardo Boy
Aulia Perdana *	Do Trong Hoan *	Gerhard Eli Manurung *
Aunul Fauzi	Dominique Boutin	Grace Villamor
Avniar Noviantini Karlan *	Dr Florencia Pulhin *	Gregoire Vincent
Benjamin Lawther Custer	Dudy Kurnia Nugroho Adi	Gui Heng *
Beria Leimona *	Dwane Arboleda	Hans-dietrich Schmidt-vogt *

* denotes active staff

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He Jun *
Hendrien Beukema
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Hoang Thi Lua *
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Huang Wenbin *
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Ilahang
Indra Suryadi
Indriani Ekasari
Iron Maria Edi
Isabel Mildred Tan
Isidra Bagares *
Iskak Nugky Ismawan *
Isnurdiansyah *
Iwan Komardiwan
Iwan Kurniawan
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Jamartin Sihite
James Roshetko *
Janudianto *
Jasnari *
Jerome Labra
Jesus Fernandez
Jesus Nedamo
Jhon Roy Sirait *
Joan Urquiola *
John Israel
Johnny Sumaylo
Josephine Arbes
Josien Ruijter
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Julito Itumay
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Katarina Riswandi
Kharmina Paola Anit *
Kristine Garcia *
Kurniatun Hairiah *
Kusuma Wijaya
Kusumanto Trikurnianti
Lang Rong *
Laura Ediger
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Leo Kris Palao
Leo Rulida
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Li Junchen
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Li Zhengli *
Lia Dahlia *
Lisa Tanika *
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Liu Wenjun
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About the World Agroforestry Centre

The World Agroforestry Centre is an autonomous, non-profit research organization whose vision is a rural transformation in the developing world where smallholder households strategically increase their use of trees in agricultural landscapes to improve their food security, nutrition, income, health, shelter, energy resources and environmental sustainability. The Centre generates science-based knowledge about the diverse roles that trees play in agricultural landscapes and uses its research to advance policies and practices that benefit the poor and the environment.

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HIGHLIGHTS