

Research Abstracts & Key Policy Questions

Environmental Services & Land Use Change

**Bridging the Gap between Policy &
Research in Southeast Asia**

Methodology Workshop

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Environmental Services and Land Use Change

Bridging the Gap between Policy
and Research in Southeast Asia

31 May – 2 June 1999
Chiang Mai, Thailand

edited by Thomas P. Tomich, David E. Thomas,
and Meine van Noordwijk

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INTRODUCTION

Minister's Address

Workshop purpose, objectives, and organization

List of the two introductory papers

Abstracts of introductory papers

Minister's Address

by HE Pongpol Adireksan, Minister of Agriculture & Cooperatives, Thailand

Dr. Pedro Sanchez, Director-General of International Centre for Research
in Agroforestry (ICRAF)

Dr. Plodprasop Suraswadi, Director-General of the Royal Forest Department

Dean Pongsak of the Chiang Mai University Faculty of Agriculture

Distinguished Participants, Ladies and Gentlemen,

On behalf of the Ministry of Agriculture and Cooperatives of the Royal Government of Thailand, I am very pleased to have this opportunity to address the opening of this regional workshop on *Environmental Services & Land Use Change: Bridging the Gap between Policy & Research in Southeast Asia*.

As the Minister of Agriculture and Cooperatives, I am particularly pleased that ICRAF and this wide range of collaborating organizations have joined with Chiang Mai University to organize this workshop in North Thailand. As a major center in this region for more than seven centuries, the Chiang Mai valley civilization has long depended on environmental services provided by the forested hills that surround it.

Upstream from Chiang Mai, remote mountain communities have depended on forests for food and many other products, as well as to renew the productivity of their shifting agriculture systems. Indeed, research findings published in what has become a classic book, *Farmers in the Forest*, provided a major advance in our understanding that sparked a new generation of research on traditional upland agriculture. The site of that research was not far from here.

And downstream from Chiang Mai, the vast paddy fields and orchards of Thailand's Central Plains, as well as the Kingdom's capital city of Bangkok, have long depended on flows of water and nutrients, as well as the timber and many forest products from the North.

I have been informed that there are more than 100 participants here from various countries of Southeast Asia and around the world. To the many participants from overseas, and especially for those of you making your first visit to Thailand and its 'Rose of the North', as Chiang Mai is known, may I extend to you all a most cordial welcome to the Kingdom and to Chiang Mai.

I would also like to take this opportunity to express my sincere thanks to the organizers and their hosts at the Royal Forest Department and Chiang Mai University for their tireless effort in making this seminar possible. My special thanks are extended to the Chiang Mai University Faculty of Agriculture and their colleagues at the ICRAF Chiang Mai office.

Ladies and gentlemen,

I believe that all of us here are aware of growing public and international concerns about land use change. Thailand, along with various other countries in the region, has experienced several decades of very rapid economic growth, and demographic and social change. During this period, land use patterns have changed dramatically, and water resource systems have been heavily modified. Many of our forests are now heavily degraded, and vast areas have been cleared of their natural forest cover and converted to other uses, from agriculture to urban-industrial centers, suburbs and resorts. Even this beautiful resort is one small example.

While many have benefited from such change, many also now believe environmental change has gone too far, too fast. Growing environmental awareness is making people more cautious about change that may threaten the productivity, resilience and

sustainability of the natural resources upon which our society depends, both now and in future generations. And now with the recent economic difficulties that are being felt across Southeast Asia, many of us are re-assessing the directions of our agricultural and natural resource policies.

In Thailand, the Ministry of Agriculture and Cooperatives is responsible for government programs related to agriculture, irrigation, fisheries and forestry. As His Majesty the King often reminds us, our economy, society and culture are strongly linked to agriculture - from the most remote subsistence farmer to the largest agro-industry. Indeed, the majority of the Thai people still live in rural areas, and agriculture plays a central role in their livelihoods. Thus, we will continue to develop and improve our agriculture, with special emphasis on the needs of the rural poor. And, we also need to further develop additional aspects of rural livelihoods, from fisheries and agroforestry to processing industries and tourism. Competition for resources is increasing, and all of these groups will continue to lobby the government to assure that they are not forgotten.

At the same time, however, we must be sure that we are not damaging the natural resource systems upon which all this activity depends. Many efforts by Departments in the Ministry are directed toward control of fire and soil erosion, rehabilitation of degraded lands, water resource management, preservation of genetic diversity, and conservation of natural ecosystems. You do not have to read many Thai newspapers before you begin to have a feeling for the pressure being exerted by those who have strong interests in these issues.

Thailand is also very much a part of regional and global trends toward more democratic institutions and participatory decision making. Our new constitution includes many provisions aimed at promoting broad participation in decision-making processes, and major efforts are underway to strengthen elected local governments. One result of these processes is the often very hot debate evident in the Thai media. And issues related to the effects of deforestation on smoke, biodiversity, soil erosion, floods and droughts have not escaped these debates.

Thus, I am very pleased to see that this gathering of the international scientific community is seeking to raise such questions as

- How much effect does land use change actually have?
- Who benefits and who loses, both now and in the next generation, and by how much?
- What are the options for action, and by whom?
- Do we have the information we need to answer these questions?
- Is that information widely understandable and available?

Distinguished participants and guests:

These are the types of questions that those of us in policy positions need to address. And, this is the type of information that is needed to improve the quality of debate and decision-making by all elements and players in the public policy process. I suspect the same is true in all your home countries.

Thus, I want to encourage you as members of the research community as you seek to address these questions during the course of this workshop. Moreover, I hope your deliberations will be fruitful and useful, and that some concrete suggestions for improved policy-relevant research will be forthcoming. These issues are important, and the needs for accurate and balanced information are urgent.

I look forward to the results of the workshop, and I wish you all a very pleasant stay at this appropriate setting in Chiang Mai.

May I now take this opportunity to declare the Regional Workshop on Environmental Services & Land Use Change: Bridging the Gap between Policy & Research in Southeast Asia open.

Workshop Purpose & Objectives

The SE Asian Regional Programme of the International Centre for Research in Agroforestry (ICRAF) and its research partners plan a major thrust in quantitative analysis of environmental services and policy problems, including the causes of regional smoke problems, the changing functional roles of landscape biodiversity, and the degradation of watershed functions resulting from land use change. This work is part of the global Alternatives to Slash-and-Burn (ASB) programme, which conducts research on sustainable upland systems as alternatives to unsustainable slash-and-burn in various parts of the tropics, including major sites in Indonesia, the Philippines, and Thailand. The purpose of the workshop is to seek a common understanding of these environmental problems and to review existing data and methods for quantitative analysis of three environmental policy issues linked to land use change: smoke, biodiversity, and watershed functions.

The workshop will bring together users of information with researchers who produce information. The objectives of this workshop are to:

- assess the needs of policymakers, landuse planners, natural resource managers and other users of information on environmental services and related policy problems
- identify usable data and appropriate existing methods for quantifying these environmental services in order to address major environmental policy problems
- identify gaps in either data or methods
- where gaps exist, to set priorities for filling them

Workshop Organization

An initial overview session will be followed by three thematic sessions—one each for smoke, biodiversity, and watershed functions--that each will comprise:

- presentations of research papers on the state of data and methods for quantifying these environmental services and studies of the scope and limits of current understanding of these environmental services and related policy problems.
- synthesis of the current availability of data and quantitative methods, their relevance to problems and opportunities facing the users of this information, priorities for filling gaps in data or methods, and strategic options for addressing each theme

Introductory papers

Asking the Right Questions: Policy Analysis and Environmental Services at Different Scales by Thomas P. Tomich, David E. Thomas, Meine van Noordwijk, and Anne-Marie Izac, ICRAF, Herminia Arocena-Francisco, EEPSEA, Ken Chomitz, World Bank, Daniel Murdiyarso, ICSEA and Blake Ratner, WRI/REPSI.

Filters, Flows, and Fallacies: Methods for Quantifying External Effects of Land Use Change by Meine van Noordwijk and Polly Ericksen, ICRAF, and John Poulsen, CIFOR.

Asking the Right Questions: Policy Analysis and Environmental Services at Different Scales

by Thomas P. Tomich¹, Herminia Arocena-Francisco², Ken Chomitz³, Anne-Marie Izac⁴, Daniel Murdiyarso⁵, Blake Ratner⁶, David E. Thomas⁷, and Meine van Noordwijk¹

Keywords: meso-level environmental externalities, transboundary smoke, biodiversity, watersheds, forest functions, environmental policy analysis

Plausible (albeit dire) scenarios for the future in Southeast Asia include increasing conflict over land and water resources and degradation of hydrological, ecological, and other environmental services, which could undermine the stability of national economies, urban centers, and national food security. But do we really know enough about these complex relationships to build a consensus for action? How big are the effects of land use change (for better or worse) on stability of production systems at the local, regional, and national level? How well do these forest-derived land uses substitute for natural forests from the perspective of local people and national objectives? What scientific evidence is available to answer these questions? Are scientists even asking the right questions? From a policy perspective, at least three sets of questions are crucial:

1. Who cares? How are people affected? Are the effects big?
2. So what? Would action serve one or more public policy objectives?
3. What can be done? Will it work?

These 3 basic sets of policy questions are applied to each of three 'meso-level' environmental concerns: smoke, biodiversity loss, and degradation of watershed functions. A seven-stage 'environmental issue cycle' is presented as a framework for analysis of how the data needs and uses change with evolution of understanding of a policy problem. In the case of transboundary smoke, the level of awareness and concern in the region is high, but it is not clear what can be done. For biodiversity, it is not yet clear who should care because the basic cause-effect relationships underlying the functional roles have not yet been established. Degradation of watershed functions is the most mature of our three environmental topics; indeed it shows signs of being 'fossilized' by vested interests in the present consensus.

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Filters, Flows and Fallacies: Methods for Quantifying External Effects of Land Use Change

by Meine van Noordwijk¹, Polly Ericksen² and John Poulsen³

Many external effects of land use change are based on modifications of lateral flows of soil, water, air, fire or organisms. Lateral flows can be intercepted in filters and thus the severity and spatial range of external effects of land use change is under the influence of filter effects. Wherever lateral flows are involved, research results can not be simply scaled on an area basis, and overall impact does not follow simple linear cause - effect relationships. This complexity has consequences for the stakeholder - policymaker - primary agent feedback loop. In this paper we review how the relative importance of lateral flows and filter effects differs between a number of externalities, and the implications this has for research methods. If flows and filters are incompletely understood, policies may be based on fallacies.

Whereas 'fire-breaks' act as filters in the lateral flow of the high temperature pulse of a fire, smoke from land-based fires can be intercepted only by rainfall acting as filter and the external impact of smoke is determined by the atmospheric conditions governing lateral flow and chemical transformations along the pathway. Cause-effect relations in smoke and haze problems are relatively simple and may form a basis for policy feedback's to at least reduce downwind damage.

In biodiversity issues landscape connectivity, the absence of filters restricting dispersal and movement of organisms, is increasingly recognized as influence on the dynamics of species richness and its scaling relations. Biodiversity research methods can extend beyond the current descriptive stage into clarifying cause-effect relations in a lateral flow perspective. The question whether connectivity is in fact desired, however, depends on stakeholder interests and situation.

Forest functions in watershed protection, presumably leading to a continuous flow of clean water in the dry season through the subsoil in stead of a rapid surface transfer, have been generally attributed to the trees in stead of the forest, with its rough surface structure, swamps and infiltration sites. A new synthesis of site-specific hydrological knowledge and tree water balance studies may be needed to separate myths from realities, and avoid wasting public funds on tree planting under the heading of reforestation, without restoring the hydrological regime of a real forest. Soil movement can be intercepted at a range of scales and in as far as soil transport entails movement of soil fertility, filter zones can be very productive elements of a landscape.

Integration of all external effects of land use will have to be built into models of farmer decision making about the use of natural resources on and off farm. Farmers ecological knowledge includes concepts of lateral flows and can be explored as an integral part of a new landscape ecological approach

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THEME 1. MANAGING SMOKE

Key questions

Interview with Nabil Makarim

List of papers on smoke

One page abstracts of selected papers on smoke

List of posters on smoke

One page abstracts of posters on smoke

Managing smoke: key questions

Banning burning has not worked, at least in Indonesia. The workshop seeks to go beyond apparently futile efforts to ban burning to identify more workable options for managing burning to reduce smoke problems.

What is the problem? Who cares? Who are the winners and losers?

Who benefits most from free use of burning for land clearing, large-scale plantations or smallholders? Which of - or under what circumstances do -- these groups contribute the most to smoke problems? How do these costs compare with the direct benefits of burning for land clearing? What are the consequences of land clearing without the use of fire?

Who bears the greatest costs of smoke from burning for land clearing? Local people in the neighborhood? ... people in the province or state? ... the nation as a whole? ... people in other countries?

What can be done? What are the options for action?

What policy options and policy instruments exist to manage the recurring regional problem of smoke from land clearing? Are there opportunities for action to improve management of smoke through policy reform or institutional strengthening? What are the main lessons from the experience of different countries in designing and implementing strategies to manage smoke?

Are there any win-win opportunities? If there are conflicting interests, should/will the victims of smoke compensate people who give up burning? Or should the polluters pay? Is either approach feasible?

Who could implement these options? Who (or which institution) has the greatest influence over smoke and/or burning for land clearing? How could they influence it? What is a workable unit for management of smoke? ASEAN or other international organizations? The nation? Whole islands? Regions? Specific landscapes? Fields? What role do local ("informal") institutions play in managing burning and smoke?

What are the priorities for further research?

What data would be useful in designing and implementing a strategy to manage burning in order to address the smoke problem? What is the role of remote sensing in managing smoke? Aside from remote sensing and better understanding of institutional functions at various levels, what other types of data or research would be useful to policymakers?

Is more or better information the answer? If more and better data were available, how could they be used? Given the inaction to date, under what circumstances would more or better data be used?

Interview with Mr. Nabil Makarim¹

by Thomas P Tomich²

Speakers are: TPT - *italics* and NM - plain text.

Many policy makers do not have time to attend workshops with researchers. In addition, participation by Indonesian policymakers in the ICRAF workshop on Bridging the Gap between Policy and Research in Southeast Asia will be especially limited because of its coincidence with the election. We want to be sure that there is some input from Indonesian policymakers and that is why I want to do the interview in English and to record and transcribe it so that it can be available as discussion material at the workshop.

There are five basic questions that I want to ask you.

- 1. What was your role with BAPEDAL during that crisis of 97/ 98. What was your job and what were your responsibilities?*
- 2. From that perspective what was your biggest headache during the crisis. What was the biggest policy problem for you?*
- 3. What could BAPEDAL or other parts of the Indonesian Government do about the problem?*
- 4. Is there any way that research or better information could help?*
- 5. What research would you say needs to be done now to prepare for the next El Niño? What sorts of data would be most valuable so that next time the problem happens we are better prepared, or even better, so the problem doesn't happen again.*

The mission of BAPEDAL is to manage environmental impact. In 1997/8 we were managing the environmental impact of the forest fires, although, of course, management of the forest itself is under the Department of Forestry.

Indonesia has an institution that monitors climate, predicting what is going to happen and so on. We have a department that takes care of disasters. But communication is at the heart of all this work. We communicate information on climate, predicting when the best opportunity is to burn, and which months will be very sensitive for burning. It is always assumed that if people know, people will not do bad things. But they do. That has shocked us. We also communicate with institutes from other countries, informing them what we are doing and so on. We channel assistance, particularly technical assistance. That's our role.

During the 97/8 crisis we monitored where the hot spots were. Every single day we reported that information to the governor, the Minister of Forestry, our Minister (the Minister of Environment, who was Dr. Sarwono Kusumaatmadja at that time), and the Bupatis (district heads). We tell the Bupatis that today you have so many hot spots in your area in such and such a location, supposing that they should do something about it.

The main problem was with big plantations; about 70 to 80 percent of the forest fires last year were on big plantations. I always thought: let me find a solution to this larger problem first, and then tackle the problem of smallholders later. But I could not find any solution.

¹ Formerly Deputy Head for Pollution Control, BAPEDAL- Indonesia's Agency for Environmental Protection (to Jan 1999) and now Secretary General of InSes, Institute for Strategic Analyses.

² ICRAF, Bogor on 16 April 1999

I agree with you that tackling the problem of the large-scale interests is a big part of the problem. It is also an easier entity to deal with. You have fewer people rather than the thousands of smallholders.

I understood the situation a bit better with some help from Bob Hasan (the most influential among Indonesia's "timber barons"). Two years ago when the problem was first developing I knocked on his door at nine o'clock at night. I said look you have to help me. He said something that surprised me. 'Look I am the victim here. My trees are 7 metres tall now and they are being burned because a new neighbour has just come and is burning the land. I want to help you.' (Well Hasan has himself opened some new land but not on a significant scale.) He helped me to understand that the problem was not the old planters, but with the new ones.

But the established planters are also large scale, they also have plantations?

Yes, and that is why in this case Hasan ended up helping us. He saw it as his problem, himself as the victim, an old established planter, who already had his trees growing.

One of the things that we heard about almost two years ago when the smoke was so bad, was that there was an unfortunate combination of factors. People were saying 'yes this is the time to burn because of the dry conditions'. At the same time, because of the cycle of development planning in the REPELITA, at the provincial level there were a lot of permits being given for land clearing. It was an unlucky coincidence that permissions were being given in order to try to meet development targets and that coincided with the weather conditions of the El Niño.

Yes, it might have been different if land clearance permits had been given slowly. That might be a solution for the future.

Indonesia has forest fires every year. The question is how big or small are they. We can see that the dryness of the climate, or in this case the El Niño oscillation, had a very close relationship with the numbers of hectares of land that burned. On the other hand we can also see that the problem also had its roots in the allocation of land clearance permits.

We all draw on personal experience for these sorts of things. My family are farmers. When I was growing up in California they grew rice. You know there is a problem of rice straw burning too. Eventually the burning of rice straw was banned. But there was a transitional period when burning was allowed, but only on particular days when the weather conditions were right so that the smoke would dissipate. It wasn't the fire that was the problem but the smoke in the atmosphere. I remember that was part of a transitional strategy going from a situation of people burning when they wanted to, to a situation when people could only burn on specific days and they had to get a permit to do that. And in that valley, like here with very big plantations, if someone was violating the regulations you could see it.

In Kalimantan you can see where the fires are with satellites. Here too the problem is with the smoke. But the second problem is with controlling the fire.

Even if there is just one plantation burning, and no others, if you end up not being able to control it the problem can be very big. This happened quite often, even with small fires. When El Niño was at its peak, some landholders just burned. The results were shown on TV. The fires weren't controlled and there was too much smoke.

So when El Niño comes back, we should be ready with more than one policy. One policy might be to stop giving permits to clear land altogether, or to give them slowly. I think Minister Nasution (the current Minister of Forestry and Plantations) has now stopped the clearing of new land so hopefully, probably in the next two or three years, our main problem will be with the smallholders.

A second might be requiring people to have a permit to burn so that you can regulate

burning and you know who is going to do it when and where. I have heard the idea, but never thought seriously of it, that burning be done throughout the season. But then people would say 'OK you burn when it is wet; I burn when it is dry'. People tend to take the easy thing for themselves. How could we allocate burning times and then ensure that people stuck to it? The problem is that the person giving permits may be taking bribes.

If you give many land clearance permits at the same time, to meet a target like you say, everyone cuts their land in the first dry season available. The fires start small. With quick action you can do a lot to control them. But when a fire gets big there is nothing you can do to control it. Even if you have airplanes and so on it is useless.

The job cannot be done by one institution, you needed many, but when I look back at 97/8 there was too much emphasis put on co-ordination between institutions and not on the credibility of each institution. Almost every two or three days we had a meeting but the credibility of these institutions, of whether they were doing their work, is not clear. There was ambiguous responsibility. There were cases when people were putting out fires and then they would stop at one point and say 'Oh that's not my department anymore. It's different ecology. It's not forest anymore. I am from forestry and I am stopping here.' Of course fire doesn't stop with departments. So that was one of the problems.

From that experience what I was doing until I left the office was rewriting the mission of each institution. What they should be doing and how they should be accountable. Each institution would write a yearly report of what they are doing. These would be compiled by the Ministry and would become a report to the press and to the public.

Another very important concept I put into the concept of regulation is that the bulk of accountability should rest with Governors. They should be able to ask for support, they could ask the military if they want, but the responsibility would rest with them.

Why did you choose the Governor and not a Minister?

Because they are there, they are close to the Bupati. Issues such as fire need a quick response. Look at it from the beginning in the field. When people see a fire they should put the fire out. If this cannot be done, it should go up and up to the Governor. If the Governor cannot do it then he can go to the Minister for assistance, but the accountability sticks to the Governor.

One afternoon at the peak of the fire crisis Sarwono asked me to call 10 Governors one by one and check what they were doing. And one afternoon I did it and I reported to him that it was hopeless. They were the Governors, but some of them were in Jakarta playing golf. This was at the height of the fires. Others were having siestas. I only talked to one, from Central Kalimantan, the rest were just not there.

Do you think it is in Governors' interests to try to restrict the smoke?

I don't think they see it that way. We invited the Governors to the presidential office and asked them to report on the situation in their areas. Every single one of them except Central Kalimantan said everything is OK. It is manageable. Don't worry about it. It would have been better if they had been accountable for what was going on and of course, if there were NGOs in place to watch them.

Is there any reason why, for Central Kalimantan, their behaviour was different? Was it the person or the situation in that province?

It was both.

We don't really know at this point what proportion of the fires were intentional and how many were accidental burning that grew out of intentional fires. If the fires were burning because people really want to burn such large areas, it's a much harder problem, than if

someone started burning something but then that spread to something that they didn't want to burn. Is there any way to know?

People don't clear land with fire in Java, but during El Niño there were hot spots in Java and those hot spots were accidental - people dropping cigarettes and so on. So we can see it only in Java. In Sumatra and Kalimantan it was the season for burning. There were reports of burning in some remote areas where there is no ownership. So the natural burning is there - forest fires as people think of them in North America. But the bulk of the problems were on plantations from people burning the land.

Would it be useful to know more about how much of it was from plantations, how much of it was accidental fires that spread, how much of it was natural forest fires, or do you know enough about that?

That would be useful because then we would know where we should be concentrating our efforts. For years the smallholders were blamed. And then that year when we looked into it we felt that no it's the big owners. But it could be that year only; we don't really know what happened in previous years. That year 1997 it was clear it was big plantations.

How did you find that out, because that was a striking difference? Previously as you say it was smallholders who were blamed. In this most recent time it was much clearer, at least in the way it was presented, that the government knew that it was the large scale interests which were the problem.

We had satellite photos overlaid with aerial photographs that showed ownership lines. Then in addition Sarwono had people in the field reporting to us via satellite telephones.

So it was information technology, satellites and so on, that made the difference?

Yes, we had a lot of satellite telephones in the field and people were in there sending us information.

A lot of the people who will be attending the workshop are specialists in remote sensing and geographic information systems. Are there, from your experience, any aspects of those tools or those types of data which could be improved in terms of dealing with this sort of situation?

Yes, the technology is definitely there. Bob Hasan showed us how technology can monitor one single tree by satellite. It can be done.

But the second thing is public policy. It is very important to have a set of policies that can be made to work. If you look at pollution for example, we have standards and we have regulations but the legal system is not working so the whole thing is useless. That is why for pollution I used a different approach of giving ratings to industry. It is the only thing I could think of which bypasses the legal system. We cannot rely on the legal system so somehow we have to think how we can have a policy to make things work in this very imperfect situation.

Just slamming the door shut is another way. Here in our imperfect system if we shut the door and then say that only guys with green shirts can come in, because the door is open a crack, they all come in. People with green shirts and people with red shirts. So why not just close the door.

But in the case of forest fires I cannot find an idea that can stop them. I am still waiting for a brilliant idea. What policy tool can be used in a situation like this?

You have emphasised how on policy you have to be realistic about what can be implemented. Sometimes scientists tend to think of solutions to a problem as though the rest of the world were perfect. In the real world in Indonesia now what would be your priorities in terms of strengthening of policies or institutions?

One vital thing we can do is to create accountability. Everybody must be accountable to the public and Ministries must be accountable to the President. Information should be there. There should be at least one institution daring enough to give information to the public in Indonesia whatever the results.

What kind of information has the most impact?

Information on the accountability of each institution. For example knowing what is the responsibility of the Ministry of Forestry and being able to see if they are doing their job.

That's why, to make it easy I was suggesting that we put the entire responsibility on to the Governors. Also there must be a change in the regulations regarding fires. If you are given land and there is fire no matter what, if the fire is on your land it is your responsibility. It must be like that so that there is no blaming each other. It's accountability of the institutions and conduct of the businesses that are important as well as public policy. And of course the information has to be there.

I cannot answer the question of how to deal with smallholders now, because at the time of the crisis I was overwhelmed by the big problems.

How do you see the role of reformasi and the process of moving towards democracy in Indonesia? Do you think that will affect the kinds of accountability?

Nothing will happen soon. In fact at the moment it is going the other way. For example, looking at the Ministry of Environment, Emil Salim and Sarwono created a reformed institution for the environment. BAPEDAL was reformed under them. Ironically during the 'reformation' it has become deformed.

How were Pak Emil and Pak Sarwono able to create a reformed Environment institution ahead of its time?

Well first of all, Emil Salim is a true democrat. He ran the office like that. He led by example. He is very open and very committed. People will follow an example and it becomes an organisational culture. And then there was Sarwono. He is less idealistic but more pragmatic. But that is perfect. A founder should be a visionary but the second has to be more pragmatic. This was natural and good until the 'reformation' era.

Emil Salim was able to bring people to understand and be committed. He did have some weaknesses in management, how to stop specific problems. In that respect he was weaker than Sarwono.

But let's look at the influence of these men at the time of the forest fires. We are lucky now to have a wet season. If we had El Niño this year there is no longer a system and we don't have leaders. We had developed a system from the experience of 82, but it could not take the shock of 97. The institution could not face the situation that developed. But then there was Sarwono. Sarwono would work until three o'clock in the morning. Sometimes he would call the Bupati and talk to him asking how the situation was in that area. And then after talking to the Bupati he would call the next two numbers, let's say the last two digits of the Bupati's number were 97, then he would call 98 and 99. Logically it should be someone living close. He would talk to these people explaining that he was the Minister and asking the people how it was in their area. If there were conflicting stories he would call back to the Bupati and say look you are not telling the truth. It is not going to happen like that now. If we had the fires now we would have even bigger problems because there is no leadership.

So what you are emphasising is that it is the leadership and the institutional capacity that was important.

What I am saying is that in the absence of a good system then good leadership is crucial. We want good institutions, that is more sustainable, but in the absence of that, leadership becomes crucial.

Earlier you talked about an approach for dealing with fires and smoke of making more information available, not just about the different agencies of government and their accountability, but also on the accountability of landholders. I take it the model for that is what BAPEDAL did for water pollution. It might be very useful for people to have a thumbnail sketch of what happened in relation to water pollution so that they can see the parallels.

What we did with the problem of water pollution was basically to measure the level of performance of each factory and give them a rating in one of five categories. A simplistic sketch of these categories would be:

Gold	for zero discharge, which means 5% of the maximum allowed or less. Nobody until now has got Gold because it requires totally different technology.
Green	if they discharge 50% of the maximum allowed or less (of course there were other things like relationships with the surrounding peoples, or impact assessments showing good management of their hazardous wastes)
Blue	factories that just met the standard
Red	if they have done something, have invested in something but haven't met the standard
Black	if they haven't done anything and they are creating pollution

How did the mechanism work for enforcement and for creating incentives for the company?

The incentives were created by making the information public. We monitored the companies in-house in BAPEDAL. Unfortunately we tried to do it though others but the results were complicated. So we selected people from in-house that we could really trust - a small number of smart and dedicated staff. That programme office was the only one that I let have music on during working hours. Those people were smart guys; they were dedicated but it is like with computer geniuses, you cannot put so many limitations on them. But they were working hard.

The information we collected was published. First the Minister reported the results to the press and so on at a press conference. Information had to be published explaining which factory got what rating. For factories rated Black Sarwono insisted we should include the name of the manager of the factory and then send the report to financial institutions. That worked even in the first year. It helped the Reds, but then some Reds remained Red and those we called the faceless businessmen. First it worked because of public opinion and of course the press was helping us and some NGOs.

Bringing in the financial institutions really worked. We had about 30 people dedicated to that. We were doing this from 95 to 98 and during that time only one company rated Black more than twice. Once a factory got a Black rating, they did everything they could to get out of it.

Why do financial institutions care about the environmental impact of their borrowers?

In the end they see it as risk. It was the power of public opinion and a little bit of threat. We kept on talking to the factories. When we collected information from the factories we also found out about their banks. So we had ratings for factories across the industry, and we knew which banks were loaning money. Then we told them you know we can put the bank in a rank. We could see which bank is supporting how many Reds, how many Blacks etc.

So it was harnessing public opinion directly on the polluting companies, but also public opinion of the banks.

And even if we do not do it, NGOs can do it.

Do you think that this kind of a model based on information collection and making it publicly available would work with the fires and smoke?

Yes it would be better with a strong public relations effort. But we need to teach the public to react. I did a small experiment during the height of the fires. I told 20 of my staff to go out over lunchtime and speak to people about how they felt about forest fires. Most people said they didn't care. This was Jakarta. Some people hoped the smoke would cover Jakarta so that people would scream. If it had gone to Jakarta instead of Singapore I think people would have reacted.

There was a research institution in Singapore that did quite a bit to put information on the World Wide Web and things like that. Did their efforts help you or make your job more difficult?

In fact during the height of the fires we always had two Singaporeans that stayed with us in the office working night and day. If we needed something quickly they would call and get it organised. They were from the climate office of the Ministry of Environment, and they assisted us; they worked with us. Also there were two people from Malaysia who were with us for three weeks. So it was good co-operation.

We have talked about remote sensing and about institutions especially at the provincial and local levels. In terms of a research agenda to think about, where would you put money and time for research? What would be the two or three things that you think are the highest priority?

The first is policy research. It is no good just saying stop burning. You have to come with a creative public policy and it is urgent.

The second is institutional research. What sort of institutions do we need? What sort of accountability do we need?

A third thing is understanding the nature of the forest fires themselves. Are we experiencing a change of climate for the long term? If this is so the wisdom that has been passed down the generations is probably just not working any more. How can we help people adapt to that change?

Papers on Managing Smoke

Monitoring and Assessing Forest Fires in Borneo using NOAA-AVHRR Data by Kamaruzaman Jusoff and Aswarti Bt Surep, Universiti Putra Malaysia.

Causes and Effects of Forest Fires: A Case Study From a Sub-District in East Kalimantan, Indonesia by Christian Gönner, c/o GTZ-SFMP, Indonesia.

When Smoke Gets in Their Eyes, Policymakers Tend to Over Look the Need for Quantifiable Data by Peter Hoare, Upper Nan Watershed Management Project, Thailand.

Assessing the Damage Cost of the Indonesian Forest Fire and Transboundary Haze on Neighboring Malaysia: The Case of Health Impacts by Mohd. Shahwahid H.O., Universiti Putra Malaysia, and Jamal O., National University of Malaysia.

Policy Responses to Complex Environmental Problems: Insights from a Science-Policy Activity on the Transboundary Haze Problems in Southeast Asia by Daniel Murdiyarso, IC-SEA, Indonesia, Louis Lebel, Walailak University, A.N. Gintings, Forest Research and Development Centre, Angelika Heil, GTZ/SCMP Project, and Merillyn Wasson, Australian University.

Monitoring and Assessing Forest Fires in Borneo using NOAA-AVHRR Data

by Kamaruzaman Jusoff and Aswarti Bt Surep¹

Keywords: forest, fires, NOAA, haze, plans

Forests are managed not only for the production of wood, but also as a safeguard for environment. One of the main factors effecting forest degradation is forest fires and uncontrolled burning. ASEAN countries especially Malaysia and Indonesia were most effected by forest fires during July -November, 1997. The worst haze occurred in Sarawak, Malaysia when it was declared emergency with the Air Pollution Index (API) indicated a danger level of 800, 300 above the 500 danger level. This paper highlighted the capabilities of satellite image (NOAA-AVHRR and SPOT image) in monitoring forest fires. Observation and studies showed that the haze was caused by fires and burning in accordance to the API data from the Meteorological Department Service. This paper also assessed the burned forest areas and the relationship between the number of "hot spots" and the severity of haze occurrence in affected areas particularly Borneo. The causes of forest fires were highlighted and management plan of forest fire control was proposed.

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Causes and Effects of Forest Fires: A Case Study from a Sub-District in East Kalimantan, Indonesia

by Christian Gönner¹

According to Indonesian-German forestry projects, the 1997/98 forest and land fires affected more than 5.2 million ha in Kalimantan. Since fires are likely to happen again due to the large amount of remaining dead wood, it is essential to understand more about the causality behind the 1997/98 fires, in order to anticipate future fire prone situations and to take measurements to reduce fire risk.

This case study suggests an interpretative causal net approach for analyzing causes and effects of forest fires. The approach resembles systems theory, but does not require a *priori* defined system boundaries. Patterns and events are investigated in a phenomenological way by describing the eco-cultural setting in a holistic and comprehensive way. This is done in two steps: A fuzzy but comprehensive background image of the local culture is compiled at first, in front of which events and resource strategies can later be analyzed more detailed, following causal chains.

Causes and effects of the fires and the drought were assessed through interviews of key-informants, semi-structured interviews, and field trips. The data suggest four major groups of fire causes:

- Fires caused by an oil palm company's land clearing activities
- Arson linked to financial compensation of forest gardens
- Other kinds of arson
- Incidental Fires

Dayak farmers did not burn during the drought for preparing swiddens, mainly because of the high risk to burn someone else's forest garden, which would have been severely fined according to traditional *adat* law.

Most fire causes were directly or indirectly related to the land clearing activities of an oil palm company. Land rights conflicts, unequal compensation practices, and internal conflicts interacted in a fatal way, destroying hundreds of forest gardens.

Drought and fire effects increased the pressure on the local population, who already suffered from the Indonesian financial crisis. Beside the burned forest gardens, many plant resources were at least temporarily lost, protein and vitamin supply was insufficient, enhancing the health problems already caused by haze.

After the fires, the economy of villages which still had some forests, recovered partially due to a new market for tortoises (collected in swamp forests), and increasing prices for rubber and rattan. Swamp forests were also used in the following year for rice cultivation.

The applied research approach revealed a complex causal web, which stresses the crucial role of land rights conflicts. Such conflicts can not only cause forest fires, but might escalate even further, involving physical violence. In order to avoid these kinds of conflicts, it is suggested to implement participatory planning steps from the very beginning. Managers and policy makers must learn that ignoring land rights issues is not a sustainable strategy. Conflicts can substantially harm all, local communities *as well as* commercial companies and governments. Only a permanent trustful co-operation between communities, companies and governments, facilitated by acknowledged mediators can avoid the escalation of lands rights conflicts and thus contribute to mutual benefits.

¹ Albert-Ludwigs-Universität, Freiburg, Dept. of Ethnology, funded by TÖB - Ffanking Programme for Tropical Ecology, GTZ in co-operation with GTZ-SFMP (Promotion of Sustainable Forest Management Systems in East Kalimantan), Samarinda, Indonesia

When Smoke Gets in Their Eyes, Policymakers Tend to Over Look the Need for Quantifiable Data

by Peter Hoare¹

Keywords: forest fires; forest fire laws; community fire management, regional smoke, slash & burn agriculture.

A fire calendar for Nan Province with estimates of the contribution to the smoke problem by different fire lighters was prepared. The estimates show that 30% of the smoke problem comes from "urban fringe" residents and the other 70% from graziers, hunters, and the burning of upland agricultural fields.

The project implementation experience for 1998 and 1999 of the Upper Nan Watershed Management Project to reduce the area burnt by graziers, hunters and upland farmers in a pilot project area of 1007 Km² in Nan Province is analysed. The government forest fire management programme is being implemented through the Royal Forest Department, and the participatory community fire management programme through Community Coordinators funded through Danish Cooperation for Environment and Development (DANCED) grant assistance.

The main findings were that 67% of the 45 villages of 5 ethnic groups already had their own regulations and fines against uncontrolled fires. However, these regulations in many cases could not be enforced due to fires spreading from neighbouring villages or being lit at night by hunters. The village fire volunteers made 93.6 km of firebreaks in 1998 and there were 765 village fireguards, who also helped Royal Forest Department staff suppress fires. The Landsat image of 17/3/1998 showed that 20.7% of the project area was burnt, mostly by graziers and hunters outside the control of the village social system.

During the last year the project has used new opportunities created through the empowerment of sub-district administration and rural communities in natural resource management to strengthen village rules and regulations on fires through Village Watershed Networks and Tambon Administrations. The preliminary assessment in 1999 is that less than 5% of the project area was burnt. However the smoke problem leading to the closure of Nan airport for 7 days in 1999 cannot be appreciably reduced until the Provincial Administration intensifies a fire control programme against the "urban fringe" fire lighters.

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Assessing the Damage Cost of the Indonesian Forest Fire and Transboundary Haze on Neighboring Malaysia: The Case of Health Impacts

by Mohd. Shahwahid H.O.¹ and Jamal O.²

The 1997 forest fire in Indonesia has contributed to a transboundary pollution problem to neighboring countries in South East Asia. Haze which is the accumulation of fine particles in the air, has enveloped Malaysia beginning August until October. The haze has raised the incidences of aggravated respiratory diseases, declines in agricultural and fishing yields, disruptions on transport services, manufacturing and tourism industry, and raised averting expenditures. This paper reports on the findings of the economic cost of the haze-related health impacts to Malaysia.³ Two dose response functions were computed one linking air pollution index with number of outpatient treatments and another with number of hospitalized cases for Sarawak, the state hardest hit by haze pollution in 1997. Sarawak is treated as a 'research site' in the context of 'benefit transfer' terminology, and these functions were then transferred to the other states in the country to serve as the 'policy sites'. With the physical quantity of outpatient treatments and hospitalized cases, the haze-related medical cost, productivity losses, and cost of inconveniences suffered were estimated for the whole country. It is estimated that the adjusted cost of illness arising from the 1997 haze during the period August to October was RM21.02 million". The per capita damage cost was estimated at RM104.72 which accounted about 1.3% of per capita income. Although in terms of income this is a small, but repetitive occurrences of such inconveniences has to be avoided. Regional cooperation is needed to address this transboundary pollution issue by identifying win-win or win-no-lose situation. The land clearings has contributed to the forest fires, including by large plantation firms (a few owned by Malaysians) for conversion to oil palm, a commodity vital to both Indonesia and Malaysia. Competing vegetable oil producers may regard the unsustainable land clearing practice as an 'environmental subsidy' for oil palm production.

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³ These findings form part of a three-country study of damages from the 1997 haze, sponsored by the Economy and Environment Program for Southeast Asia (EEPSEA) and the World Wide Fund for Nature-Indonesia. The work was carried out between October 1997 and February 1998.
One USD = RM2.5 in August 1997

Policy Responses to Complex Environmental Problems: Insights from a Science-Policy Activity on the Transboundary Haze Problems in Southeast Asia

by Daniel Murdiyarso¹, Louis Lebel², A.N. Gintings³, S.M.H. Tampubolon⁴, Angelika Heil⁵ and Merilllyn Wasson⁶

Keywords: land management practices, environmental governance, policy intervention, science-policy dialogue.

Transboundary pollution from vegetation fires is a recurrent and highly politicised environmental problem in Southeast Asia. This paper is a critical synthesis of the policy response to the recent haze episodes. It is based on a series of science-policy activities co-ordinated by the Impacts Centre for Southeast Asia aimed at exploring land-use planning and management options to reduce the impacts of transboundary pollution from vegetation fires. We begin with a brief summary of what is known about the causes of the fires and haze, the composition and distribution of haze, and the main impacts. Policy options and instruments are considered at a range of levels, from local waste-wood management options and national land development strategies, through to regional and international institutions. In these analyses we seek to understand the interaction of different interest groups and identify potentially complimentary policies as well as likely trade-offs. Ultimately, the goal of this science-policy activity is (1) to improve the use of existing research-based knowledge in the public policy process and (2) highlight key gaps in understanding for the research community.

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Posters on Managing Smoke

An Information System for Forest and Land Fire Management: A Case Study in Humid Tropical Forest of Kalimantan, Indonesia by Chay Asdak, Pajajaran University, Indonesia.

The Coincidence of Land and Forest Fire and Peat Distribution in Indonesia: An Approach for Preventive Measures by Muhamad Rahman Djuwansah, R&D Centre for Geotechnology, Indonesian Institute of Sciences (LIPI), Indonesia and Muchlisin Arief, National Institute of Aviation and Aerospace.

Globalization, Sustainable Forest Management, and the Firm: Implications for Environmental and Land Use Change in South East Asia by Jacob Park, University of Maryland (USA) and UN University/Institute of Advanced Studies (Japan).

Impact of Forest Fire on Berbak National Park's Biodiversity and Water Quality in Jambi - Sumatera by Nyoman Ngurah Suryadhi Putra and Irwansyah Reza Lubis, Wetland International-Indonesia Programme.

Forest Land Clearing and Preparation Using Composting Technique to Prevent from Forest Fire Hazard: Research Results of Felling/Slashing-Composting-Planting (FCP) Technique by R. Sudradjat, Watershed Management and Technology Centre, Indonesia.

Techniques of Zero Burning in Land Clearing for the Establishment of Plantation Agriculture: Malaysia's Experience by Mahmud Abd. Wahab, Forest Research Institute of Malaysia, Jamaludin Nasir, Golden Hope Plantations Berhad, Ramli Majid, Mentiga Plantation Berhad and Yew, FK, Malaysia Rubber Board.

Paradox and Implication of Policy of Land and Forest Fire Control: Case Study of Indonesia by Hariadi Kartodihardjo and Kukuh MurtiLaksono, Bogor Agricultural Institute, Indonesia.

An Information System for Forest and Land Fire Management: A Case Study in Humid Tropical Forest of Kalimantan, Indonesia

by Chay Asdak¹

In spite of the current serious economic crisis in Indonesia, the early prediction of the incidence of forest and land fires and the prompt mitigation of the resulting effects remains one of the most important challenges facing the country in environmental management. Last year's destruction of large areas of forest and land in Kalimantan have been attributed to a combination of abnormal climatic condition well known as El Nino, exacerbated by human activities, especially in relation with land preparation for both agricultural and forest plantation purposes. This environmentally catastrophic event and strong protests from Indonesia's neighboring countries has forced government to engage in a large-scale deployment of human resources and technology in order to monitor and fight the fires. This paper was part of a particular study on forest fires being conducted by the government of Indonesia. The paper will focus on how to effectively compile and manage the numerous information available on forest and land fires, and hence, design a procedure of an integrated information systems for forest and land fire management. The benefits of this program will impact all of the stakeholders including the Government of Indonesia, ASEAN regional members, the public, NGO's, and private forestry and plantation companies.

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The Coincidence of Land and Forest Fire and Peat Distribution in Indonesia: An Approach for Preventive Measures

by Muhamad Rahman Djuwansah¹ and Muchlisin Arief²

Land and Forest Fire (LFF) usually happen since long time ago in Indonesia. Within traditional Shifting Cultivation agricultural system of indigenous people, forest or bush "slash and burn" is periodically practiced for land preparation at the end of dry season. Nowadays, not only the indigenous farmer that perform slash & burn, but also the transmigrants who do not master to control the fire of forest burning, and the enterprises who normally perform large scale land clearing simultaneously for converting the forest into plantation. The extension and quantity of LFF is getting more and more important with the increasing economic activity, particularly related with forest conversion, because land clearing cost by burning is low compared to that by cutting down the trees. Since the forest burning is not managing properly, the accumulation of these burning often become a big disaster. The events of devastated LFF, such as happened at 1994 and 1997, in fact, coincide with the year of severe dry season related to ENSO phenomenon.

Daily monitoring of LFF in Indonesia is performed since 1996 by National Institute for Aviation and Aerospace (LAPAN). Hot spots of Land or Forest Fire is recognized from satellite as the pixels that possess average soil surface temperature over 49°C filtered from thermal band image of NOAA or LANDSAT-TM. Most of hot spots in Sumatera and Kalimantan. The number of hot spots increase from April and reach the maximum at the end of September. Geographically, the majority of hot spots is found on peat-land or organic-rich soils, mainly for the fires at August-September. The extension of peat deposit in Indonesia covering about 27 million hectares, spread out mainly in the lowland of eastern coastal Sumatera and Kalimantan. Naturally, peat land is found as inundated bog and covered densely by tropical forest. At the end of September, water content of peat is the minimum, and peat become easily burnt. In fact, peat is an excellent combustible, especially when the humidity is very low (par ex: some industrial estate use peat with 20 % humidity for their fuel). The humidity of peat or soil-organic matter will decrease with water table lowering, such as by drainage, or with increasing evaporation such as when vegetation cover was removed. Under dry condition, the fire will be difficult to be controlled. Therefore, peat, peaty soils and organic rich soil provinces should be considered as the vulnerable area for wild fire.

Dealing with LFF problems, preventive measure posses many advantages than that of curative. Since triggering conditions of wildfire depend much on climate and soil organic matter , an alert system of LFF could developed based on micro climatic parameters. Early warning of LFF could be obtained by monitoring of soil and air humidity and water table at vulnerable area. When their value is reaching the critical level, the alert status could be announced for the surrounding inhabitants. Considering that wildfire require immediate handling, the system will effectively operate if the responsible institution for the alert status announcement and wild fire suppression should be held by local level organization: District or sub district.

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Globalization, Sustainable Forest Management, and the Firm: Implications for Environmental and Land Use Change in Southeast Asia

by Jacob Park¹

Deforestation and smoke problems are ecological consequences of a larger regional and global economic and business phenomenon that have had and will continue to have a multi-dimensional and sectoral impact on the forests and natural resources of Southeast Asian countries. This paper argues that understanding this multi-dimensional and sectoral impact is crucial in designing and implementing a sustainable environmental and land use transition on the regional level.

The relationship between global economic and business imperatives and environmental & land use changes in Southeast Asia can perhaps be best seen in the regional and global pulp & paper industry, in which the demand and consumption of timber, plywood, and forest resources often clashes with the goals of sustainable forest management.

Another important link between global economic and business imperatives and environmental and land use changes in Southeast Asia is the development of the agro-commodities (e.g. oil palm, cocoa, and others) industry. Developing the agro-commodities industry may be critical in reviving the regional economy and generating export earnings, but the ecological consequence of such commodity-led development has not yet been fully explored.

Will the rush to recreate the so-called "Asian economic miracle" disrupt the fragile balance between environmental conservation and economic development in the ASEAN region?

¹ University of Maryland (USA) and UN University/Institute of Advanced Studies (Japan)

Impact of Forest Fire on Berbak National Park's Biodiversity and Water Quality in Jambi – Sumatera

by Nyoman Ngurah Suryadhi Putra¹ and Irwansyah Reza Lubis

The impact of forest fire on the bio-diversity and water quality in Berbak National Park was studied during March to October 1998. The study covered three swampy areas: Simpang Palas, Simpang Datuk and Air Hitam Dalam. The first two had been burnt twice (1994 and 1997) and the third once (1997).

Impact on Water Quality. The survey indicated that forest fire had caused acidification and increased ion concentration in the water of the areas studied. The pH of these areas was very low (3.3 – 3.5) with acidity ranging 120 – 760 ppm, compared to the adjacent area which received no direct impact from forest fire (i.e. the Batanghari river: pH 5.8 – 7.1, no acidity values detected). The acidification of these swampy areas is thought to have resulted from the release of sulfate (through drought and fire) from soils containing sulfides or free sulfur, which then oxidized in the presence of water to form sulfuric acid. The survey recorded that the sulfate (136-695 ppm) and iron (1.7 – 6.4 ppm) content of these swampy areas was very high compared to the Batanghari river (sulphate: 14-29 ppm, total iron 0.30 – 0.62ppm). Physical degradation of organic matter during the forest fire in Berbak had also significantly increased ion (Ca, Na, Mg, K, SO_4^{2-} and CO_3^{2-}) concentration in the waters. This effect has been demonstrated in the laboratory using a simulation model.

Impact on vegetation. Forest fire has destroyed 75-98 % (24 – 48 species) of plant species in the study areas. The highest loss was recorded in Air Hitam Dalam (98% or 48sp from a total of 49 species found in unburnt areas), followed by Simpang Palas (96% or 25 from total 26 species) and Simpang Datuk (75% or 8 from total 32 species). Although significant numbers of plant species were destroyed during the fire, the loss of thick canopies has enabled several dormant plant species to emerge from the ex-forest fire floors.

Impact on fauna. Forest fire has created many patches of open areas in Berbak. This implies loss of living habitat, feeding grounds and nesting habitat for certain creatures (e.g. sun bear). During the October 1998 survey, crowds of predator birds (e.g. Lesser adjutant, and Brahminy kite) were observed searching for food in these open areas, while sun bears (also other herbivorous mammals) were reported frequently attacking the villagers' crops (e.g. coconut trees). Villagers reported finding many freshwater fishes dead in Berbak NP during the 1997 dry season, due to the disappearance of water from the swamps, and also in the 1998 early rainy season. The 1998 fish deaths are suspected to be due to water acidification. A number of these fishes (e.g. the climbing perch (*Anabas testudineus*), snakeheads (*Channa striata*), sepat rawa (*Trichogaster leerii*) and Seluang (*Rasbora agyrotaenia*) have since reappeared in these ex-forest fire swampy areas. A minimum of between 20-21 adult individuals and 15 ducklings of WWD (White Winged Duck, *Cairina scutulata*) were found in Desa Sei Rambut and Air Hitam Dalam. (These areas have now become new records for WWD populations found in Sumatera). In the short term forest fire has had no significant impact on the occurrence of WWD in these areas, but in the long term due to habitat loss this might affect their presence.

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Forest Land Clearing and Preparation Using Composting Technique to Prevent from Forest Fire Hazard: Research Results of Felling/Slashing-Composting-Planting (FCP) Technique

by R. Sudradjat¹

The aim of this investigation is to achieve composting technique on forest leaves and litters to be applied integratedly with forest land clearing and preparation. By applying this technique, hopefully forest fire can be suppressed while soil more fertilised.

This investigation was conducted at HPHTI (Industrial Timber Plantation Estates) Musi Hutan Persada, Barito Pacific Group, South Sumatera. The methodology used are as follows: (1) composting technique on site, i.e in shrub forest, alang-alang forest (*Imperata cylindrica*), acacia forest floor; (2) composting technique off site, namely controlled process. Other supporting data have been collected: (1) leaves and litter potency in shrub forest (2) in secondary forest (3) in acacia first rotation logging area (4) Litter potency on acacia forest floor (5) alang-alang potency. Effective Microorganisms 4 (EM4) of Japan licence trade mark product was used to enhance organic matter decomposition, hence shortening of time lag in nutrients cycle.

Results of this investigation recommend the best composting technique at shrub forest is to spray fresh litters by EM4 and covers the top of the bulk by soil from its left and right sides. This treatment obtains C/N ratio of 12.58 within 8 weeks. The best composting technique for litters at acacia forest floor is to spread litter homogeneously, spray with EM4, covers with soil, within 8 weeks the C/N ratio decreased to 10.92. The best composting technique for alang-alang, is to plough and turn over, that bring about the decrease of C/N ratio down to 8.9 within 8 weeks. Spraying of EM4 on shrub leaves should be applied 1 month after felling meanwhile leaves have already split off naturally from their branches and twigs. Spraying EM4 on acacia forest floor should be applied when litters has been highly accumulated that is started with acacia of 4 years old.

After 1 year, all compost samples that were covered by soil had already soil clay to form humus. This phenomenon indicate that the biomass carbon from plantations had been reduced and metabolised into energy and microbial carbon. Hence, flaming of dry leaves or litters could be avoided or forest fire could be suppressed to some extent, even soil become more fertile.

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Techniques of Zero Burning in Land Clearing for the Establishment of Plantation Agriculture: Malaysia's Experience

by Mahmud Abd. Wahab¹, Jamaluddin Nasir², Ramli Majid³ and Yew, F. K.⁴

In the past, for the establishment of plantation crops, it was a common practice to burn remnants of trees after felling prior to land preparation. Such action often carried out during the dry months, resulted in the emission of large quantities of total suspended particles into the atmosphere and with excessive and prolonged burning, hazy conditions resulted. Currently, in Malaysia, the zero burning technique has been developed and adopted as a standard policy not only in replanting but also for new planting from jungle or logged-over forests.

The main operations of zero burning involves firstly, the extraction of saleable and useable timber. This is to reduce the amount of residual wood which may take years to decompose and also, to enable the residual wood to be used as temporary bridges or rollers to strengthen the foundation of roads in peat areas. This is then followed by land preparation with the operations differing between flat, mineral and peat soils and hilly and undulating areas. For peat areas, to facilitate land preparation operations, excess water is removed. Natural streams passing through the land, are cleaned-up, widened and deepened and additional outlets and perimeter drains, constructed with special care taken to avoid rapid drying.

Soon after extraction of the timber, road and drain constructions are done with lining carried out to determine the location of all roads, main drains and subsidiary drains. In most cases, these are done simultaneously with blocking of the fields, felling and stacking. Base lines are then pegged to earmark the planting rows and avenues for the stacking of residual timber and wood debris. During felling, trees are pushed and uprooted and cut into reasonable sizes before stacking them in interrows at every two palm rows.

In peat areas, additional work in terms of compaction is carried out to avoid drastic shrinkage of the soil after planting. In hilly and undulating areas, after extraction of useable timber, main and feeder roads are constructed with the road system properly planned to ensure sufficient access. The density of contour terraces are predetermined and prelining for terrace construction are also carried out. During the construction of terraces, all debris are pushed and stacked between terraces with large obstructing timber or logs along the terraces, cut into smaller pieces.

Once the stacking is completed, legume cover crop is then established in the interrows and adjacent to the stacking row to encourage quick coverage over the debris, thus enhancing the decomposition of the debris. Once these operations are completed, lining, ploughing and harrowing which are confined only in the planting rows and in flat areas on mineral soils, together with holing and planting operations are then carried out.

It is obvious that zero burning of land clearing is an environmentally friendly technique which helps safeguard the environment from air pollution. The technique allows recycling of plant nutrients through the decomposition of wood residues. Large quantities of organic matter are returned to the soil thus restoring and improving soil fertility. On hilly areas, loss of valuable top soil is minimised. The absence of open burning eliminates loss of soil moisture. Fallow period of planting oil palm is also reduced and coupled with savings on burning, restacking and reburning as practised in clean clearing method, zero burning therefore provides economic advantage.

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Paradox and Implication of Policy of Land and Forest Fire Control: Case Study of Indonesia

by Hariadi Kartodihardjo¹ and Kukuh Murti Laksono²

Keywords: causes, consequences, fire, performance bond, property right, resource accounting

There has been six huge land and forest fires with lost of billions rupiah in Indonesia for last 20 years. Nevertheless, it showed that the repeated land and forest fires have not been to be lesson for all of the stakeholders. Even, the terrible forest fire of 1987/1988 was happening though early warning system was being implemented.

Thus, the thing must be carefully take into account is that the lost and consequences of repeated land and forest fires were just artificial one. It is just due to institutional problem, so that the causes action and consequences or lost have no absolute relationship. The fact in the field indicated that there was very limited time available to tackle with applicable extinguish technology when the fire is still small (less than two hectare) running to situation where the technology could not be applied anymore due to very huge and extended land and forest fires. Other fact showed that the fires were not stopped by effort of extinguishing, but by rainfall in the beginning of rainy season. Therefore, the success of fire control could not only depends on centralised and organised institutions, but it also depends on willingness and capability of local people of the society (farmers, dwellers, forest and estate concessions, etc.) wherein land and forest fires is happening.

In order to express the willingness and lifting up the society capability, prevention of land and forest fires depend on the success of government in **arrangement of property right** on land and forest. Aside from that, the government must cancel immediately the policy of land clearing without fire and replace it with **performance bond**. Each of government institution related with effort of prevention of land and forest fires must implement **natural resource accounting** as the performance. The implementation of the three components is predicted consuming plenty of time due to economic-politic factors and the high of conflict of interest on land and forest arrangement among the stakeholders.

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THEME 2. CHANGING ROLES OF BIODIVERSITY
IN THE LANDSCAPE

Key questions

List of papers on biodiversity

One page abstracts of selected papers on biodiversity

List of posters on biodiversity

One page abstracts of posters on biodiversity

Functions of biodiversity in the landscape: key questions

Much discussion of biodiversity conservation focuses on global existence values – in other words, preventing extinctions. Much less attention has been given to local functional values of biodiversity (belowground as well as above). This workshop seeks to put aside, for the moment, legitimate global concerns with extinctions, in order to focus on local, functional roles of biodiversity in landscapes where people seek their livelihoods.

Who should care at the local and national level? Who loses from biodiversity loss at the local level? How? Are there winners too?

1. Are there threshold effects of biodiversity loss on stability of production such that land use change that could be sustainable for a limited number of actors on a limited area would be an ecological catastrophe if everyone did it?
2. From a local perspective, how important are stabilizing functions of biodiversity compared to its other ecological services? In other words, are the effects of biodiversity on production stability big or small compared to:
 - opportunities for direct use and marketing of forest products by local people, either under normal conditions or during difficult times
 - effects of biodiversity conservation on prevalence of human pests (tigers, elephants) and diseases (malaria)
 - less tangible aesthetic and spiritual roles of biodiversity for local people, which also may be developed as a basis for ecotourism and other new economic activities

Does the relative importance of these different ecological services to local people shift with rising incomes or with market integration? Is there any way to predict how these local values may shift as a result of new economic opportunities?

3. Should national policy makers worry about loss of these ecological functions in the same way they seem concerned about loss of watershed functions? From a national perspective, how important are the stabilizing functions of biodiversity compared to other pressing national concerns? How about all ecological functions taken together? Do we have any idea of these magnitudes? Can they be valued and compared to loss of watershed functions, transboundary smoke, or other environmental concerns that do capture policymakers' attention from time to time? Are there concerns about biodiversity loss at the national level that are distinct from local concerns? How can diverse societies identify these functional roles of biodiversity and assess tradeoffs with other public policy objectives? How would these functional values of biodiversity to a nation compare to the compensation that people in the rest of the world would be willing to pay to preserve natural habitats to prevent extinctions?

So what? How does biodiversity affect the level and stability of production? How big are these effects?

4. What are the functions of biodiversity in the stability of production systems at the plot level? In contrast to well-recognized watershed functions—enumerated in a separate workshop theme—the ecological functions of biodiversity in the stability of local production systems have not been articulated clearly. For example, suppose for a moment that a perennial monoculture plantation provides watershed services that are indistinguishable from natural forest. What, if anything, would be lost (or gained) on-

site from conversion of natural forest to monoculture plantation in terms of stability of the production system?

5. Perhaps an even more important question is what effect (if any) would conversion from natural forest to a monoculture plantation have on the level and stability of production *off-site* on land adjacent to the monoculture plantation? Would neighbors face fewer production options because of loss of wild seed sources? ... new difficulties in managing fallows or soil nutrients? ... would they suffer more (or fewer) outbreaks of pests and diseases of crops and livestock? ...or would familiar pests and diseases be replaced by exotics? In short, should the neighbors worry? If so, about what? What is the evidence on these effects? Has anyone tried to measure them? More generally, how much/what types of biodiversity is needed to maintain productivity and stability?
6. Is it possible to produce a short list of key ecological functions of biodiversity regarding the stability of production systems at the plot level? ... encompassing interactions across plots within a landscape--land uses and their combinations in different patterns or 'landscape mosaics'?

What can be done? Do we even have the methods and data that we need?

7. To what extent is it feasible to go beyond plot-level measures of richness and to scale-up to the landscape level? Or, alternatively, is it better to begin with landscapes as the unit of analysis? And what is the appropriate unit for analysis at the landscape level? How big must a landscape unit be meaningful for local communities? ... for policymakers?
8. What are the appropriate scales - in space and in time - for assessing the effects of biodiversity loss on stability of production systems?
9. Is it necessary to measure everything? (Let's hope not!) Can insights from better understanding of the functional roles of biodiversity help guide priorities for measurement?
10. Are there important functions of biodiversity at the local or national level that are unquantifiable? If so, how can these be incorporated in the debate?

Papers on Biodiversity Functions

Perception of Rural Communities on Development of Forest Lands and its Environmental Impacts by Dimbab Ngidang, Gabriel T. Noweg and Abdul Rashid Abdullah, Universiti Malaysia Sarawak.

Agroforestry, Elephants and Tigers: Balancing Conservation Theory and Practice in Human-Dominated Landscapes of Southeast Asia by Philip Nyhus and Ronald Tilson, Sumatran Tiger Project, Way Kambas National Park, Indonesia, c/o Minnesota Zoo, USA.

Assessing Biodiversity at Landscape Level: the Importance of Environmental Context by A.N. Gillison and N. Liswanti, CIFOR.

Using Indigenous Knowledge to Assess Biodiversity at the Landscape Level by William H. Thomas, Avian Institute of New Jersey, USA.

Landscape Scale Impacts of Biodiversity on Ecosystem Functioning by John Poulsen, CIFOR, and Rien Beukema, University of Groningen.

Analysis of the Willingness to Pay for Protecting Lake Danao National Park in Ormoc, Leyte, Philippines by Canesio D Predo, Nicomedes D Briones and Herminia A Francisco, University of the Philippines Los Baños.

Community Livelihoods and Incentives for Conservation in the Togean Islands, Indonesia by Jim Cannon, Conservation International, USA and Ida Purbasari, Conservation International, Indonesia.

Perception of Rural Communities on Development of Forest Lands and its Environmental Impacts

by Dimbab Ngidang, Gabriel T. Noweg and Abdul Rashid Abdullah¹

The state of the environment is believed to have intricate relationships with various facets of cultural practices of communities living in and around an area. Awareness of the need for environmental conservation in a specific area also is often found to be dependent upon the value which local communities attach to it. How these communities view and value the environment, however, varies. For effective environmental and natural resource management, these basic issues have to be addressed. To approach the issue, a baseline survey was conducted throughout the state of Sarawak, aimed primarily at studying the perception of members of the rural communities towards the environment in relation to their cultures.

The findings from the study show an overwhelming dependency of rural people on the environment for material culture and their socio-economic well being. There are a considerable degree of awareness concerning the adverse effects of logging, plantation agriculture and shifting cultivation. On the overall, respondents feel that the logging industry, while being a significant contributor to the state revenue, is posing long-term adverse impact to the environment. Similarly for plantation agriculture, although being aware of its potential adverse effects, quite a sizeable proportion of the study samples did not see it as a serious threat to the environment. Also, comparatively more respondents feel that shifting cultivation does not necessarily cause environmental problems such as soil erosion, destruction of natural landscape, pollution to water supply and degradation of wildlife habitat than those who view such an age old farming practice as being destructive to the environment. This contradicts the general official view about issues related to the state of the environment in Sarawak.

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Agroforestry, Elephants, and Tigers: Balancing Conservation Theory and Practice in Human-Dominated Landscapes of Southeast Asia

by Philip Nyhus and Ronald Tilson¹

Keywords: Agroforestry, Tigers, Elephants, Conservation, Conflict

Concern for loss of biological diversity has focused efforts to maximize conservation benefits of forest edge and agroforestry systems. Conservation biology theory suggest that large mammals are best conserved in landscapes where large habitat patches are connected by corridors, surrounded by multi-purpose buffer zones, and integrated into a greater ecosystem. Complex agroforestry systems, particularly those adjacent to protected areas, provide both economic benefits to people and conservation benefits to large species. They also create conditions that increase the probability of conflict between wildlife and people using the same habitat. We use the island of Sumatra, Indonesia, and our study of conflict between people and Sumatran tigers and Asian elephants to illustrate this point. If these species are to survive, we suggest that more attention needs to be given to the issue of reducing this conflict in forest edge habitats where agroforestry is often implemented. Agroforestry systems are likely to play an increasingly valuable role in the conservation of large mammalian species. We believe this value can be increased still further if the agroforestry community decides to assume a leadership role in addressing the issue of human-wildlife conflict, which is fast becoming one of the most central threats to the survival of many large animals, particularly large endangered species like tigers and elephants.

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Assessing Biodiversity at Landscape Level: the Importance of Environmental Context

by A.N. Gillison¹ and N. Liswanti²

Keywords: Biodiversity assessment, biodiversity indicators, gradsects, plant functional types.

Most biodiversity assessment methods tend to sample isolated areas of land cover such as closed forest or local land use mosaics. Contemporary methods of assessing biodiversity are briefly reviewed and focus on the relative roles of the Linnean species and Plant Functional Types (PFTs). Recent case studies from Central Sumatra and Northern Thailand indicate how the range distributions of many plant and animal species and functional types frequently extend along regional gradients of light, water and nutrient availability and corresponding land use intensity. We show that extending the sampling context to include a broader array of environmental determinants of biodiversity results in a more interpretable pattern of biodiversity. Our results indicate sampling within a limited environmental context has the potential to generate highly truncated range distributions and thus misleading information for land managers and for conservation. In an intensive, multi-taxa survey in lowland Sumatra, vegetational data were collected along a land use intensity gradient using a proforma specifically designed for rapid survey. Each vegetation sample plot was a focal point for faunal survey. Whereas biodiversity pattern from samples within closed canopy rain forest was difficult to interpret, extending the sample base to include a wider variety of land cover and land use greatly improved interpretation of plant and animal distribution. Apart from providing an improved theoretical and practical basis for forecasting land use impact on biodiversity, results illustrate how specific combinations of plant-based variables might be used to predict impacts on specific animal taxa, functional types and above-ground carbon. Implications for regional assessment and monitoring of biodiversity and in improving understanding the landscape dynamics are briefly discussed.

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Using Indigenous Knowledge to Assess Biodiversity on the Landscape Level

by William H. Thomas¹

In an era of reduced funding, Indigenous Knowledge (IK) can provide the basis for conservation planning. Preliminary results from research among the indigenous residents of Papua New Guinea's Central Range indicate that indigenous knowledge of predator/prey relationships can be used to reveal underlying ecosystem dynamics. These relationships not only identify the web of interactions surrounding organisms, but also the functional roles of biodiversity, such as pollination and seed dispersal. Rather than relying on plot level surveys, IK generated data provides a landscape wide over-view of the relationship between human activity and biodiversity conservation.

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Landscape Scale Impacts of Biodiversity on Ecosystem Functioning

by John Poulsen¹ and Hendrien Beukema²

Very little empirical evidence exist on the effect of spatial patterns and processes of biodiversity and ecosystems, on ecosystem functioning and services. However, it is generally accepted that landscape structure and processes affect ecosystem functioning. We will therefore in this paper discuss how biodiversity itself may be affected by spatial structure. In the context of assessing the impact of biodiversity on ecosystem functioning, we shall discuss the importance of considering different levels of biological organization and type of stressors over several spatial scales (from alpha to gamma level). We will address the critical questions when assessing the landscape scale impacts (externalities) of human interventions at the patch (field or farm) level: a) at a given spatial scale, what are the most important environmental correlates of biodiversity patterns?, b) at what spatial scale does a given stressor affect the parameter of interest?, c) how far from the impacted patch, spatially, does the stressor activity affect biodiversity?, d) assessment of impact at one spatial scale, but what is the impact at another spatial scale?, and, e) how does this vary with the intensity of impact? Important sampling design issues when conducting studies of landscape scale impacts shall also be discussed. These include: spatial extent and grain (resolution) of study, spatio-temporal auto-correlation (in relation to pseudo-replication), "sampling effect".

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Analysis of the Willingness to Pay for Protecting Lake Danao National Park in Ormoc, Leyte, Philippines

by Canesio D. Predo¹ and Nicomedes D. Briones² and Herminia A. Francisco³

The study was conducted to estimate the willingness to pay (WTP) for preservation benefits of protecting the environmental attributes of Lake Danao National Park (LDNP) in Ormoc, Leyte, Philippines. This was implemented using the Contingent Valuation Method (CVM) with three willingness to pay question formats: open-ended, payment card, and iterative bidding. A total of 210 respondents were interviewed from urban and rural categories. Factors affecting WTP bid for protecting LDNP were identified and analyzed using the Tobit (censored regression) model. The environmental attributes of LDNP considered in deriving total WTP are forest quality, wilderness/biodiversity, and lake quality.

Results showed that all respondents were aware about LDNP as a recreation site in Ormoc City. Forest quality was most preferred among urban respondents, whereas lake quality was considered more important to rural respondents. Urban and rural respondents attached equal importance to biodiversity as an environmental attribute. There were 91% of the respondents who expressed WTP for a protection program to preserve the environmental attributes of LDNP. The mean annual total WTP for LDNP's environmental attributes protection was estimated to be P121.70 for urban respondents and P93.09 for rural respondents, or P108.45 for the total respondents. For all the households in Ormoc, the total social WTP was estimated to be P2.62 million annually. This value reflects maximum amount that Ormoc residents are willing to invest to preserve LDNP.

Willingness to pay for various motives of protection (recreation use, option, existence, and bequest) was derived in the study. Of these various motives, the last three (collectively termed as preservation value) received the highest allocation (77% to 91%) of total WTP. Recreation demand was significantly influenced by years of education, household size, household annual income, number of visits per year to LDNP, number of days spent on places other than forest, willingness to pay for an entrance fee, environmental attributes preferred, organization membership, and household location. The factors that significantly affected preservation demand are age, education, household annual income, sex, forest visitation rate, willingness to pay for an entrance fee, and the concern of the respondents towards environmental protection.

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Community Livelihood and Incentives for Conservation in the Togeian Islands, Indonesia

by Jim Cannon¹ and Ida Purbasari²

The Togeian Islands are located in the Wallacea transition zone between the Australasian and Indo-Malayan biogeographic regions and are known for their high marine and terrestrial diversity and endemism. Konsorsium Togeians (KT), a consortium of Conservation International - Indonesia Program (CI-IP) and Yayasan Bina Sains Hayati Indonesia (YABSHI), is working to build a consensus with local communities and government to manage the islands as an integrated conservation and recreation area. The consensus building efforts include economic valuation of alternative development options to guide decision-makers.

A Participatory Analytical Conservation Economics (PACE) workshop using rapid valuation methods was carried out with local government officials. The PACE approach fully utilizes the knowledge of local stakeholders and raises awareness among all participants of the role economic valuation can play in supporting decision-making. The ultimate goals of the Participatory Analytical Conservation Economics approach are to provide decision-makers with enough information of adequate quality to guide land use and development decisions and to be widely applicable in developing countries.

In order to achieve the first goal, decision-makers must accept the results as credible, requiring that the methods used be easily understood and that data and assumptions are perceived to be reasonable. The approach must also be rapid, easily carried out and inexpensive if it is to be widely used. These requirements largely restrict the analyses to those using currently available data, which are generally market based. However, such an approach does not capture all values and provides only a partial valuation that represents a minimum lower bound on the actual total economic value.

However, in many cases a partial economic valuation may be sufficient to guide land use and development decisions. In these cases, the social costs of only a few impacts may be greater than the private profits of the activity, enabling development decisions to be made using only current information. An analysis using currently available data is the first step in an iterative process. If the values based on currently available data are not sufficient, then additional data can be collected and further analyses carried out.

The results of the workshop suggested that decision-makers were sufficiently satisfied with analyses based on currently available data to make certain decisions. However, the workshop participants recommended that an improved understanding of community livelihoods and incentives was required before firm decisions regarding zoning and managing the islands could be made. Village profiling was carried out as a precursor to a combination of participatory rapid appraisal (PRA) and other socioeconomic survey techniques. Special attention was paid to the ethnic and livelihood heterogeneity of the Togeian Islands communities. Initial results support the hypothesis that the economic interests of the Togeian Islanders and Central Sulawesi would be best served by a multiple-use conservation strategy, both as a basis for tourism and to allow the continued use of marine and terrestrial biodiversity.

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Posters on Biodiversity Functions

Indigenous Ecological Knowledge About the Sustainability of Tea Gardens in the Hill Evergreen Forest of Northern Thailand by P. Preechapanya, Doi Chiangdao Watershed Research Station, F.L. Sincliar, University of Wales.

Dayak Rubber Forest Garden Systems and Their Economic Value as Providers of Environmental Functions by Franz W. Gatzweiler, Humboldt-Universität zu Berlin.

Biodiversity and Reserved Forest: Extractive Reserves in Amazonia and NBCAS in Lao PDR by Catherine Aubertin, IRD-ORSTOM.

The Socio-Cultural Significance of Minor Crops and Wild Plants by Hanne Christensen and Ole Merts, University of Aarhus, Jytte Agergaard, University of Copenhagen.

Assessment of Impact of Forest Conversion on Belowground Biodiversity by Iswandi Anas, IPB, Indonesia.

Resource Diversification and Avian Diversity in a Traditional Agroforest System: A Case Study from East Kalimantan, Indonesia by Christian Gönner, c/o GTZ-SFMP, Indonesia.

The Conditions of Biodiversity Maintenance in Asia: Philippine Studies by Percy E. Sajise, Mariliza V. Ticsay-Ruscoe, William Sm. Gruezo, J.C.T. Gonzalez, A.T.L. Dans, H.A. Francisco, C. Torres and D.K. Vergara, SEARCA, Philippines.

Biodiversity Scaling by Rien Beukema, University of Groningen. (No abstract available)

The Effect of Strip Felling System on the Diversity of Natural Regeneration Species of Lowland Tropical Rain Forest in South Kalimantan by Soewarno Hasanbahri, Gajah Mada University, Budianto, Fac. of Forestry, INSTIPER.

General Patterns in Local Understanding of Biodiversity: Issues of Scale in Relation to Perception and Knowledge Acquisition by Fergus L. Sinclair and Laxman Joshi, University of Wales.

Indigenous Ecological Knowledge about the Sustainability of Tea Gardens in the Hill Evergreen Forest of Northern Thailand

by P. Preechapanya¹ and F.L. Sinclair²

Analysis of the knowledge base established that the farmers recognised two kinds of tea, at least 17 forest trees species and four dominate ground flora in the miang tea gardens. The forest trees were believed to be the dominant plants in the miang tea gardens ecosystem; controlling the microclimate and both water and nutrient cycles. A comparison was made between the ground flora; *E. adenophorum*, *P. aquilinum*, *D. linearis* and *I. cylindrica*, and their effect in controlling surface run-off and soil erosion. *I. cylindrica* is believed to be most efficient in controlling soil erosion and *P. aquilinum*, *D. linearis* in reducing surface water run-off. Finally, the role of cattle was analysed, and their effect on the nutrient cycle and the germination of seeds.

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Dayak Rubber Forest Garden Systems and Their Economic Value as Providers of Environmental Functions

by Franz W. Gatzweiler¹

An attempt is made to value the numerous environmental functions of rubber forest gardens, based on field data from a trip to West Kalimantan in 1997/98. Rubber forest garden systems are primarily established (...) for their direct use values which provide local people with subsistence and cash income. However, (...) numerous indirect use and non-use values are simultaneously maintained. Biodiversity is conserved as a positive externality. Apart from the linkage between production and biodiversity, the high option values may guaranty the sustainability of these systems.

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Biodiversity and Reserved Forest: Extractive Reserves in Amazonia and NBCAS in Lao PDR

by Catherine Aubertin¹

The term biological diversity, which accounts for the objectives of life sciences, entered the arena of social choice as "Biodiversity". Biodiversity is now seen to be a global environmental problem encompassed within the rhetoric of sustainable development.

The definition of biodiversity, of its values and of its functional roles, the threats to it, the damage sustained by it, the proposed solutions, and the newly-created agencies responsible for managing biodiversity are supposed to be universally agreed and recognized by all the signatory countries to the 1992 Rio Convention on Biological Diversity. Any consensus on both the conceptualization and the modes for protecting biodiversity at the global scale implies the development and application of universal judicial, economic, and commercial norms and criteria. The concept of biodiversity —itself emblematic of globalization— connotes various goods, services and values comprising a planetary asset which we now need to learn how to collectively manage and conserve.

As the outcome of a complex game comprising various actors and various interests —often contradictory— the biodiversity concept itself is necessarily full of contradictions. Protecting and defending biodiversity —and who could be against that?— thus find local expression: but often in forms far from narrowly environmental preoccupations; reflections, rather, of local political conflicts or local economic interests.

One such agreed norm is the creation of reserved forests, with tropical forests especially put forward as representing the greatest receptacles of biodiversity. These reserves, theoretically, are removed from market-driven economic development. The State —with or without the agreement of the inhabitants of such areas— regulates access to the resources there.

In Brazil, there exists a highly developed regulatory apparatus intended to protect —to some degree or another— biodiversity. In Laos there exist some twenty National Biodiversity Conservation Areas (NBCAs), beyond which all other forests, countrywide, are subject as well, to five landuse categories.

It would seem interesting to us to link the rhetoric which led to the creation of extractive reserves in Amazonia and NBCAs in Laos. The visions of the functional roles of biodiversity are certainly quite different, with the integrity of "socio-diversity" and the promotion of agroforestry systems foremost in Brazil, while the protection of watersheds for hydroelectric production and the eradication of slash and burn cultivation are the main priorities in Laos.

But one still finds common points there with the emergence of common political stakes in the denial of the actual factors of deforestation; in the desire to open up the forested regions of the country; in promoting hydropower as key to industrialization; and in questions of national sovereignty;. The overall effect is to reduce such reserves to islands of biodiversity within a larger national landscape where biodiversity is not seriously considered.

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The Socio-Cultural Significance of Minor Crops and Wild Plants

by Hanne Christensen¹, Ole Merts and Jytte Agergaard²

It is often argued that strategies for conservation of biodiversity in the humid tropics should focus more on indigenous natural resource management to ensure that local people become the primary stewards of resource management. Mostly attention has focused on agricultural uses of forest areas such as shifting cultivation and on the extraction of forest products for commercial use. However, the knowledge and use of plants that do not have any obvious commercial importance has attracted less attention. The objective of this paper is to emphasize the ritual, cultural, and religious importance of minor crops and wild plants which are not marketed. We argue that such plants may play a role in sustaining adequate indigenous land stewardship and definitely are important for the cultural identity of local communities and individuals.

Ethnobotanical data was collected in 1993-98 in the Iban longhouse of Nanga Sumpa in the Ulu Batang Ai, Sri Aman Division, Sarawak, Malaysia. A total of 679 cultivated, semi-managed, and wild species had known uses in this community. Of these, 111 species with religious or magic properties were recorded and divided into three main categories: plants for rice protection (38), for ceremonies and offerings (42), and for human protection and curses (22). A residual group of 27 species had various properties, such as taboo plants, plants for attraction, etc. These plants are found in all types of environments and some are planted and have alternative uses. Hence, they contribute to agricultural as well as natural biodiversity.

The knowledge of religious plants and their uses is mainly confined to the older generation, and the urge to provide school education for children, engage in off-farm work, and conversion to Christianity is likely to send this knowledge into oblivion. While this classical development scenario represents positive progress in terms of increased welfare, it could have the potential to undermine the foundation of indigenous resource management. The reduced knowledge base is likely to lead to a reduced interest in the traditional conservation of areas with e.g. taboo or other religious plants. Younger people are primarily driven by incentives for wealth accumulation and conversion of forest to cash crop fields is considered the most profitable activity. Although certain forest products may have commercial value, they are often not sufficiently abundant or easily marketed to provide incentive for conservation.

If communities are to see the advantage of conserving forest areas without significant commercial value, it is essential that knowledge and understanding of traditional Iban religion and culture is encouraged. Plants are an inseparable part of this culture and even if younger people no longer perform the rituals and ceremonies in which plants are important, the knowledge of their existence may encourage conservation and strengthen cultural identity.

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Assessment of Impacts of Forest Conversion on Belowground Biodiversity

by Iswandi Anas¹, FX Susilo², Suryo Hardiwinoto³, Robert Simanungkalit⁴, Yadi Setiadi¹, Djunaedy¹ and Meine van Noordwijk⁵

As part of the Alternatives to Slash and Burn project an initial assessment was made of the impacts on the presence of major groups of soil organisms when forests are converted to a range of land uses. The comparison focussed on Forests, Agroforests, Rehabilitation (young tree-based systems), Cassava and Imperata (or in reverse order, the ICRAF series) in Lampung and Jambi (Sumatra, Indonesia). The survey combined soil monolith and litter layer sampling for microbial and macrofauna groups with pitfall traps for surface-active fauna.

Effects of land use on total population size for most microbial or soil macrofauna groups were found to be smaller than expected. For example, the Imperata grasslands (often expected to be biologically 'degraded' when compared to forest soils) had the highest densities of earthworms and the highest mycorrhizal spore diversity and abundance. The Cassava + Imperata samples had a reduced diversity in litter fauna (woodlice, ants and spiders), but similar total catches in pitfall traps of surface active organisms. Nematodes were assessed at genus level, but differences between replicate samples in the same land use were larger than those between land uses as a group, so the null-hypothesis of 'no land use effect' could not be rejected.

An attempt was made to use the data for 'landscape scale' assessments, by using the 'lack of fit' in a principal component analysis and ordination technique as indication of diversity in parameter combinations. If all measured soil biological and soil chemical properties were combined for the 31 sample points in the whole survey, the Jambi sites clearly differed from the Lampung sites, but the total area spanned by the Imperata + cassava samples did not differ from that spanned by all (agro)forest soil samples. There is some indication that partial 'savanization' of the previously forested landscape can increase overall diversity.

Effects of land use change on the admittedly crude indicators of belowground diversity are much smaller than effects on aboveground indicators such as plant species richness. Contrasting hypotheses can be formulated on this basis:

- the belowground system responds much slower to land use change and the full effects of the change in condition have not fully manifested themselves,
- the belowground system shows a large resilience and the various energy channels in the belowground foodwebs can adjust to the organic substrates formed by different plants.

The first hypothesis might be interpreted as a 'doom' scenario with large impacts appearing at a later stage, the second may lead to an exploration of the limits to this resilience.

Studies made of the direct impacts of slash and burn practices on soil organisms showed that most effects were of short duration; within a few weeks of the burning microbial population sizes are back to normal, probably based on recolonization from surrounding non-burnt vegetation. Surface burns reduced earthworm numbers to one-third, but this effect is still within the range of normal variation in years with a long dry season. Overall, our data support a cautious optimism for the opportunities of soil biota to maintain essential ecosystem functions under a wide range of land uses.

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Resource Diversification and Avian Diversity in a Traditional Agroforest System: A Case Study from East Kalimantan, Indonesia

by Christian Gönner¹

Regarding the rapid deforestation in Indonesian Borneo, mainly due to land conversion, the maintenance of biodiversity is one of the most demanding tasks for the new century.

Given the rather isolated distribution of national parks and nature reserves as well as their limited extends, it is crucial to find ways of keeping a high level of biodiversity within the managed landscape.

During at least 300-400 years of swidden agriculture and forest management, Dayak Benuaq farmers have created a mosaic, consisting of more than 1,700 forest gardens (rattan, fruit, rubber) and hundreds of swidden fallows in different succession stages on an area of 9,200 ha. This mosaic forest provides local people with a wide range of resources, covering their subsistence needs as well as their demand for financial income. More than 740 taxa are used, including at least 398 extracted plant species, 246 cultivated crop varieties and 99 hunted animal species. Out of this diversity, about 10-15 species are regularly used as traded commodities. The actual set of income sources shows great variation over time, depending mainly on market prices and resource availability. Hence, dynamic flexibility is crucial in order to minimize risks of unstable markets. Like in many other traditional societies, risk is minimized through resource diversification, and labour is not merely allocated for profit maximation, but rather for a more balanced way of life, regarding social, ritual *and* economic aspects.

Besides ensuring a living for local people, the mosaic forest maintains a high level of biodiversity.

Avian species richness showed no significant difference between the managed parts of the forest and an old, undisturbed area, reflecting a great diversity of patchy habitats within the agroforest. 102 bird species were counted during 24 standardized census walks along a 1,500 m transect, cutting through old secondary forest, while 101 species were found along a transect through forest gardens and swidden fallows. Species composition, however, differed between the two sites due to the different forest structure (Sørensen's Index = 68%).

A combined set of methods was applied during this research, ranging from cultural anthropology (participant observation, semi-structured household interviews, interviews of key-informants, and informal interviews), over geography (mapping, based on GPS field marks, transects and cognitive community maps), to ecology (bird census walks, computer based simulations of species richness). The combination of these methods was found to be suitable in describing and analyzing spatial and temporal patterns of resource management strategies and their impacts on biodiversity.

Partly triggered by the Asian financial crisis, planners and decision makers increasingly suggest the conversion of, what they regard as inefficient land use systems, into more productive ones, such as oil palm or rubber estates. However, they must be aware of the dynamic flexibility, the risk minimization and the conservation potential of traditional agroforestry systems before they replace them. Further research is also suggested towards assessing aspects of social stability through traditional agroforestry management, as social conflicts are a frequent consequence of the non-participatory replacement of indigenous resource systems.

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The Conditions of Biodiversity Maintenance in Asia: Philippine Studies

by Percy E. Sajise, Mariliza V. Ticsay-Ruscoe, William Sm. Gruezo, J.C.T. Gonzalez, A.T.L. Dans, H.A. Francisco, C. Torres and D.K. Vergara¹

The study, instead of dwelling on the conditions that bring about the loss of biodiversity, focuses on the conditions associated with successful biodiversity maintenance. It proposes to develop and apply a comparative, interdisciplinary, and policy-oriented approach to identifying the bio-social circumstance responsible for biodiversity maintenance in Southeast Asia.

Discussion starts with a brief description of aims and methods and a description of the study sites in Mount Makiling in Laguna province: (1) mossy forest, (2) dipterocarp mid-montane forest, (3) grasslands, and (4) agroecosystem. The multiple methods used to analyze floral, and a lesser extent faunal diversity on the mountain are also discussed. Floral species diversity in each of the aforementioned four zones on Mt. Makiling are presented followed by a comparative analysis of floral diversity levels, looking first at differences among the four zones, then differences by study sites, then by ecosystems, and then by landscapes. The functional roles of flora and the utility of indicator species were also discussed.

The analysis then shift to the fauna of Mt. Makiling beginning with the detailed accounting of the rigorous field methodology used to trap, net, and survey Mt. Makiling's fauna and then the discussion of the (1) field data on the diversity of amphibians, reptiles, birds and mammals, (2) the impact on this diversity of habitat disturbance, (3) the implications of site-specificity for diversity, (4) the implications of community structure for diversity, (5) the status of threatened species on Mt. Makiling, and (6) the socio-cultural importance of fauna.

Succeeding analysis combines the results of the floral and faunal studies to examine their functional relationships, in particular between floral and faunal "indicator" species involving (1) seed dispersal, (2) pollination, (3) herbivory, (4) other sorts of interactions, and (5) flora-fauna relations in agricultural systems.

Further analysis of biodiversity on Mt. Makiling is extended into the agricultural zone on part of its lower slopes. Background information on the community, their farming system, and their attitudes towards biological diversity is presented. Agricultural biodiversity is then correlated with a number of socio-economic variables including household income, farm size, age of farm, and age and education of household head. Finally a comparison of scientific versus "folk" conceptions of "indicator" species, and seven different indicator species used by the local community are presented.

Finally, synthesis and analysis of the overall pattern of biodiversity on Mt. Makiling in relation to one particularly important determinant: namely, fragmentation of the landscape, specifically fragmentation or patchiness of forested landscapes is presented. The results generally indicate that biodiversity initially increases as fragmentation increases, only to later decrease as fragmentation exceeds some fixed limit. The results supports this study's hypothesized curvilinear (inverted U-shaped) biodiversity function along the nature-culture continuum.

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The Effect of Strip Felling System on the Diversity of Natural Regeneration Species of Lowland Tropical Rain Forest in South Kalimantan

by Soewarno Hasanbahri¹ and Budianto²

The strip feeling system which consisted of conservation strip and feeling strip has been tried in production forest areas since 1994. It will do hope that the commercial species diversity could be conserved and play the important role in sustainability and resilience of production system.

The research evaluation after four years (1998) applying the various strip wide treatment showed that all of the treatment unit areas have high value of the diversity index of natural regeneration between 75 to 96 percent. It could be interpreted that this system recommended for maintaining the diversity of tree species.

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General Patterns in Local Understanding of Biodiversity: Issues of Scale in Relation to Perception and Knowledge Acquisition

by Fergus L. Sinclair and Laxman Joshi¹

Here, we address the question: how localised is local knowledge of biodiversity? Our focus is on locally derived, functional, understanding of biodiverse vegetation that people depend upon for their livelihood.

Firstly, we consider the spatial scales at which people perceive ecological relationships. Landscape level effects emerge from indigenous knowledge either because local leaders or institutions exert control over how resources are used at this level or as an emergent property of individual farmer's decisions when they are using a reasonably common knowledge base.

Secondly, evidence is presented of similar knowledge being held by farmers across large distances and the existence of general patterns in the way agroecological processes are understood. This makes acquisition of local knowledge possible over geographic areas commensurate with the scale at which policies are made and suggests that local knowledge may be transferable from localities where it was derived to distant places with similar agroecological conditions.

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THEME 3. LOSS OF WATERSHED FUNCTIONS

Key questions

Interview with Hadi Pasaribu

List of papers on watershed functions

One page abstracts of selected papers on watersheds

List of posters on watersheds

One page abstracts of posters on watersheds

Watershed functions: Key questions

National concern for natural forest conservation and reforestation often focuses on the degradation of the watershed functions, which typically is understood as some combination of:

- on-site declines in land productivity as a result of soil erosion,
- off-site concerns about water supply (quantity) including annual water yield, peak (storm) flow, dry season base flow, and groundwater recharge or depletion,
- off-site concerns about water quality, including siltation of reservoirs and environmental damage from runoff of pesticides, fertilizers, or animal wastes.

Who cares? Who should worry about loss of watershed functions? Why? Do we have the methods and data to answer these questions?

1. **When is soil erosion a problem for farmers?** Can the on-site impact of erosion on productivity be measured at the plot level? Can these on-site effects be estimated for bigger units? ... for landscapes? ... for states, provinces, or nations? What is an appropriate time scale for such estimates? Are these effects big? If so, under what circumstances?
2. **When is soil transfer a problem (or an opportunity) for people downstream?** Can the off-site impact on productivity of soil transfer (erosion net of sedimentation) be estimated at the landscape? ... for states, provinces, or nations? What is an appropriate time scale for such estimates? What do available estimates tell us about effects of soil transfer on productivity for larger spatial units? Are these values big or small? ... under what circumstances? How do the net effects on productivity compare with other effects of soil transfer, siltation of reservoirs for example?
3. **Which among (a) on-site effects of soil erosion on productivity, (b) off-site effects of soil transfer on productivity, (c) other off-site effects of soil transfer, (d) flooding, (e) water shortages, and (f) water pollution from land use are of greatest concern in terms of the stability of production at various scales (communities, provinces, nations)?** Can this question be answered?
4. **What is "big"?** Which among these six concerns counts is the biggest worry for policymakers at the local, provincial, or national level? How big does a problem (or opportunity) have to be to attract policymakers' attention? Are these six concerns "big" problems? Do we have the methods and data to answer that question in a way that is comparable to policymakers' other concerns?
5. **What do we believe are the relative values of offsite effects of ecological functions (the roles discussed under the biodiversity theme) and watershed functions?** What do we believe are the relative values of these environmental services combined in comparison with (a) onsite production, net of onsite resource degradation and (b) analogous global concerns - climate change and species existence?
Onsite >> landscape / watershed services >> global services ?
Onsite << landscape / watershed services << global services ?
Some other pattern?

So what? Does land use matter?

6. **Do landscapes - land uses and their combinations in different patterns or 'landscape mosaics' -- matter for soil transfer?** Are there significant differences in soil transfer among landscapes? How does the sedimentation arising from various landscapes compare with other sources of sedimentation, road construction for example? Do methods exist to quantify erosion from natural processes, agriculture, and other activities (such as road construction) and to assess the impacts (positive as well as negative) of resulting sedimentation at the landscape, provincial, or national scale?
7. **Do landscapes differ significantly in their impact on water supply functions?** How do landscapes matter for total water supply (annual yield)? ... for risk and severity of flooding? ... for risk and severity of water shortages?
8. **Is there a relationship between watershed functions and loss of landscape biodiversity?** Are these separate topics, or does it make sense to treat them as a single, composite issue?

What can be done?

9. **What are the options for influencing land use change?** If there are "big" concerns at various scales, what are the policy and institutional options for addressing them? ...at what scale? As Meine van Noordwijk (and others) have pointed out, land use planning can lead to nice colors on maps in planners' offices but has had little impact on the ground. What policies and institutional options REALLY can influence the rate and pattern of land use change? How do we know any of this will work?
10. **Who are the winners and the losers?** If there are conflicting interests across groups, is it possible to strengthen or create mechanisms for conflict management—between neighboring communities; upstream and downstream populations; local, national, or perhaps even global concerns? Is it possible to create and manage mechanisms for compensating people for foregone opportunities?

Interview with Dr. Hadi Pasaribu¹

by Thomas P. Tomich²

Speakers are: TPT - *italics* and HP - plain.

This series of interviews aims to get input from decision-makers so that they can highlight what they see as the most important issues. Instead of asking you to write a conference paper, the interview will be transcribed. We will get your comments on it to make sure it reflects what you really want to say. It will then be distributed to people preparing papers for the conference.

There are five main questions:

- 1. What is it that you do?*
- 2. What are the biggest problems from your point of view as a decision-maker? In the conference there are three themes: on smoke, biodiversity, and loss of watershed functions. We can talk on any of those, but given your responsibilities I thought we might focus on watershed functions to hear how you see the loss of watershed functions as a problem in Indonesia.*
- 3. What can the Department of Forestry do about that?*
- 4. What are the key questions for researchers?*
- 5. What kind of data would be most useful to you in making decisions?*

Let's start with your brief description of what your responsibilities are.

I work on soil conservation in the Directorate General of Reforestation and Land Rehabilitation particularly in the Directorate of Rehabilitation. It is my responsibility to provide the macro guidelines on how forestry institutions implement watershed protection in relation to soil and water conservation.

At the moment the government is only focussing on this area of watershed protection. This is one of our main weaknesses, that we do not take a wider approach to watershed management in this country. We are trying to create awareness about a broader concept of watershed management in other ministries such as home affairs, public works and environment. We are trying to promote it in such a way that local government sees watershed management as part of regional development, linked with economic activities.

The forestry ministry wants watershed management to be implemented to protect watershed functions, not only in terms of soil and erosion control, and sedimentation, but also looking at the whole aspect of the water cycle, biodiversity and environment. The government is trying to form a National Watershed Committee around this concept. We are trying to use the NAWAB in order to analyze watershed management options and to reformulate research policy.

While it is a good idea for the government to reformulate policies on watershed management in this country, in reality it's not as easy as you might think. Institutional responsibilities are duplicated. We are also dealing with professionals from many different backgrounds. Within the forestry department, 90% understand what we mean by watershed protection. But when we talk to professionals within the Ministry of Environment for example they just see the watershed from the perspective of industrial waste.

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² ICRAF, Bogor on 13 November 1998

Since 1983, the government has tried to establish criteria and indicators to categorize watersheds as "supercritical", "critical" and "non-critical" in order to prioritize action. Even with these broader indicators, the processes and procedures are still really based on the concept of "critical land" (basically slope and vegetation). Public Works has different criteria for prioritising watersheds; they use an index for water supplies, and analysis of variance of water regimes, and so on.

In 1992 we organized the first workshop and invited all agencies involved, including researchers and NGOs, to re-evaluate and determine the criteria to identify the critical watersheds. We came up with five indicators, which involve 73 sub-indicators. We used the analytical hierarchy process and were helped by Dr. Ridwan Hamid and Dr. Anwar Abdini, experts on AHP modeling. From this we established a list of the watersheds, based on real watershed boundaries, that were categorized as critical one, two, and three. This is the data we have now and it is very important to follow this up, decide how we act on it and what kind of further research we need.

The 5 main criteria were:

1. "critical" land as a factor
2. hydrology as a factor
3. socio-economic criteria
4. land form criteria
5. regional policies

Regional policy is the basis of activities to protect these resources. But many regions do not have policies to support environmental protection at all. By having these criteria and categorizations each district should be able to develop policies to protect their resources. We want to understand the relationship between administrative regions and watershed boundaries: in which regions do the upper areas and the lower areas lie; which are protectors and which are beneficiaries of the watersheds. This will allow us to look at incentive systems, and to see protection of the watershed as part of economic development.

The people are asking why the government does not apply a tax system on lower areas, the productive areas, and use this income to subsidize farmers in the upper areas, to pay them for their services in watershed protection. With the present administrative set up this is not easy because the political boundaries under Governors and District Heads do not coincide with watershed boundaries. So first we need to reformulate and unify policies at the central government level otherwise it will not work.

Take for example the Citanduy watershed, where I worked for more than seven years. Cilacap is one district of five, which drain the Citanduy river. Administratively, Cilacap district belongs to Central Java province. It has productive land that benefits from the watershed, which lies in the same kabupaten. But if you look at others for example Ciamis, Tasikmalaya or others in West Java, they don't derive direct benefits from the watersheds in their district, yet the government insists they protect the watersheds nevertheless. But they don't have any money to do that.

So we have to think of the watershed as part of economic development. There have to be agreements for example between the Governor of Central Java and Governor of East Java. Or there has to be a policy from the Central Government to ensure that benefits gained from watershed resources are shared by those who have to protect the watershed.

This is the area where we need to do very precise research. We need to look at responsibilities of central and regional governments, at decentralisation, public finance and taxation so that we can look very specifically at who benefits and what is the monetary value of the water resource.

TPT:

What do you see as the main watershed services and if the watersheds are degraded, what problems will emerge?

The main watershed service is water supply, both quality and quantity. A problem associated with this is erosion. We are not able to quantify the economic losses resulting from soil erosion. We cannot quantify what is the cost of say one cubic meter of erosion that flows down into a reservoir.

TPT:

Is that cost in loss of production in the field or loss of reservoir water?

Loss of reservoir water can be calculated for example in terms of the electricity we produce. But the loss of production in the uplands, we cannot even identify it. If we cannot identify it then it's difficult for us to know how much we need to pay back to the catchment area. Without this information, we don't know exactly whether a subsidy should be given to the upland farmers or how much. We are just grabbing figures from the air. We don't know how much money has been lost for one hectare of land, in terms of direct costs and benefits.

Water is very cheap in this country. For example in Bogor I pay around Rp 45,000 (\pm US \$ 5-6) per month for good quality water. For me it's very cheap. I can use it to wash my car, etc. But on the other hand poor people said 'Oh it's very expensive - water in Bogor'. So the government also has to think about how to subsidise the poor and how to take more from the rich when it comes to water charges.

TPT:

Do you see water supply and the scarcity of water as a big problem?

It is a problem in terms of the dry season. In 1996 we had a dry season of almost six months here. Bogor has been classified as a surplus water production area. Yet within one week of the start of the drought there was water rationing. The government reduced the usual 24 hour supply of water to just 6 to 8 hours per day. So we have to think of the cost of collecting the water and the cost of storing it. In Central Java in the dry season the water tastes awful and people don't use the regular water supply, they use pumps instead. There is the same problem in Jakarta with salt water intrusion from the bay - but even here water scarcity is still the main problem.

TPT:

How about water supply on other islands?

About six months ago I went back to my home town in North Sumatra, in Simalungun District where I grew up. My mother told me that they had a problem with water supply. The government only supplied water 12 hours per day instead of 24 hours. This is typical of everywhere, and an indication that watershed functions have been disturbed. This problem is critical for the future because if we cannot reformulate our policy for watershed protection then it will be very hard for us to recover the environmental functions.

TPT:

We have talked about erosion, sedimentation and water supply, how about flooding?

It is a part of the process. There are a lot of variables affecting flooding in Java. There are many rivers in West Java. We see a lot of people using the rivers for fish rearing. That really affects the rivers, raising the riverbed and minimizing the capacity to carry water. Another factor is the occupation of "bantaran" (floodplains). Most of them are now occupied, and again, that minimizes the rivers' capacity to carry water.

There are also problems further up the river systems in the catchment areas. Even though the Ministry of Forestry has said there should be no clear cutting in forest areas with a

slope of more than 25%, this is not respected and there is still a lot of clear cutting going on.

In some areas of Java we still experience flash floods, i.e. a rush of water coming into the system in a very small period of time. In West Java flooding is not only caused by degradation of upland resources, but also because of problems in low-lying land. There are poor drainage systems, particularly in the cities, and obstacles that then trigger and contribute to flooding.

Outside of Java there is misuse of forest land by concessionaires. For example in South Kalimantan it was announced that in the last 6 months the Barito watershed had the highest erosion rate in this country. The main cause of this erosion was not problems in the upland areas, but the fact that the river is being used to transport logs. The damage is from the churning up of the riverbank associated with this.

TPT:

How is the erosion measured?

In South Kalimantan they measure it in Trisakti harbor, using an echo sounding system to monitor accumulation of sediment. The problem is that we don't know how long the sedimentation has been occurring. That is the weakness of the system: the lack of data.

Whatever the intentions of the government on these issues it is very hard to reform the policies when we don't have any data.

TPT:

Talking about policy reform at the national and regional level, what kind of policy reform is needed and how can the government influence the watersheds?

Historically, government has implemented most of the research in this country. There has been no private sector involvement on these issues, yet they have the resources, which could be used. The government is trying to hand over to them some responsibility for research efforts. In this way it is trying to collect more data, and information to be used in redirecting our policy reform in forestry.

In the forestry sector over the last three years, for example, the government has tried to transfer some activities to the concessionaires. The government has asked the concessionaires to have one water level recorder station for each watershed.

Outside Java, concessionaires are automatically blamed by the public for many problems such as floods, even though they may have nothing to do with them.

In East Kalimantan for example the problem lies not with the concessionaires, but with mining. So we have to change public opinion and educate people. We need to broaden our research base to include the private sector, concessionaires, NGOs and others so we can look again at our policy.

TPT:

You have been involved with the strategy for reforestation and re-greening programs. How do you see those programs and their effectiveness in terms of watershed functions?

The government has only one program that really shows public concern about watershed protection, the "reboisasi" (re-greening) program. Starting in 1976, we spent almost a hundred billion Rupiah per year on this program. There are arguments both for and against this program. But at least in Java, one of the results of the re-greening program has been tremendous development of interest in tree planting. For example, in the early 1980s I brought 2 truckloads of tree seedlings and tried to distribute them to farmers, but they said they did not need them. Now they try to find and buy seedlings themselves even at a high price.

But from the 1970s until early 1990s this program was not backed up by research. This is the weakest aspect of this program. We have spent a lot of money on this program but have no research back up.

In 1990 we began to realise that without good, systematic research, it would not be effective. So in 1992 the government committed itself to develop research to really support this program. A working group was established to find out which technologies could support the program at the implementation level. In 1994 this group really did intensive work. The scope of research was on soil and water conservation, a little bit on agroforestry, but mostly concentrated on small scale farming systems. We have to broaden the scope of this work.

Outside Java farmers have been dealing not just with crops, but also with trees. This has not been touched by the government. That's why the re-greening program is just concentrated in farming areas, with very little attention given to how to develop private forestry and agroforestry. There is an opportunity for these activities, but no technological back up on how we do this and no extension services that offer training in agroforestry and private forestry development. These are the areas where we need input for the next stage to develop this policy.

Yesterday we had a meeting with the management team, chaired by Dr. Herman Haeruman, Deputy V of Bappenas. We agreed that one of the strategies for funding in the future would be that money for the program would be given directly to the farmers without any government bureaucracy involved. This is a good intention, but the farmers have to be prepared. This is an area for research, not only in the physical aspects, but also on micro policy, extension work and social aspects. The weakest link in research for this programme is that there has been none in the area of social development and institutions at the farmer level. The government has already taken the decision on the new funding mechanism so now we need to look at how it can be implemented at the local level. We need research, for example, on how to empower local institutions, what are the rules of the local institutions, what are the support systems we need for this program.

TPT:

You mentioned the need to know something about environmental impacts, the costs and benefits. Is there any ongoing research that would link say investments in re-greening to the environmental impact?

Not yet, that is the intention this year, to look at the effect of the program from the physical, environmental, and social-economic aspect.

We don't have enough information on watersheds and issues such as sedimentation and water. We don't have any research on other environmental indicators, like quality, or on the effects of the re-greening program on rural quality of life. There is a debate whether the program should touch on these issues. Should we make the programme broader and risk duplication with other environmental programs? While I am not insistent that these issues should be merged into the re-greening program, there should be a program that looks at these indicators.

TPT:

What are the 2 or 3 kinds of data that would be most useful to you as a decision-maker, in the context of strategy for the development of re-greening?

One must be on data on private forestry (farm forestry). No one knows how many hectares of private forest we have, what species we are talking about, and the distribution. The Ministry of Forestry policy for the next 5 years in the Repelita VII is that the contribution of private forestry to Indonesia's wood supply should be 9 million cubic meters per year of the 42 million cubic meters that Indonesia requires per year.

But where is this going to come from? What are the species and what are the legal issues? What do we want to do with this resource? Keep it as a store, or develop it for supply? If

we agree that the private forests in Java will be kept, will they be kept to become one of the suppliers for domestic consumption?

However, there is a problem with private forestry and logging of natural forest - it cannot compete financially. For example I recently visited a private forest in Riau with almost 10 thousand hectares ready to cut. But they can not compete with the illegal logging of natural forests. What should the government policy be on this? If we let the illegal cutting continue, then there is no hope at all of developing private forestry outside Java.

So there is a law enforcement issue relating to this. What is the government policy going to be on the issue?

TPT:

This brings us back to the production component, which complements the environmental services.

If we go to a real example, like Cimanuk watershed, in order to reformulate land use policy, we need to know the existing land use and watershed functions. Again we have to really start from zero, making a map, taking an inventory of the land, and meeting with farmers. This takes time. But often donor countries provide money for only for 5 or 7 years. So we have to start from zero making surveys, and at the same time start implementing the programme.

TPT:

Are there any big gaps in what we have discussed? If you were addressing a group involved in this type of research, what is the single message that you would want to make sure that they heard?

The research group should be aware of the complexity of the problems and the constraints on resources of this country. There is a need to integrate different sectors and accommodate all the interests, because research is not in touch with the real problems in the field. There is a risk that researchers are thinking of their own agendas, to use research for their own advantage, to get promotions or whatever.

I have collected almost 1,200 research topics in watershed and soil conservation, but it is amazing how many of them are duplicated and contradicted. We divided the research topics into watershed management, soil and water conservation, socio-economic issues, institutions, and agroforestry (which is very poorly represented). We have developed this information into a CD Isis system to make it available to universities and to students.

Papers on Watershed Functions

Historical evidence for watershed degradation in Northern Thailand: How important is agriculture and how reliable is the science? by Timothy Forsyth, Institute of Development Studies, University of Sussex.

Toward Understanding the Cumulative Impacts of Roads in Agricultural Watershed of Montane Mainland Southeast Asia by Alan D. Ziegler, Ross A. Sutherland, and Thomas W. Giambelluca, University of Hawaii.

Conducting Policy Analysis at a Landscape Scale: Examples from a Dynamic Model of a Philippine Watershed by Gerald Shively, Purdue University, and Ian Coxhead, University of Wisconsin.

Impact of Patch Orientation on Dynamics of Total Phosphorus by Machfudh, Forestry and Estates Research and Development Agency, Indonesia.

Impact of Soil and Water Conservation Practices on Soil Erosion and Stream Flows in an Agricultural Catchment, Indonesia by Naik Sinukaban, Bogor Agricultural Institute.

Distributed Hydrological Process Modeling by Rob Vertessy, Cooperative Research Centre for Catchment Hydrology, CSIRO, Australia.

Aiming at a moving target: lessons from long term watershed studies in Kenya and Sri Lanka by Chin K. Ong, ICRAF, David N Mungai, University of Nairobi, B Kiteme, ICRAF, R. Sakthivadivel and W.K.B. Elkaduwa, International Water Management Institute.

Worth of watersheds: a producer surplus approach for valuing drought mitigation in Eastern Indonesia by Subhrendu Pattanayak, Research Triangle Institute, and Randall Kramer, Duke University.

Market-based instrument for water resource conservation in Mt. Makiling, Philippines by Rex Victor O. Cruz, L.A. Bugayong, P.C. Dolom, and N.O. Espiritu, University of the Philippines Los Banos.

Potential land and water use conflict: A case study of a watershed in Sarawak, Malaysia by Murtedza Mohamed and Lau Seng, University Malaysia Sarawak.

Natural resource policies and community-based approach to watershed management, Leyte, the Philippines by E.C. Godilano, International Rice Research Institute, and S.D. DeGloria, Cornell University.

Identification and implementation of management scenarios through a decision support system with application to the Mae Yort sub-catchment, Thailand by Claude Dietrich, Tony Jakeman, K. Trisophon, Michelle Scozzimarro, and Andrew Walker, Australian National University and IWRAM.

Historical Evidence for Watershed Degradation in Thailand: How Important is Agriculture and How Reliable is the Science?

by Timothy Forsyth¹

Keywords: watershed degradation, water shortages, Cesium-137 measurements of soil erosion, tree species, local knowledge, sociology of scientific knowledge, northern Thailand

Most land-use policies assume upland agriculture is degrading to watersheds without questioning the scientific basis for this assumption. In this paper I summarize the results of three research projects in northern Thailand that have conducted detailed empirical research of historic impacts of upland agriculture on water shortages, soil erosion and forests, and also questioned the sociological basis upon which scientific knowledge is constructed. The results suggest that much so-called watershed degradation is actually the result of long-term naturally occurring biophysical processes, and that upland communities may lessen degradation through conservation practices. The implications of these results are that upland agriculture is less degrading than commonly thought, and that researchers need to question more the social and political basis for scientific statements about degradation.

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Toward Understanding the Cumulative Impacts of Roads in Agricultural Watersheds of Montane Mainland Southeast Asia

by Alan D. Ziegler, Ross A. Sutherland, and Thomas W. Giambelluca¹

Collaborators: Sanay Yarnasarn², Sawasdee Boonchee³, Sathaporn Jaiarree⁴

Through fieldwork in northern Thailand we have been working toward realistic assessment of hydrological and geomorphological impacts of roads versus agricultural activities in mountainous tropical watersheds. Herein we present results from field rainfall simulations, surveys of road and traffic phenomena, and initial computer simulations. Compared with other basin land-use types, roads generate Horton overland flow (HOF) during most rain events. Because of continual vehicle detachment, sediment is flushed from road surfaces by HOF throughout the rainy season. Footpaths are potentially important source areas for HOF, and can increase sediment transport in agricultural fields where HOF is otherwise rare. Vehicle detachment during storms creates a new supply of material that is flushed by surface flow. The fieldwork has provided data needed to parameterize and validate the physically based KINEROS2 model to simulate road runoff and erosion. Road sediment transport in the study area is best modeled when the finite surface layer of detached sediment is explicitly treated. This work serves as a foundation for future work aimed at quantifying road and agricultural contributions to cumulative watershed effects in SE Asia.

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Conducting Policy Analysis at a Landscape Scale: Examples from a Dynamic Model of a Philippine Watershed

by Gerald Shively¹ and Ian Coxhead²

This paper demonstrates a methodology for modeling links between economic policy changes and erosion and sedimentation outcomes at a landscape scale. Analysis focuses on using empirical data on agricultural price changes, land allocation decisions, and on-farm erosion outcomes to predict aggregate erosion outcomes in a stylized watershed economy. A model is presented that is based on observed patterns of agricultural activity in the Manupali watershed in the Philippine province of Bukidnon. The framework explicitly incorporates the role of policy changes in altering behaviors and outcomes on farms. The model uses representative farms and incorporates biophysical feedback from erosion to agricultural production. Results based on four policy simulations are presented and discussed.

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Impact of Patch Orientation on Dynamic of Total Phosphorus

by Machfudh¹

This study examines impacts of patch orientation on the dynamics of total P through simulations of a mixed watershed in the North Appalachian Experimental Watershed Station, Coshocton, Ohio, USA. We used a spatial landscape model and computer simulation to conduct experiments in which we examined functions of patch orientation on the accumulated total P at the outlet of the basin. The watershed was divided into 11,124 grids. The resolution of each grid was 5.2 m x 5.2 m. The WEPP hydrology software was used to estimate runoff on each grid. Map-IT, a geographic information system (GIS) software, was used to estimate cumulative concentration of runoff, sediment, and total P on each grid.

Analysis of simulating landscape structures indicated that with an increase of introduced patch size into a matrix, a role of a matrix decreased. The role of a landscape structure to the total P at the outlet was depended on the existence of the landscape structure relative to the flowpath of runoff and characteristic of the patches in term of its role in blocking runoff and sediment. Coupling landscape structures and relative orientation of patches and selecting vegetation for patches and matrix seems to be a concept that is of considerable ecological significance. The findings of this study apply to dendritic flow pattern such as that found on WS166. Impact of landscape orientation to optimum length of intercepted flow, optimum number of flow pathways intercepted and trade off between the last two are issues that should be considered for future research.

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Impact of Soil and Water Conservation Practices on Soil Erosion and Stream Flows in an Agricultural Catchment, Indonesia

by Naik Sinukaban¹

Keywords: Rainfall Soil Erosion, peak flow, base flow, quick flow, low flow, and water yield.

Established agricultural practice in upland vegetable growing areas in Indonesia includes cultivation up and down the slope and burning of crop residues. Combined with high rainfall intensities, these practices have contributed to high runoff and severe erosion. Collaborative research between Indonesia and Australia has been carried out to study the impact of applying soil and water conservation practices (SWCP) in vegetable growing areas on soil erosion and stream flows in a small upland catchment (10.2 ha) in West Java. The type of SWCP employed were planting on the ridges across the slope or planting on ridges constructed at 15 to 30 degrees with respect to the contour.

Data from two wet seasons indicate that soil erosion can be reduced to an acceptable levels for tropical soils (< 25 ton/ha/yr) if planting on ridges across the slope is adopted combined with appropriate cropping pattern. None of these practices adversely affected crop yield.

Hydrographic analysis from three years of observation appear to support the premise that the adoption of SWCP results in a significant reduction in quick, while substantially increasing and prolonging low flows. Corresponding to the introduction of SWCP on 31% of the catchment the magnitude of quick flow was reduced from 72% to 39% while low flows increased from 28% to 61% of total water yield. The runoff coefficient decreased from 35% to 24% of annual rainfall.

The trend indicated by these data may have positive benefits for upland farmers, as a result of improved moisture status during the early part of the dry season, as well as improving the water supply for downstream areas during the dry season.

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Process-based Distributed Hydrological Modelling

by Rob Vertessy¹

Introduction

All over the world, catchments are being manipulated through land use, leading to major changes in catchment water and material balances. Water quantity and quality are changing, sometimes for the better, but usually for the worst. Catchment managers requires tools to help them assess how particular forms of catchment stewardship will affect water values. The 'empirical age' of catchment treatment experimentation has served us very well but is now waning because of cost and time constraints. From the experiments we have learnt much about basic hydrologic processes and how different land uses affect catchment balances. Managers have also learnt that many of their pressing questions have a spatial dimension to them. For instance, how does topographic position effect the response of a hillslope to disturbance by forest logging.

Hydrologic models provide a way of forecasting how catchment might respond to different forms of management. Amongst the many different styles of hydrologic modelling sits the so-called 'process-based distributed' hydrologic models. The term 'process-based' implies that these models focus on the physical laws governing water and material (particulate and solute) movement in landscapes. The term 'distributed' (climate, topography) is represented. This class of models is regarded as data-hungry and difficult to use, but also the only class of models suited to capturing the complex feedbacks that occur in hydrological systems when they are perturbed.

One of our main arguments for the use of such models is that they capture important spatial dependencies in hydrologic systems. Hydrologic processes and rates vary enormously in space according to system properties such as soil type, land cover type and rainfall rate. Similarly, the response of any catchment or part of a catchment to disturbance will depend on the particular distribution of system properties applying in that area. Furthermore, land use systems usually have a complicated mosaic pattern. We have observed that the particular configuration of that mosaic (eg. The proximity of a logging road to a stream) is a major determinant of catchment response to land use. This is another compelling reason to use process-based distributed hydrologic models.

Some example models

The Cooperative Research Centre for Catchment Hydrology has developed two such models, referred to as Topog and Macaque. These are suited to different scales and problems but reflect where the state-of-the-art with respect to process-based distributed hydrologic modelling. In this presentation we describe both models through their application to example catchment management problems.

Topog is suited to simulating the dynamic function of small catchment (usually less than 10 km²) over long time periods. It runs using timesteps ranging between minutes and days, depending on the particular processes of focus. An innovative feature of the model is that it uses a novel flow net to describe how water and entrained materials move laterally through the landscape. This is based on a contour and flow trajectory system which is demonstrably superior to conventional grid-based methods used in most other hydrologic models. Topog integrates the water, carbon, solute and sediment balances and is thus useful for exploring complex feedbacks between system properties. It includes a physiologically based plant growth module which allocates carbon to above and below

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ground compartments of various plant forms (including grasses, crops and trees), dependent on water, nutrient and light availability, ambient temperature, and soil salinity. Thus plant growth and water use and soil-water solute dynamics are closely linked. In the past, the model has been used to assess how global warming and elevations in atmospheric CO₂ concentrations might affect forest growth, evapotranspiration and water yield from catchments. Developed since 1989, Topog is now well documented and published in the international literature. It is also available free of charge over the internet at www.clw.csiro.au/topog.

Macaque has some of the above-ground modelling features of Topog, though does not simulate carbon assimilation and allocation. Further, its below-ground modelling components are much simpler, permitting application of the model to large catchment scales (up to 1,000 km²). It has many features common with GIS-based models, principal amongst these is a dependency on grid-based digital elevation models, vegetation cover maps, soil maps and climate maps. Like Topog, it runs on a daily timestep, though is only able to predict runoff at this stage. Macaque is undergoing very rapid development at the moment and has recently been modified to run under WINDOWS NT in a Borland C++ Builder environment. Because of its rapid development cycle it is currently not available for public distribution.

Model applications

Topog is described by way of an application to an agroforestry application in south eastern Australia. The context of the application is that extensive tree planting is being advocated across grazing and cropping lands which have become degraded from excessive groundwater recharge and salinity. Why? Essentially, after European settlement the indigenous deep-rooted evergreen forests were replaced by annual, shallow rooted vegetation which evapotranspired much less than the original vegetation. This permitted more rainfall to percolate to groundwater, thus raising watertables which brought ancient salt stores with them into the plant root zone and onto the ground surface in certain places. The environmental consequences of this have been drastic and people are now scrambling to reverse the problem via tree planting. The problem is that most landholders cannot afford to give up their entire land resources base to trees.

The impetus for our Topog modelling of this problem is that methods are needed to say where the maximum impact from tree planting can be gained. Furthermore, because of high climate variability we experience in Australia, there is also a sustainability dimension to this problem. Landholders are expecting to generate commercial quality and volumes of timber in landscapes which previously supported scattered woodland or open forest. They are planting fast-growing species such as Tasmanian Bluegum (*Eucalyptus globulus*) using traditional commercial plantation management techniques. In intermediate annual rainfall areas (c.800 mm) initial growth has been very impressive, but once the soil water profile has been depleted the trees become susceptible to drought stress. Even mild droughts are sufficient to result in the mortality of over half the trees planted.

We have used Topog to design alternative plantation design systems, and to predict their performance over full rotations, usually lasting 30 years or so. Our focus has been on sloping terrain where there is some prospect for lateral water movement downslope via subsurface and surface pathways. These lateral flows can thus complement the natural rainfall and enhance tree growth. Specifically, we have compared the water balance and growth performance of two systems, namely block planting (as widely practised now) and strip planting. For the same total area planted our model results reveal very different outcomes in tree growth and thus water balance benefit which is positively correlated to growth. On the basis of our model results we are advocating the establishment of widely spaced and thin belts of trees on sloping land, which can benefit from lateral flows of water yielded from the interbelt grassland which is grazed by animals.

We describe Macaque through an application to water yield prediction on a large (161 km²) forested basin near Melbourne, Australia which is relied upon for urban water supply. The problem here is that managers have observed a strong relationship between forest age and water yield, with old growth forests aged 200+ years yielding about twice as much runoff that regrowth forest aged 30 years. Hence the demography of the forest is of critical importance to water supply. The catchment managers (Melbourne Water) need a means of forecasting the water yield consequences of wildfire and different logging regimes. Macaque has been used to estimate how basin water yield might change for different forest burning and logging patterns. To test Macaque we applied it to the Maroondah basin for an 85 year period spanning 1910-1995. During this period (primarily in 1939, but also on other occasions) much of the basin was burnt by wildfire, resulting in significant water yield changes. Macaque was able to simulate these changes effectively, giving us confidence that it can now be used in forecasting. It is currently being applied to the nearby Thomson basin (500+ km²) to help resolve a heated debate between water and timber harvesters regarding the relative value of wood and water and the effects of forest logging on the economic output from the catchment.

The problem of data

As stated earlier, Topog and Macaque belong to a class of models regarded as data hungry. Indeed, the need for data (for input, calibration and testing) has been a major constraint in their application, the models have really only been applied to intensively monitored research sites where sufficient banks of data exist. However, we are witnessing very rapid and exciting developments in spatial data acquisition which are set to transform the utility of these models and enable much wider application.

One of the most exciting developments is the advent of rainfall radar. Our previous large scale hydrologic modelling work has told us that errors in rainfall are by far and away the biggest source of error in hydrologic models. When modelling large systems it is imperative that the space-time distribution of rainfall is accurately represented. Doppler radar systems being operated by weather forecasting agencies such as the Bureau of Meteorology in Australia now enable the space-time distribution of rainfall to be captured for input to models.

For many years, conventional remote sensing (e.g. AVHRR, LANDSAT, SPOT) has been of great use to hydrologists in terms of land cover mapping. In fact, our own Macaque modelling has depended on spatial maps of Leaf Area Index (LAI) derived through the calculation of greenness indices (eg. NDVI) obtained via LANDSAT-TM scenes. In more recent times however, aircraft-mounted hyperspectral (ie. Broad and intensively sampled band width) scanner data are revolutionising our ability to 'type' land cover. Such data can now be gathered at sub-1 m pixel resolution over large tracts of land and yield information on canopy structure and photosynthetic activity. Soon, we will be able to derive long transects of tree growth and water use to test our distributed models.

Until now, one of the main constraints to the application of distributed hydrologic models has been the mystery surrounding everything below the ground. Soil hydraulic properties have a major bearing on how water and materials move through the landscape. Yet, traditional field survey methods are so logistically demanding that soil properties cannot be sampled on anything but the smallest of study sites. The increasing use of aircraft mounted gamma radiometrics sensors are about to change all that. Used by geophysicists for some years in mineral prospecting, environmental scientists are now discovering that gamma radiometrics can reveal all kinds of geomorphic and pedologic features. For instance, CSIRO scientists have been able to derive maps of soil hydraulic properties over large tracts of forested land deposition of sediments have also been obtained, providing a new way of testing distributed models of erosion and deposition.

Last, but not least, new generation laser altimeters mounted on aircraft are yielding high resolution digital elevation models (DEM's) which will have a huge impact on our ability to

simulate distributed hydrologic processes. Horizontal resolution of 1 m and vertical resolution of 25 cm can be obtained at a cost of only \$4000 per 10 km². In a couple of years time, such sensors will be based on satellites (probably with slightly coarser resolution), providing world wide coverage of high resolution topographic data. This will be of particular value in low relief areas where conventional DEM's are simply unable to define hydrologic flow paths.

The four new sensing technologies are still in their infancy and require much more testing. However, in the next decade, almost all of this technology will be operationalised, permitting routine process-based distributed hydrologic modelling over large tracts of land in almost any part of the world. In the meantime, catchment modellers must start to adjust their models to exploit these new forms of data.

Aiming at a Moving Target: Lessons from Long Term Watershed Projects

by David N Mungai¹, Chin K. Ong², B Kiteme³, W.K.B. Elkaduwa and R. Sakthivadivel⁴

The rate and characteristics of land use change in tropical watersheds due to changing demographic, economic and policy factors have important consequences for catchment health and environmental services. Few tropical watershed studies have lasted long enough to facilitate a credible analysis of the long-term effects of land use change on the environmental services provided by watersheds. This paper examines the driving forces and patterns of historical land use change in two long-term watershed studies in Kenya and Sri Lanka; and the lessons that can be drawn from them.

The Upper Ewaso Ng'iro North basin is located to the north and west of Mt. Kenya, and has experienced dramatic changes in both land ownership and land use due to rapid population growth of 7-8% per annum. The Upper Nilwala basin is located in the south of Sri Lanka and the area has undergone serious deforestation over the last 50 years, for agricultural land uses mainly for tea and home gardens.

The loss of watershed functions associated with the impacts of land use change and their socio-economic dimensions are also discussed. The case studies confirm the importance of long-term monitoring of the interaction between land use changes and catchment health. The involvement of all stakeholders is crucial for problem identification through to the research and the search for any viable ecological, social and economical solutions. A holistic approach involving relevant disciplines in watershed studies is vital. The use of models that integrate both biophysical and socio-economic data should be encouraged to derive decision support tools for farmers and managers alike who are faced with resolving conflicts and other issues related to limited land and water resources.

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Valuing Watershed Services: Concepts and Empirics from Southeast Asia

by Subhrendu Pattanayak¹ and Randall Kramer²

Keywords: Economic-ecological modeling, watershed protection, drought mitigation, valuation, profits, producers surplus, tropical deforestation, Indonesian National Parks, Southeast Asia.

Although proponents of watershed protection claim that it generates several soil and hydrological benefits, few studies have attempted to quantify the nature and extent of these benefits. This research addresses the neglected, but critical, question of the importance of protected tropical watersheds to poor farming communities in southeast Asia. We develop an organizing framework, find credible estimates of values for a watershed service, and offer lessons for researchers at all stages of data collection and analysis. The estimated positive value of drought mitigation in Manggarai, Indonesia, provides evidence of a substantive, quantified economic benefit of tropical forest conservation. We do not claim that this exercise has established the precise value of a complex ecosystem service. Instead, the estimated economic models and the parameters provide management signals for policy makers and forest managers regarding the spatial distribution and economic magnitude of watershed protection benefits. The paper also generates a research agenda to generalize the results (for policy evaluations of watershed protection in geographically and socio-economically similar sites) and to improve results by varying the model assumptions and the econometric analyses.

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Market-Based Instruments for Water Resource Conservation in Mt. Makiling, Philippines: a case study

by Rex Victor O. Cruz¹, L.A. Bugayong², P.C. Dolom³ and N.O. Espiritu⁴

The Makiling Forest Reserve (MFR) is an experimental and educational forest reservation 65-km south of Manila. To conserve the water resources from MFR, the development of appropriate economic instruments for more reasonable water pricing was initiated. The development of economic instruments was initially based on the willingness of users to pay using the contingent valuation technique.

An additional amount that the users are willing to pay on top of the current fees they are charged for using water was generated. About 67% of the domestic water users agreed to pay an additional amount ranging from \$0.03 to \$0.04 per cubic meter of water they use. Assuming that a minimum of \$0.02 is added to the current charges per cubic meter of domestic water consumed, sufficient money can be generated and used to implement various management activities to protect the watersheds within the MFR. Modes of payment, fund management and other aspects of implementation are also discussed in this paper.

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Potential Land and Water Use Conflict: A Case Study of the Bakong Watershed in Sarawak, Malaysia

by M. Murtedza¹, L. Seng, L. P. Ling, L.Y. Howe, N. Bessaih and K. A. A. Rahim

Failure to integrate land and water use elements in a watershed development plan may result in a conflict detrimental to the environment. The proposed large scale agricultural development and establishment of a major water intake system in the Bakong watershed in Miri District, Sarawak, Malaysia illustrates the eminence of such conflict. There are four primary sources of pollutants presently affecting and potentially capable of further deteriorating the aquatic environment of the Bakong river: (1) the land conversion activities for which sediment yields in excess of $1000 \text{ t km}^{-2} \text{ y}^{-1}$ have been estimated for the plantation areas within the catchment, (2) the operation and maintenance activities of the plantation estates which include the use of agrochemicals, (3) the peat swamp leachate with high humic contents, and (4) the river bank settlements discharging raw sewage directly into the river. From the perspective of future water use of the Bakong as a source for the municipal supply, the aforementioned problems may result in a raw water with (a) high levels of turbidity, suspended solids, mineral ions and water hardness, (b) high concentration of dissolved organics that may be precursors of hazardous chlorinated organics generated during the normal treatment process, (c) possible presence of persistent pesticides, (d) significant level of aesthetic contaminants, and (e) prevalence of pathogenic organism in excess of acceptable limits. Key mitigation measures recommended include the employment of least impact land conversion practices, establishment of a Catchment Management Committee for effective monitoring of land and water use, and incorporation of certain modifications to the raw water treatment process.

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Natural Resource Policies and Community-Based Approach to Watershed Management

by E.C. Godilano¹ and S.D. DeGloria²

The watershed forms a convenient and logical landscape unit to assess effects of human-induced disturbance on ecological processes, and to formulate community-based management plans to mitigate such disturbances. Our research goal is to develop a spatial analysis framework to strengthen the capacities of community stakeholders to evaluate environmental quality, formulate alternative land management strategies, and provide mechanisms to strengthen policies through the application of geographic information and technology.

The Matalom River Watershed in Southern Leyte, Philippines served as the study site for our research. The approach was to evaluate relevant natural resource policies that impinge on the integrity and sustainability of the natural resource base, construct a spatial database, conduct spatial analyses, and involve communities in a case study developing multipurpose cadastral maps. Combining geographic information technology coupled with global positioning systems further enhances the planning process, providing an integrated tools to involve stakeholders in problem solving, conflict management, and to mitigate their natural resource base.

Policy analysis showed that overlapping policies, foreign interventions, and commercialization of reforestation programs have become the bottleneck to implementation of government natural resource programs. At the village level, results indicate that 40% of the villages are located downstream where soils are acidic, a major constraint to food production. Sixty percent are located upstream on calcareous soils but in an environment that is difficult to access. Of the total cultivated area, 49% (2008 ha) are occupied by tenant cultivators, while timberland areas (841 ha) continue to be encroached by the community, and are under intensive resource extraction. This encroachment is contrary to government policies that abolished tenancy 25 years ago.

Land use suitability coincidence using spatial analysis and modeling between slope gradient, community land use map, and rational development plan showed that (1) in all categories, owner cultivators are mostly located in favorable environments, (2) tenants dominate areas planted to perennials, mostly coconuts, and (3) tenants maintain 73 percent of grassland areas.

Spatial analysis using geographic information technology identified areas of accelerated land and water resource degradation, determined areas best suited for conservation practices, and implemented "what if" scenarios based on policy guidelines. This analysis provides mechanisms for stakeholders to mitigate the fragile ecosystems in the watershed. This research contributes to a new science of natural resource management using tools of many fields of study to find an acceptable balance between natural resource conservation and utilization.

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Identification and Implementation of Management Scenarios Through a Decision Support System with Application to the Upper-Mae Yort sub-catchment

by Andrew Walker¹ and Claude Dietrich

Keywords: forest policy, Thailand, Decision Support Systems, upland cultivation, Hmong, Karen

Catchment management relies increasingly on computer simulations to encapsulate and model the catchment processes perceived to be of major importance by stakeholders. Very often, such processes contain both bio-physical and socio-economic dimensions. While bio-physical processes are generally amenable to modelling, socio-economic processes are likely to introduce non-quantitative and subjective elements that complicate significantly the design of computer aided Decision Support System (DSS). In collaboration with various Thai institutions, the Integrated Catchment Assessment and Management Centre (ICAM) is involved in the design of a DSS for land and water management issues affecting various sub-catchments located in the Mae Chaem catchment, northern Thailand. This paper sets out the overall structure of the DSS being developed and outlines its application in relation to the upper-Mae Yort sub-catchment, one of five case study sub-catchments being investigated by the project. The key resource management issue in this sub-catchment is the regulation of agricultural activity in forested upper-watersheds. We outline a DSS methodology that will enable decision makers to assess the trade-offs between socio-economic and biophysical impacts of watershed regulation policies.

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Posters on Watershed Functions

Studies on the Effects of Human Disturbances to Hydrological Function in Hainan Island and the Measure to Restore its Function by Xie Guishui, Jiang Jusheng, Lin Weifu, Zeng Xianhai, and Wang Yuekun, the Chinese Academy of Tropical Agricultural Sciences.

Community Based Forestry Management/Philippines: Factor Influence on Economic Decisions by Johann Meyer, Tufts University.

Simulating Runoff and Hydrological Impacts Resulting from Forest Conversion to Rubber Plantation at Rayong by Pongsak Witthawatchutikul and Warin Jirasuktaveekul, Royal Forest Department.

Land Use Effects on Water Resource of the Sand Dune Ecosystem in the Philippines: the use of cumulative effects assessment (CEA) by Floramante Pastor and Victoria O. Espaldon, Mariano Marcos State University, Philippines.

How Changing Land-Use is Modifying Hydrologic Processes in Mountainous Areas of Southeast Asia by Thomas Giambelluca, Alan D. Ziegler, Liem T. Tran, Ross A. Sutherland, and Michael Nullet, University of Hawaii.

Dry Season Water Shortage Control: A Case Study in Dong Nai River basin, Vietnam by Binh T. Nguyen, University of Minnesota.

Effect of Land Use Change on Soil Erosion and Farmer's Income at Naborosahon Sub Catchment, Toba Lake catchment - North Sumatra, Indonesia by Tyas Mutiara Basuki and Irfan Budi Pramono, Balai Penelitian Kehutanan Pematang Siantar, Indonesia.

Erosion in Bench Terraced Upland Volcanic Terrain, West Java, Indonesia by A. van Dijk and L.A. (Sampurno) Bruijnzeel, Free University, Amsterdam and Edi Purwanto, Centre for Education and Training of Forestry and Plantation Officials, Bogor, Indonesia.

Reflections on the Upper Ewaso Ng'iro River Basin Studies in Kenya by David N Mungai, University of Nairobi, B Kiteme, Laikipia Research Programme, Chin K Ong, ICRAF.

Use of Historical Data as A Decision Support Tool in Watershed Management: A Case Study of the Upper Nilwala Basin in Sri Lanka by R. Sakthivadivel and W.K.B. Elkaduwa, International Water Management Institute.

Integrated Watershed Management, from Paradigm to Reality: the Kali Garang Pilot Project: A Case Study by Pascal Antoine Perez, CIRAD, I. Gatot Sumarjo, CSAR, Bogor, Indonesia.

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Measuring the Effects of Policies and Reforms on Land Use in SE Asian Watersheds by Ian Coxhead and Xiaobing Shuai, University of Wisconsin, Gerald Shively, Purdue University.

How will medium term agricultural sustainability in the Philippine Highlands be affected by induced reductions in commodity prices for annual crops, by adoption of technologies that reduce erosion, and by combinations of the two? by D.J. Midmore, Central Queensland University, D.D. Poudel, University of California Davis and T.M. Nissen, University of Illinois.

Indonesian Farmer Learning in Conservation Farming: Converting Information to Knowledge by Andri Wahyono, Ministry of Forestry and Estate Crops of Indonesia, Indonesia.

Weeds Management Under Coffee Plant for Soil and Water Conservation in Upper Tulang Bawang Subwatershed, Western Lampung, Indonesia by Afandi B. Rosadi, and T.K. Nanik, Lampung University, M. Senge and T. Adachi, Gifu University, Y. Oki, Japan Okayama University.

Controlling Siltation of "Embung" (Harvested Rain Water Reservoir) Watershed and Its Conservation in Dry Land Ecosystems of East Nusa Tenggara, Indonesia by Beth Paul Naiola, LIPI, Bogor, Indonesia.

Hydrology of Coppiced *Gmelina arborea* Plantation in the Philippines by Evangeline T. Castillo, College, Laguna, Philippines.

Studies on the Effects of Human Disturbances to Hydrological Function in Hainan Island and the Measure to Restore its Function

by Xie Guishui, Jiang Jusheng, Lin Weifu, Zeng Xianhai, and Wang Yuekun¹

Keywords: human disturbances, hydrological function, problems, and measures and Haiana island.

In recent decades, there had been many changes in climatic features and soil characters in Hainan Island. The tendency of hydrological function in the watersheds of Nandu River, Changhua River and Wanquan River, which are the major rivers in Hainan, was analyzed in details.

The disturbance of human activities was the chief reason. Slash and burn is still very popular in mountain and minority nationality regions, such as in Dongfang, Ledong, Tongza, Qiongzong, Linshui and Baolin counties etc. the natural tropical forest was over cut in the past decades, in the 1950's there remained 863000 hectares of the natural forest and in the end of 1990's it sharply declined to 331000 hectares in Hainan Island. More frequently applying chemical fertilizer and pesticide have caused water resources seriously polluted, according to the statistics that the applying amount of the chemical fertilizer and pesticide reached 250000 ton and 9700 ton respectively in 1995 which increased ten times compared with 1960's.

These human disturbances have resulted in many environment problems, such as water losses and soil erosion, disasters of flooding and drought, rainfall decreasing, soil fertility degrading, water pollution, etc. Because the natural forest was sharply declined, the forest orographic rain was decreased significantly, which made dry season more droughts in Hainan. Most of rainfall become surface run off water directly into rivers that caused easy flooding and easy drought. The ratio of the flooding level and the lowest level of water in rivers increased year by year. Soil erosion and water loss is very seriously based on the observation. It was recorded that the amount of soil erosion in farming land with slash and burn was 20 times more than that of in western forestland and 800-1000 times more than that in eastern forestland. The another feature of the soil erosion is more sands into rivers. According to the investigation that the current sand content in rivers is 39% more than that of in 1950's. All which have been caused difficulty to retain water for reservoirs, decrease its engineering benefit and making many reservoirs can not reach 50% of the designed irrigating ability.

Finally, the measures to restore the normal hydrological function were discussed. These measures include the slash and burn will be prohibited in the mountain areas where the slope is greater than 25 degree, devote major efforts to planting trees to conserve water and soil, reduce the applying amount of the chemical fertilizer and pesticide to protect water pollution and construct more water conservancy projects to retain more water for irrigation etc. Some policy suggestions were also put out in the study.

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Community Based Forestry Management/Philippines: Factor Influence on Economic Decisions

by Johann Meyer¹

This paper explores Community Based Forestry Management/Philippines (CBFM) influences on its third goal, sustainable management of forest resources. To understand the conditions in the program site that lead to sustainable management of forest resources, specifically agroforestry, the factors of uncertainty, farm size, family size, human capital, labor availability, environmental awareness, credit and land tenure are measured and analyzed through a multivariate probit model. Preliminary data of factor influence on the economic activities choices of slash and burn farming, agriculture and carabao logging from case study site in Quirino Province, Philippines are used to suggest targets for higher probability of involvement in agroforestry.

These observations indicate conditions to be addressed in the operation and implementation of CBFM, further suggesting accomplishments and challenges in the organizational structure and national policy.

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Simulating Runoff and Hydrological Impacts Resulting from Forest Conversion to Rubber Plantation at Rayong

by Pongsak Witthawatchutikul and Warin Jirasuktaveekul¹

Hydrological impact of forest conversion at Rayong watershed was determined by the developed simulation model using water budget equation with interception, infiltration, percolation and evapotranspiration estimation as a base. The model was verified by observed data from natural forested watershed and apply to detect surface runoff, interflow and groundwater flow in rubber plantation.

Results indicated that, simulated values for streamflow increases from 16.17 to 22.44 % of storm rainfall by average. Regarding to forested area, the component of streamflow which composed of upper layer interflow, lower layer interflow and groundwater flow are average at 3.69, 37.12 and 59.19 %, respectively. After changing to rubber plantation, the component of streamflow is mainly surface runoff about 54.07 %. The other components which are mentioned above are calculated at 4.02, 16.39 and 25.52 %, respectively.

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Land Use Effects on Water Resource of the Sand Dune Ecosystem in the Philippines: the Use of Cumulative Effects Assessment (CEA)

by Floramante Pastor and Victoria O. Espaldon¹

Ilocos Norte sand dune ecosystem is a national geologic heritage as this displayed a process unique to the Philippines. Current trend shows a gradual conversion of some of the areas into varied land uses - residential, agricultural, hotels, resorts, and golf courses. Using the cumulative effect assessment methodology, the effects of the different land uses of the sand dunes in Ilocos Norte, Philippines was analyzed. The study examined how land use conversion would possibly affect the water resource of the sand dunes. Results of the study showed that the estimated water supply based on pumping test and estimated renewable safe water yield based on the recharge rate comparably substantial. Current land use takes up 4% of estimated supply of 76.15 M lpd or renewable safe yield of 74.8 M lpd (based on recharge rate). The estimation of water demand based on future expansion under different scenarios showed that full-range development of the sand dune is predicted to consume 68% of the available safe yield. Hence, water availability may not be the limiting factor for expansion. However, the degrading water quality will be the serious concern in the future. Indications of water contamination have been observed in some sampling points.

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How Changing Land-Use is Modifying Hydrologic Processes in Mountainous Areas of Southeast Asia

by Thomas Giambelluca, Alan D. Ziegler, Liem T. Tran, Ross A. Sutherland, and Michael Nullet¹

Collaborators: Jefferson Fox (Director) and Stephen Leisz²; Le Trong Cuc (Director) and Dao Minh Truong³; Sanay Yarnasarn⁴; Sawasdee Boonchee⁵ and Sathaporn Jaiarree⁶

In recent years, the land use, and hence watershed functions, of the mountainous portion of Southeast Asia have undergone transitions resulting from increasing population density, the expansion of the rural road network, and (in Thailand) a national logging ban and eradication of opium cultivation. At this time it is important to be aware of the changing influences on land use in order to understand how land cover and watershed functions are changing and to anticipate future changes. This paper examines the influences of several land cover change issues likely to be important in the coming decades: changing patterns of secondary vegetation, changing degree of land-cover fragmentation, and increasing road density. Two intensive field measurement projects are currently being conducted in the region to examine some of the important ways in which hydrologic processes are influenced by land-use change. The study sites, Pang Khum Village, Chiang Mai Province, Thailand, and Ban Tat Hamlet, Hoa Binh Province, Vietnam, are both areas of swidden agriculture. Preliminary results of our field observations allow us to characterize the basic hydrologic fluxes within the variety of land covers typical of each study site, to assess the importance of road-related impacts on the surface hydrologic processes and soil erosion, and to examine the effects of patch size on evaporative flux and overland flow.

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Dry Season Water Shortage Control: A Case Study in Dong Nai River Basin, Vietnam

by Binh T. Nguyen¹

The Dong Nai is a major waterway in southern Vietnam. Covering 35,000 km² with a population of 10 million, this river provides a range of goods and services (irrigation water, drinking water, hydropower, freshwater fish production, sea water extrusion, etc.) essential to the economic development of Dong Nai province and Ho Chi Minh City, the country's economic hub.

Dry season water shortages are the biggest challenge to the future prosperity of the region. Currently, water resources management relies on large-scale infrastructure projects, such as irrigation and drainage systems, dams, and weirs. But rapid urbanization and industrialization in the river basin have brought into question the long-term economic efficiency and environmental sustainability of this approach.

This paper examines the technical and legal issues associated with increased dry season water supply through improved soil and water conservation practices (e.g., grass strips, terraces), the rehabilitation and maintenance of irrigation and drainage systems, and the establishment of a water market.

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Effect of Land Use Change on Soil Erosion and Farmer's Income at Naborosahon Sub Catchment, Toba Lake Catchment - North Sumatra, Indonesia

by Tyas Mutiara Basuki and Irfan Budi Pramono¹

The area of Toba lake catchment is 259.594 Ha (FAO, 1987), around 65,100 Ha (25% of the area) is covered by forest, and the rest is belong to the local people. Almost 93% the land of the local people has steep slope and it is used for seasonal plants, without any conservation practices. So that accelerate erosion is above tolerable value. If this condition admitted, soil fertility will decrease rapidly.

Based on the background above, a study to evaluate effect of land use on erosion and farmer's income was conducted at the one of sub-catchment of Toba Lake catchment. Furthermore, it seeking the best land use model that can support The Program of Forest, Land and Water Sustainability, without losing farmer's income.

Naborosahon sub-catchment is chosen as the representative sub-catchment, because its dense population and intensive farming system at steep slope areas. The area of the sub-catchment is 5.775 ha, it is located at Parapat tourism area, District of Simalungun and North Tapanuli, North Sumatra Province, Indonesia.

In this study, ANSWER (Area Non point Sources Watershed Environment Responds Simulation) model (Beasley and Huggins, 1981) was used to predict erosion. Input data for this model are: rainfall, soil characteristics, land use and surface parameters, channel characteristics, and individual element information. Output data is soil erosion resulting from land use models. Rapid Rural Appraisal was used to evaluate social economic aspects.

Base on land use map and field check, it is found that the dominant land use in the study area bride field, that is 2652.5 Ha (45.9% of the study area), following by natural forest 1408.5 Ha (24.4%) mixed garden 573.0 Ha (10%), Eucalyptus urophylla 422.7 Ha (7.3%), Pinus merkusii 366.0 Ha (6.3%) and paddy field 352.3 Ha (6.1%).

The prediction result by using ANSWER model shows that present land use (the first model) causes 22.53 ton/ha/year, and income of the farmer is Rp. 9,114,768,000.- /year.

Due to large area of dried field, the second model is made by conversion of 392 ha of bried field into mixed garden in the steep slope areas. It will reduce 26% of erosion and the farmer's income decreases only 0.5%/year.

The third model is by conversion 127 ha of pine forest into dried field. The third scenario is made because there is a trend the farmer's plant ginger by replacing pine forest. It causes increases 3% of erosion, but income of the farmer only increases 2.3%.

Among the three models, the second model is the best scenario in order to reduce soil erosion and the farmer's income do not loss significantly. Although soil erosion in the second model is still above the tolerable value, but it can be reduced by soil conservation practicers, especially in the steep slope areas.

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Erosion in Bench Terraced Upland Volcanic Terrain, West Java, Indonesia

by Albert I.J.M. van Dijk and L.A. (Sampurno) Bruijnzeel¹, and Edi Purwanto²

II. Process modelling across a range of scales.

Results obtained during the first phase of the Cikumutuk Hydrology and Erosion Research Project (CHERP) suggest that the bulk of the sediment produced in this volcanic upland agricultural catchment originates from (the bare risers of) rainfed bench terraces, particularly on steep slopes. Also, a surprisingly low sediment delivery ratio was obtained for a sub-catchment draining *c.* 180 terraces (see Part I). To clarify the underlying processes, the second phase of the project (1998-2002) includes an effort to model these processes in a physically meaningful way across a continuum of scales, *i.e.* from individual terrace risers and beds, via the toe drains, to drainage ways along field boundaries into gullies, and finally into the stream draining the entire catchment. Three physically-based models are used: (i) VAMPS (Schellekens, 1996) for modelling the one-dimensional water balance of a vegetated surface; (ii) GUEST (Rose, 1993) to model on-site runoff rates, erosion and sediment transport; and (iii) TOPOG (Vertessy et al., 1990) to model (sub-)catchment hydrology, erosion and sediment transport in a spatially distributed manner. The three models will be integrated and modified where necessary to be applicable in the given setting (backsloping bench terraces). Examples of modifications include:

- incorporate direct sediment transport by splash in GUEST and allowing for lateral contributions from both bed and riser sections to the central toe drain;
- develop a method to translate DEM/TOPOG-based slope data into terrace geometry data (size and slopes of riser, bed and toe drain) for use in GUEST, *e.g.* through empirical relationships between slope steepness and terrace geometry based on field surveys;
- develop and incorporate a procedure to model runoff and sediment dynamics in drainage ways.

To validate the models and their modifications, field data are being collected in addition to the baseline monitoring programme (*cf.* Part I), including:

- continuous measurements of water and sediment outputs from terrace riser and bed sections as well as from complete terrace units of variable geometry;
- event-based separated measurements of splash and wash erosion;
- monitoring changes in sediment storage at the respective levels of scale.

The final result (expected around 2002), will be an integrated and validated combination of the above-mentioned models and their modifications which will enable the prediction of runoff, erosion and sediment transport in tropical terraced terrain for soil conservation and watershed management purposes, in a user-friendly but physically meaningful way.

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Reflections on the Upper Ewaso Ng'iro River Basin Studies in Kenya

by David N Mungai¹, B Kiteme² and Chin K Ong³

Introduction

Mt. Kenya and associated mountain ranges are important in many ways to the welfare of millions people living in the vicinity of the mountains but also to the Kenyan economy in general. The mountains provide water for Kenya's major rivers and their tributaries upon which agriculture, tourism and power generation depend. The rivers also constitute an important source of domestic water supply. The mountain and the associated highlands are endowed with fertile soils and their slopes covered with forests and other vegetation forms which provide timber, fuelwood and a rich biodiversity including rare species and medicinal plants. Mt. Kenya is also one of the international benchmark sites for the study of mountain ecosystems.

The importance for research of the Mt. Kenya area was recognized in the mid 1970s by scientists at the Universities of Berne, Switzerland and Nairobi, Kenya. This paper describes the ecological, demographic, planning and policy formulation and implementation studies which have been carried out in the Mt. Kenya and Upper Ewaso Ng'iro region of Kenya at various spatial scales.

Objectives

An extensive measurement network was established to monitor the climate, water, soil, and vegetation resources as well as landuse and cover. The major aims of this monitoring system are to (1) collect baseline data for climate, water, soils, vegetation and landuse in the catchment, (2) collect long-term data for the assessment of variability or trends of the monitored parameters and their impact on resource availability, productivity and degradation, (3) provide data for detailed analysis of specific processes or of different management strategies and (4) provide data for model adaptation or development for tactical and strategic advisories to all stakeholders including researchers.

Climate & vegetation

The distribution of 100 climatological stations varies from 920 m at the catchment outlet to 4,500 m at the peak of Mt. Kenya.

The soils of the Upper Ewaso Ng'iro catchment have been mapped and characterized at various scales. There are numerous other soil studies at farm or settlement level. In addition, runoff, soil loss and soil moisture data have been collected at 20 representative sites for ten different landuse types. In the run off plots, soil cover has been monitored.

River discharge measurements have been made since 1960 through a hydrological network initiated and maintained by the Water Department. Sediment discharge has also been monitored for some of the rivers for specific studies where assessment of catchment soil loss was necessary. As at 1997, there were 32 river gauging stations in the Upper Ewaso Ng'iro catchment, all manned by the LRP staff. To assess river water abstraction in the major rivers, 8 river abstraction furrows each fitted with a flume were constructed at various times between 1991 and 1995. Landuse and cover are periodically assessed using

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remote sensing data. These are complemented by observations of ground cover condition at 5 small catchments.

Socio-economic research

The growth of the population and the demographic characteristics since pre-colonial times have been documented. The demographic studies show a population growth rate of up to 8% per annum. The indications from these studies is that the population in the Upper Ewaso Ng'iro catchment will continue to grow given particularly the high rates of immigration with consequences on the natural resources of water, vegetation and soil.

The translation of research findings into recommendations and the transfer of these to the planning and development agencies in the region have been important activities for the LRP. To address as fully as possible the constraints to sustainable resource use and development, interdisciplinary research and transfer methods of the findings have been given high priority. Self-help groups are common in the area and they act as important vehicles for rural development. A study was carried out between 1986 and 1989 to find out to what extent the self-help groups could function as entry points in the transfer of research findings and development activities. The study was regional in character covering an area of some 10,000 km² and 354 peasant self-help groups and a time frame of twenty years (1970-1990).

Major findings

Land use changes and water conflict

The dramatic land use changes and intensification of farming activities, due to population increase and the subsequent rise in demand for irrigation water have led to serious degradation of land and water resources. Today, there is less water reaching the lower parts of the basin than thirty years ago due to increased number of abstractions most of which are illegal. The occasional drying up of the Ewaso Ng'iro river and some of its tributaries leading to movements by the pastoral communities and wildlife into the upper reaches of the catchment in search of water and pasture attests to this. This situation has served to increase and complicate conflicts over water resources between farmers in the upper reaches of the basin and other interested groups in the lower areas of the catchment.

Farming systems

Following land use and ownership dynamics in the district, (through subdivision of large scale farms into small-scale holdings) new farming systems have been subsequently introduced. These changes have taken place without adequate information to the new settlers on how to adjust and adapt to the new agroclimatic conditions. This resulted to the development of farming systems that put pressure on the scarce natural resources especially water.

Inadequate policies

Development efforts and specific intervention policies for water resource use have often proved inadequate to respond effectively to the needs and conflicts arising from competition for water whose causes and effects assume a regional dimension. Moreover, catchment protection has been hindered by a lack of a comprehensive environmental protection policy.

Minimum data set

The minimum data set may be defined as the lowest amount of data which can provide an accurate assessment of the baseline biophysical and socioeconomic conditions including

the rates at which changes in the state variables are occurring. In defining such a minimum data set, a number of boundary conditions need to be defined.

The characterization of a study catchment in terms of the control variables of the various hydrological processes is necessary in determining the sampling intensity. The control variables which should be used include altitude and land use/land cover. A knowledge of the differentiation of areas with different rainfall and storm generating mechanisms would also be very important. Where spatially and temporally representative hydroclimatological data are available, an attempt should be made to regionalize and use the derived regions to set up a monitoring system. The available long term data should also be used to determine the efficiency in parameter estimation using data of various lengths. The studies in the upper Ewaso Ngiro were lucky in that a fairly representative network existed before the project. The network belonged either to the Government or to private land owners and it monitored only a few parameters.

Challenges ahead

Interdisciplinary team

The combination of research for basic solutions on the one hand and area specific and problem-orientated research on the other, is difficult and is a growing problem. It requires a professionally and highly qualified interdisciplinary team (from both socio-economic and natural sciences) that is necessary for the formulation and implementation of specific research activities.

Integration of database and research projects

The building up of an integrated database on ecological processes and socio-economic dynamics is a time-consuming, professionally/scientifically complex and financially demanding process. The most challenging task is to maintain the database updated, consistent, extensive and easily accessible to those who want to use it. Furthermore, it was necessary to integrate information from two scientific disciplines, natural and socio-economic sciences. As the institution expands its activities with more stakeholders and geographical coverage, it became more difficult to integrate individual research projects and accommodate various scientific interests.

Extension and transfer activities

The process of database development through research is not complete if it is not linked to development process through extension and transfer activities. The main constraint in accomplishing this task lies in the capacity and ability of the institution and its collaborating partners to maintain a sustained transfer activity to ensure continuous information dissemination to relevant users at all levels of development process throughout the period. There is a general lack of technical and financial/logistical capacity among the key collaborating institutions, especially government sector departments, who are expected to take the findings to the beneficiaries.

Internal and external institutional capacity limitations

As the institution establishes itself to a level of sub-national and national scientific recognition, more institutions seek for formal association and affiliation. This creates enormous demand on the parts of the research institution in respect of professional, technical, and logistical and financial supports. Consequently, a number of requests could not be granted.

Coping with a moving target

Since every institution is established and operated in accordance with set goals and objectives, it becomes practically difficult to tackle new and emerging environmental issues as well as continue with long term monitoring.

Use of historical data as a decision support tool in watershed management: a case study of the upper Nilwala basin in Sri Lanka

by R. Sakthivadivel and W.K.B. Elkaduwa¹

Considering technical, financial and time constraints of the current state-of-the-art of assessing hydrological impacts of land use transformations in watersheds, particularly in the tropics, this method was tested in a 37,950-hectare hilly-terrain watershed in the wet zone. The objective was to use the proposed methodology as a guide in identifying appropriate land use management options and policy interventions. In this methodology, changes in hydrologic response of the same watershed to land use transformations made in the past are ascertained. Long-term historical time series data on stream flow, rainfall and land use are analyzed. The variability in the hydrological response due to inter-annual variations in weather was minimized by establishing the correlational relationships among hydrological variables based on long-term (57 years) data and using five-year moving averages, instead of annual data, in the trend analysis.

In 1940, natural forests covered 50% of the catchment. It has decreased to 43% in 1948, 30% in 1964 and less than 15% in 1997 due to conversion into other agricultural uses. The mean annual water yield has increased by 17.5 cm (10.82%) during 1948-1964 compared to the 1940-1947 period and 80% of the increase was due to increased base flow. Nevertheless, this increase in base flow was short lived. During 1965-1997 period, mean annual water yield reached that of 1940-1947, however, there was a reduction in base flow and an increase in storm flows. Therefore, very conspicuous changes in flow regimes have occurred with reduction of forest cover from 30% to 15% during 1965-1997 and changes were at their peak during 1990-1997. This indicates that the new cover dominated by tea and home gardens, respectively in 50% and 20% of the area, is not well-managed to be as effective as natural forests in maintaining high infiltration rates.

The observed adverse environmental impacts were directly related to changes in flow regimes. Rapid runoff was responsible for high soil erosion (reduced land productivity) and frequent flash floods. High sediment supply has caused aggradation of stream channels increasing the likelihood of flash floods, reduced land productivity in rice fields with deposition of coarse material, and silting of irrigation canals. During dry spells, relative droughts and irrigation water shortages have occurred. In the downstream, increased high flows have aggravated the flooding whereas reduced low flows have decreased the dependable supply of water and increased the salinity intrusion at the river mouth. Linking this watershed analysis, land management prescriptions were developed to each land use category so that the hydrologic response would be closer to the desired conditions that existed with a great percentage of forest cover by mimicing the natural forest eco-systems.

The results showed that this method holds scope for planning suitable land management options in the tropics with a rapid assessment of their possible impacts at watershed scale if reliable historical time series data of rainfall, stream flow and land use are available. Further, this rapid appraisal technique would become very useful with the availability of remote sensed data.

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Integrated Watershed Management, from Paradigm to Reality the Kali Garang Pilot Project, A Case Study

by Pascal Antoine Perez¹ and I. Gatot Sumarjo²

The Kali Garang Pilot Project (KGPP) started in 1996/97 and was elaborated by the Center on Soil and Agroclimate Research (CSAR) in collaboration with the Provincial Government of Central Java and the Centre for International Cooperation in Agricultural Research for Development (CIRAD). The objective of the project is to improve the water management in the farming sector in order to control the risks of flooding and drought within the watershed.

The proposed strategy consists in collecting part of the excess water during the rainy season and then, in using this water to secure the production during the dry season. The various technologies (On-farm reservoir, Re-infiltration well) should contribute to the most violent flash foods but also should secure the water resource in order to minimize the climatic risk for the farmer.

This project is complementary to others initiatives coordinated by the Provincial Bureau of Planning (BAPPEDA) and concerning the river regulation or the management of the hydrogeological resources. The KGPP clearly focuses on the agricultural sector, this justifies the fact that the executive agency is the Provincial Agency for Technology Assessment (BPTP) located in Ungaran.

A preliminary review of the existing data and the already installed monitoring equipment was carried on. Then, it was obvious that some new equipment was required in order to guarantee an accurate representation of the spatial and time variation of some climatic, hydrological or agronomical variables. So as to strengthen the efficiency of the activities, a House of Project has been settled in the village of Gunung Pati, centre of the watershed. The activities are divided into 4 components:

Climatology: The new equipment gives reliable and fast information about storm water patterns (7 automatic rain-recorders) and the climatic variables necessary for computing the climatic demand (PET). The primary data are analyzed and then transferred to the other components as required.

Hydrology: Three automatic water level recorders were installed upstream the three main tributaries. These devices will provide useful information concerning the hydrological behavior of the Highlands and its long-term evolution influenced by the landuse alteration. The validation of an Early Warning System using flood modelling is in progress.

Agronomy: A crop water balance monitoring program has been implemented in order to determinate the supplementary irrigation needs and then, to size the On-farm reservoirs and to optimize their management. The introduction of new crops, as ginger, provides opportunities to modify the traditional irrigation schedules.

Socio-economy: A Rapid Rural Appraisal was conducted in five villages. It gave relevant indications concerning the importance of the water management within the whole set of factors contributing to the local farming systems.

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Stakeholder participation in a decision support system: the IWRAM Project's case study approach

by Nootsuporn Krisdatarn¹, Helen Ross, Andrew Walker and Nina Pangahas²

Decision support systems (DSS) need careful design to ensure the software actually addresses its users' decision-making needs. The past development of software has too often been led by technical capacity. Participation in the design of DSS offers the way to make sure the information system is truly able to *support users' decisions*.

The *Integrated Water Resources Assessment and Management Framework* (IWRAM) project is a partnership between the Royal Project Foundation and the Australian National University, which develops an integrated framework and tools for assessing catchment water and land-use options. It is producing decision support tools that will assist the Royal Project Foundation, government and other stakeholders to identify and assess socioeconomic and environmental implications of a series of 'what if' land and water scenarios.

The project

- Recognises that many parties ('stakeholders') make decisions and take actions affecting the highland river basins. These include local people, government departments, NGOs, and business interests.
- Accepts that these stakeholders can have very different - sometimes conflicting - policies, concerns, and visions for the future of these basins.
- Aims to provide all these decision-makers with ways of integrating social, economic and environmental information, in order to increase their awareness.
- Will provide outcomes which will be accessible to and can be used by a wide range of stakeholders.

We are currently inviting stakeholders to collaborate with our team in developing case studies in five sub-catchments of the Mae Chaem basin (a tributary of the Ping). These will allow issues to be explored in detail with stakeholders, so as to provide a focus for designing the software.

This poster describes how stakeholders contribute to every aspect of the development of the IWRAM project's software. The *issues* the software addresses come from their visions and policies for and concerns about land and water management. Stakeholders provide information for the GIS, statistical and text *databases*, and for the *models* of socio-economic and environmental processes in land and water use. The models reflect stakeholder decision-making realistically. We will provide *outputs and indicators* for the presentation of information to meet stakeholders' wishes.

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Bridging the Gap Between Farmers' Production Orientation and Watershed Conservation Goal in Indonesia's Regreening

by Fahmuddin Agus¹ and Meine van Noordwijk²

Regreening is the main Indonesia's watershed conservation program conducted on prioritized farmers' land through farmers' participation. Initiated in 1976 by a Presidential Instruction, the program put emphases on establishment of village-level soil conservation demonstration units and nurseries. Each demonstration unit is established on about 10 ha of farmers' land involving a group of 20 to 50 farmers. Participating farmers receive technical guidance from the district-level Forestry and Conservation Service extension workers, subsidized seeds, seedlings, fertilizers, and partial labor payments. In about 100 ha impact area surrounding each demonstration unit, farmers receive tree seedlings (commencing one year after the establishment of demonstration units) and technical guidance. In 500 to 1000 ha outer area, farmers only receive guidance from extension workers and, on their own, are expected to imitate the conservation practices as conducted in the demonstration unit. Watershed resource conservation and farmers' prosperity improvements are the main program's objectives, but farmers' participation in the impact and the outer areas has been very little. The low level of adoption is attributed to mismatched between farmers' production orientation and government's environmental objectives and to the different levels of subsidies. The program recommends tree planting and terracing as the main mythical cures, and gully control, drainage system improvement and drop structures as supplementary cures of watershed degradation. Slope determines the number of trees to be planted. The trees are evenly distributed on the land and little attention has been paid to existing farming system, land tenure, farm size, and subsistence nature of farming. Terracing or terrace improvement has been demonstrated on lands having slopes lesser than 40 % and little consideration has been taken to soil stability and high costs to replicate. We believe that the district agency responsibility is to facilitate farmers in understanding environmentally related problems, exploring alternative measures to address the problems, and to explain advantages and disadvantages that may accrue from implementation of each measure. It is the farmers to decide which measures to be implemented. Future research should be designed to produce two pronged (production increase and environmental protection) technology options. Distribution, rather than just the number of trees per unit area determines tree effectiveness in controlling erosion and runoff. This principle could be used a working hypothesis to develop watershed scale research agenda. Identifying and solving implementation problems should be the main research focus of already scientifically proven effective conservation measures. For this purpose, the demonstration units should also be used as village laboratories from which the government and non-government agencies can learn and improve regreening performance. Levels of subsidies and guidance given to farmers in the demonstration units and the outer areas should be equalized to obtain a fair judgement across these areas.

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Measuring the Effects of Policies and Reforms on Land Use in SE Asian Watersheds

by Ian Coxhead, Xiaobing Shuai¹ and Gerald Shively²

How do economic policies affect agricultural resource management in uplands? We present evidence on land allocation in a Philippine watershed to evaluate farmers' responses to price and policy changes, using conditioning variables to account for demographic and geographic conditions. Policy reforms affect both the mean and the variability of prices, and there may be policy interactions in mixed crop systems. We use econometric findings to derive parameters to simulate potential impacts of policy changes. Simulations use a range of assumptions about risk aversion. Some policy/price changes elicit land substitution (and to a lesser extent, intensified input use), while others primarily induce expansion of total farm area. We draw out implications not only for policy but also for the analysis of resource allocation in semi-commercial upland agricultural systems.

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How will Medium Term Agricultural Sustainability in the Philippine Highlands be Affected by Induced Reductions in Commodity Prices for Annual Crops, by Adoption of Technologies that Reduce Erosion, and by Combinations of the Two?

by D.J. Midmore¹, D.D. Poudel² and T.M. Nissen³

Vegetable farmers in the highlands of northern Mindanao with current farming practices predispose soil to erosion: annual rates exceed 60 t/ha. Family incomes show that many farms are not economically viable. Strip cropping, contour planting, or alley cropping with short-stature perennials crops all reduced soil loss, and were more profitable than the farmer practice of planting up-and-down the slope. Interplanting trees in vegetable fields also reduced loss of soil through erosion, but yields of vegetables progressively declined as competition with trees for light and nutrients was exacerbated. Since vegetable and corn prices are inflated due to government import policy, we subjected our data to a range of price scenarios, for both vegetables and timber. These analyses show that for a worst case scenario of continuous cropping for seven seasons, even a 20% farm-gate price reduction would result in non-viability of annual cropping.

Agroforestry would only be competitive with annual cropping on a per hectare basis if crop yield declined by 20% annually due to disease and loss of fertility. Agroforestry would be relatively more attractive than annual cropping if food prices fell by 20%. We believe that adoption of erosion control practices could offset the need to introduce price reform in annual crops.

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Indonesian Farmer Learning in Conservation Farming: Converting Information to Knowledge

by Andri Wahyono¹

In a world full information, there is a desperate shortage of knowledge, a commodity which people acquire from information by a process of learning. For most farmers, learning means adding to or making changes in their own knowledge. An increasing of farmers' knowledge can be recognized by describing how they think, feel and act which results in changes in attitudes and behavioural patterns. This paper is a general review of how Indonesian farmers learn in conservation farming, of their major importance to prevent and rehabilitate land degradation over watersheds.

The paper contends that the slow learning that is occurring in the field is not the fault of farmers but the fault of extension services which have been slow to employ adult learning processes in its programmes. It examines where extension has gone wrong in the past and proposes that extension needs a new adult learning approach. The principles of and strategies for adult learning with implications for farmers are discussed and extension activities within conservation farming examined for its findings and summarizing key points for extension workers. The criteria of good farmer groups and successful extension worker are determined as means to evaluate the progress of learning in conservation farming.

The paper concludes with an eight point-plan for a new, more visionary, people-based extension service which is more in tune with the adult learning challenge which exists in conservation farming.

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Weeds Management under Coffee Plant for Soil and Water Conservation in Upper Tulang Bawang Subwatershed, Western Lampung, Indonesia

by Afandi, B. Rosadi, Tumiar K. Manik¹, M. Senge, T. Adachi² and Y. Oki³

Most of coffee plant in Lampung province are growth in the western mountainous areas where the soil and crop management are poor. Clearing up all the ground cover under coffee tree is the most popular technology for weeding. Lately, the "booming" of coffee price in 1998, has encouraged the people to open more protected forest area for new coffee plantation. The objective of this research is to measure the effects of weeds management under coffee plant on the extent of soil loss and runoff as well as the dynamic soil moisture pressure. Location. The study was located at Sumber Jaya, Western Lampung, Sumatra, Indonesia. The slope gradient is 15 degree with an altitude of 780 m. The initial soil properties are: sand 25.2%, silt 23% and clay 51.8%, bulk density 0.957 g cm⁻³; particle density 2.62 g cm⁻³; PH 4.92; N total 0.26%; C organic 3.48%; CEC 13.3 me/100 g. Treatment. The test plot consisted of three treatment with each treatment has an area of 100m² (20x5). The treatments are: coffee without cover crop (T1); coffee with *Paspalum conjugatum* sp. as cover crop (T2) and coffee with natural weeds (T3). The plots were planted by coffee in November 1995 with planting distance 1.5 X 2 m. Weeds management was done every two weeks with clearing all the weeds in T1 and cutting around the coffee plants with 1 m in diameter for the T2 and T3 treatments.

Treatments	Ratio run-off to rainfall			Soil loss (t/ha)		
	1995/96	1996/97	1997/98	1995/96	1996/97	1997/98
Coffee (T1)	15.9	3.7	9.6	10.4	12.5	9.4
Coffee +Paspalum(T2)	1.5	0	0	0.38	0.03	0
Coffee+natural weeds(T3)	9.0	0.3	3.9	3.37	0.3	0.3

Beside of better coverage, the abundant of weed roots made the process of alternate wetting and drying of the soil profile (is shown in tensiometer data) were more rapid at T2 and T3 created cracking in deeper layer. As the result, the soil erosion and run-off were suppressed at the weed treatments. However, the competition between weeds and coffee made the coffee growth was severe. Better weeds management would make the using of weed as cover crop, especially *Paspalum conjugatum*, is promising.

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Controlling Siltation of "Embung" (Harvested Rain Water Reservoir) Watershed and its Conservation in Dry Land Ecosystems of East Nusa Tenggara, Indonesia

by B. Paul Naiola, Wahyu Widiyono and Albert H. Wawo¹, Y. Manudima² and Libreth Foenay³

"Embung", local name for a relatively small harvested rain water reservoir in rural areas of Eastern Nusa Tenggara, Indonesia totally rely its source of water upon the rainfall, thus must be established in a hilly area outside the village, then allow them to collect and recharge their stored water (capacity varies between 30 to 60 million liters) from run-off flow during 3-4 months rainy season only in a year, is capable to serve about 50 to 100 local villagers' family for their domestic need and home garden farming during 270 days of dry within a year.

This experience of having near distance source of water had never been undergone by their older generations who had to travel up to 5 km daily to get water merely for drink and cook only. Thus embung has broken up the "myth" of "water shortage in a dryland province", really a great contribution. The collaboration between R&D Center for Biology-LIPI and East Nusa Tenggara Government, Indonesia has successfully promoting demonstration programs on "*embung based efficiently watering farming system*". Demonstration plots were as appropriate farming technology models of efficient watering systems including potting, drip watering, showering and sprinkler farmings, have high potential and promising to push up the household economic of local villagers.

However, the euphoria arises from the embung stored water may be disappear in the near future. Two main reasons causing the malfunction of embung watershed *firstly*, threatening by a potentially dangerous natural phenomenon, i.e. siltation/sedimentation due to soil erosion from its watershed, driven by poor tree vegetation (low density and low frequency of trees per unit area) in the embung watershed; *secondly*, unconfined (wildly) grazing in the embung watershed has brought an environmental cost i.e. seedlings that emerge during the rainy season are soon eaten by the cattle, thus never reach their mature status to stabilize the savanna vegetation. The predicted life-span of an embung to reach more than 25 years seems unrealistic. Evidence showed many embungs have vanished and become disfunction under 10 years due to siltation.

Agroforestry and reforestry systems in the embung watershed (about 6 to 10 hectares) may increasing the quality of soil conservation thus to prolong their life-span. Better vegetation (i.e. higher density and higher frequency of plant occurrence per square area) will bring benefit for at least two points. *Firstly*, controlling the siltation process due to erosion through run-off flow. *Secondly*, reduce the temperature around the embung. Research is needed to study whether lower temperature around the embung (as a result of better vegetation) could reduce the water temperature, hence the loss of water by evaporation. Plant rows in the alley cropping model of agroforestry around watershed, may functions as a wind break. Reducing wind flow over water may result in higher humidity and an increased boundary layer, would reduce the water potential gradient ($\Delta\Psi$) between the stored water and the air above the water surface, thus consequently reduce the escape of water molecules from the embung to the "thirsty" atmosphere.

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Hydrology of Coppiced *Gmelina arborea* Plantation in the Philippines

by Evangeline T. Castillo¹

The hydrologic response of a *Gmelina* plantation totally coppiced and allowed to regrow for four years was investigated in comparison with a seasonally-burned control grassland catchment in San Mateo, Norzagaray, Bulacan Central Philippines from 1994 - 1997 using the paired - catchment approach. The study was conducted by Dr. Evangeline T. Castillo, Supervising Science Research Specialist at the Ecosystems Research and Development Bureau (ERDB), Department of Environment and Natural Resources.

The coppiced *Gmelina* plantation in the watershed produced a mean annual runoff of 105 mm lower than the grassland catchment which is equivalent to a mean reduction of 19.4% over the control. Sediment yield was reduced by an annual average of 61.2%. Infiltration rate was much faster in the yemane catchment and a longer time to saturate (6.5 hrs vs 6 hrs in grassland catchment).

The runoff and sediment yield reduction effected by the coppiced *Gmelina* relative to the control catchment can be accounted to the quick vegetative growth both in the understorey and by the overstory canopy as well as in the production of litter covering the soil layer. Coppiced *Gmelina* trees regrowth was relatively fast with mean growth rates of 1.8 m/yr for height, 1.92 cm/year for stem diameter 0.6 m/year for crown depth and 0.02 m/year for crown diameter. *Gmelina* trees produced mean height of 5.19 m on the first year and 12.3 m on the fourth year; mean stem diameter of 6.82 cm and 14.5 cm on the first and fourth year respectively; mean crown diameter of 2.04 m and 2.62 m on the first and last year; and mean crown depth of 4.28 m and 6.8 m initial and final values. After four years, the *Gmelina* plantation gave rise to 30 undergrowth species comprising grasses, herbs, vines, shrubs mosses and trees dominated by *Chromolaena odorata*. This is in contrast with the control catchment with only 19 species limited to grasses, sedges and vines. The initial unvegetated ground layer was 7.7% on the first year was finally reduced to 0.5% of the ground area. Litterfall accumulated at a rate of 358 g/m² /year with peak fall months in May and December and lowest in April and May.

Soil analysis indicated significantly higher cation exchange capacity and soil pH in the *Gmelina* catchment but significantly lower nitrogen and potassium content. Soil physical properties such as bulk density and porosity was initially higher in the grassland watershed but improvement in the *Gmelina* catchment was observed on the fourth year.

Results of this investigation inferred the positive utilization of *Gmelina* as industrial species owing to its quick growing coppicing potential but also for its protective capability of reducing surface runoff and sediment yield.

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POSTERS FOR COMPUTER SESSION

List of posters for computer session

One page abstracts of posters for computer session

Computer Session

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Application of WaNuLCAS Model in the Economic Valuation of Alternative Land Use Options for Philippines Grasslands by D.B. Magcale-Macandog, C.D. Predo and A.E de la Cruz, SEAMEO SEARCA, Philippines.

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WinAKT Demonstration

by Fergus L. Sinclair¹

WinAkt is the Agroforestry Knowledge Toolkit for Windows. It is knowledge-based systems software and a methodology for acquisition and use of ecological knowledge in agroforestry research and extension. It is designed to help people acquire local and scientific knowledge about interdisciplinary topics and then evaluate and use this knowledge to plan research and extension. Users may be researchers or extension workers, though the system is most powerful where there is an institutional investment in making better use of qualitative information. The system is currently being used in a range of applications by governmental and non-governmental organisations around the world, some of which are listed below:

- i. Assessing farmers knowledge in participatory crop improvement programmes for maize/millet (Agricultural Research Station, Pakhribas, eastern midhill of Nepal) and cassava/maize (Corpoica, Caribbean Region, Colombia) the government sector.
- ii. Assessing farmers knowledge of soil fertility and green manure in an NGO crop improvement programme in the Nepalese Terai (LI-BIRD).
- iii. Assessing farmers knowledge of gap rejuvenation techniques for jungle rubber agroforests in Indonesia (ICRAF).
- iv. Assessing local knowledge of rubber intercropping practices in Sri Lanka (Rubber Research Institute)

Knowledge is collected by the user and input to the system by either a diagrammatic or textual interface. The knowledge is represented using a restricted syntax that enables automated reasoning. Some useful automated reasoning tools are provided together with a task language that allows the user to customise these tools or write new procedures to suit their requirements. Using a rigorous analysis of existing knowledge as a basis of planning research and extension has had profound implications for the type of work that is subsequently done.

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DOMAIN and PFAPro Demonstration

by A. N. Gillison¹

DOMAIN: Potential Mapping Software for Plants and Animals

There are ongoing needs for cost-efficient software to help design natural resource surveys and for the subsequent extrapolation of spatially-referenced data for mapping and other management purposes. One software package that can be used to assist is DOMAIN. This user-friendly, Windows-based software can be used by persons with limited computing experience to usefully explore patterns derived from geo-referenced data sets. Data acquired via the ASB project have been used to generate and test spatial models of key sets of taxa and functional types and to couple these with productivity patterns based on land use. For this purpose a potential mapping software package DOMAIN (Carpenter *et al.* 1993) will be used. Unlike other packages such as BIOCLIM (Busby 1991) or CLIMEX (Sutherst and Maywald 1985) that are either climate-dependent or else require detailed, process-based knowledge about species, DOMAIN uses any georeferenced data that are considered to be important in influencing individual performance. This may include environmental data used to construct a gradsect-based survey (Gillison and Brewer, 1985). DOMAIN accepts known distribution points for specific taxa or functional types and constructs an environmental envelope for these using environmental correlates and a distance measure based on the Gower metric. It then computes a grid-based distribution map of according to the similarity matching of each pixel or grid with the original environmental domain. DOMAIN has been used in previous baseline studies in Sumatra (Gillison *et al.* 1996) and has been modified by CIFOR to run as a user-friendly, Windows based package on a PC. The software is available gratis from the CIFOR home page on the internet (<http://www.cgiar.org/cifor>). Since its installation in August 1997 CIFOR has recorded downloads from users in 43 countries.

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PFAPro: Software for the entry and preliminary analysis of vegetation survey data

A field proforma has been designed for rapid vegetation classification and survey. Because the recording method is generic, the proforma can be used to record and compare vegetation between any one or more locations. The data include **site physical features**: latitude and longitude (deg. min. sec.), elevation (m), slope (%), aspect (deg.), soil depth (cm), litter depth (cm), soil type (USDA), parent rock type, **vegetation type**, **site use history**, **vegetation structure**: Mean canopy height (m), crown cover % woody plants, crown cover % non-woody plants, crown cover % total, cover-abundance of bryophytes, cover abundance of woody plants <2m tall, basal area (m^2ha^{-1}) and furcation index of the nearest 20 trees from the center of a 40x5m plot., **Vascular plant species** and **Plant Functional Types (PFTs)** (Gillison and Carpenter, 1997). A Windows-based, user-friendly software package (PFAPro) has been developed (Gillison and Carpenter, 1999, unpubl.) to facilitate data entry and preliminary analysis. The package allows the user to:

- Enter all site physical, vegetation structural and species data according to a specific format,
- Enter PFT data according to a prescribed rule set.
- Edit and insert data.
- Use automatic, error-checking protocols to ensure correct data entry.
- Automatically construct tables of all data from within each plot (for each 5x5m quadrat along a 40x5m strip transect),
- Summarise and tabulate data for all plots.
- Produce between and within-plot, distance matrices (upper or lower-half or full) for PFTs based on a choice of distancing algorithms (Gillison and Carpenter, 1997).
- Generate and print graphs of specific relationships within and between plots (e.g. total vascular plant species against total unique PFTs); construct species richness-area and PFT richness- area curves for each 40x5m plot.
- Generate Shannon-Wiener and Simpson's diversity indices for PFTs (functional diversity) and functional complexity (Gillison and Carpenter, unpubl.).
- Import and export data in comma delimited and *.pfa format that is compatible with MSAccess.

While the current software is still under test, it is expected that the package will be released gratis on the internet (CIFOR web page) at the same time that a training manual in CD-ROM and hard copy, for vegetation classification and survey will be released by CIFOR (mid-1999).

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ESCAPE and ANDALAS presentation

by Daniel Murdiyarso¹

ESCAPE: greenhouse gas Emission-Sequestration Calculation Procedure

1) *Objective*

This software is designed to assist users in calculating flux of greenhouse gas (GHG) emission and sequestration from samples measured in different type of land use.

2) *Features*

- Quality control data with outlier detection procedure (Grub's Method)
- Database management integrated in a software

3) *Platform/Programming language*

Stand-alone on Windows system, programmed using DELPHI.

4) *Target users*

Researcher involved in measuring GHG Emission/Sequestration, particularly in land-use/cover change. A prototype of this software (programmed in Pascal for Windows), is currently used by ASB Consortium.

5) *Input and Output type*

a) Input

Measurements of GHG (CO₂, CH₄, N₂O) sampled in certain time interval from several different type of land-use (according to ASB Protocol format).

b) Output

Flux of GHG from each land-use type and statistical summary of input data.

ANDALAS: Analyses of Driving factors Affecting LAnd-use change in Sumatera

1) *Objective*

A model to study the process of land use change focusing on biophysical/anthropogenical driving forces (case study on Bungo Tebo Benchmark Site, Jambi, Sumatera).

The current version still assumed people are the main factor of land use change.

2) *Platform*

STELLA Research 5.1.1 update

3) *Target users*

Researcher engaged in land use change issue in Sumatera

4) *Conceptual Framework*

a) Human Population Model

Parameters used to model the population dynamics are age-specific mortality rate, age-specific fertility rate, and net migration flow rate.

b) Forest logging model

c) Land-use change model

5) *Time step* : 1 year

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WaNuLCAS: Water, Nutrient and Light Capture in Agroforestry Systems

By Betha Lusiana and Meine van Noordwijk¹

WaNuLCAS was developed to represent tree-soil-crop interactions in a wide range of agroforestry systems where trees and crops overlap in space and/or time (simultaneous and sequential agroforestry). The model is based on above and below ground architecture of tree and crop, elementary tree and crop physiology and soil science. It can be used for exploring positive and negative interactions for different combinations of trees, crops, soil, climate and management by the farmer.

WaNuLCAS makes use of the STELLA modelling environment and thus allows users to modify parameters between simulations and add model structure and relations of specific interest. It can be used for teaching as well as research.

Users of WaNuLCAS maybe:

1. Agroforestry researchers who are not very familiar with modeling or with quantitative descriptions of resource capture in agroforestry, but who may be tempted to use the model as part of their toolbox, for exploring new variants of agroforestry system before they embark on field experimentation,
2. Modelers who know little about agroforestry but a lot about component processes and who may find in WaNuLCAS a framework for exploring the system context of their favoured aspect of tree-soil-crop interactions.

The model is conceived as four layers of soil exploited by roots of two components (a crop and a tree). A simple vertical water balance is maintained on the basis of precipitation entering the top layer and drainage leaving the bottom layer. Water leaching downwards carries nutrients, based on the current average concentration in soil solution. Each layer of soil has its own potential uptake of water and nutrient; actual uptake is based on a comparison of the summed potential uptake from all layers and the current 'demand' as determined by the plant biomass. Plant growth is limited by light supply as well as the minimum of relative nutrient and relative water uptake. The two plants interact primarily via the belowground resources and also by shading.

References

Van Noordwijk, M. and Lusiana, B., 1999 WaNuLCAS 1.0, a model of water, nutrient and light capture in agroforestry systems. *Agroforestry Systems (in press)*

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CDFU Presentation

by Meine van Noordwijk¹

CDFU: Crop-Down, Fallow-Up

Shifting cultivation or fallow rotations use the fertility stored in the topsoil and aboveground biomass of a natural vegetation for a few years of cropping, before they allow the system to recover. The 'Crop-Down, Fallow-Up' (CDFU) model implements a simple description of these two phases, first proposed by Trenbath (1984). CDFU extends the previous description of a single field to a spatially distributed set (100 fields managed by a single entity) to explore the sustainability of crop production for various combinations of:

- human population density,
- half-recovery time of the fallow (different values for natural fallow, 'improved fallow', cover crop and fertilizer categories),
- use of farmer knowledge in selecting the best fields currently available (yes or no).

A number of secondary parameters is available for modifying results, including variability in initial soil fertility and recovery time, and decision criteria for the rice stock to induce intensification or extensification.

CDFU provides outputs of rice production, food self sufficiency, above and belowground carbon stocks and plant species richness (average per plot and total for the whole landscape), on the basis of input parameters as collected during the Alternatives to Slash and Burn (ASB) project for a number of benchmark sites in the humid tropics.

How to use it?

To run the model you have three options: 1) demo version of Stella (freely accessible on the web: <http://www.hps-inc.com/>), 2) Commercial Run Time (CRT software, as distributed to ANAFE and SEANAFE networks), 3) Stella Research 5.1. These three options will allow you (progressively to): 1) run the model but not save your results, 2) run the model and save results, 3) run and modify the model and save results.

If you open CDFU in Stella or in the Commercial Run Time (CRT) version of it, you will see some explanatory text and a number of buttons that allow you to navigate through the program, to save your (modified) version of the program under a new name and to quit. The main control screen in the model allows you to run the model, set a number of key parameters (by moving sliders) and look at the output via some direct screen output, a stack of graphs and tables. From this screen you can also go to a number of parameter input screens to modify parameter settings before making a new run.

References

- Trenbath BR (1984) Decline of soil fertility and the collapse of shifting cultivation systems under intensification. AC Chadwick and SL Sutton (eds.) Tropical Rain-Forest: the Leeds Symposium, Leeds Philosophical and Literary Society, Leeds. pp 279-292.
- Van Noordwijk, M (1999) Productivity of intensified crop fallow rotations in the Trenbath model. Agroforestry Systems (in press)

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FLORES Demonstration

by John Poulsen¹, Attachai Jintrawet, Pornwilai Saipothong and David Thomas²

FLORES: Forest Land Oriented Resource Envisioning System

What is FLORES?

FLORES is a suite of inter-connected computer models to help researchers, decision-makers and opinion-formers explore diverse options and investigate possible consequences for rural livelihoods, land use patterns and biodiversity conservation. In the short-term, FLORES is intended primarily for researchers to synthesize existing knowledge and to construct formal tests of socio-economic propositions. In the longer term, it should be useful for land use planners and their advisors, and eventually as an educational resource.

Although the concept is well-developed, FLORES presently exists only as a prototype designed and implemented during a workshop at Bukittinggi in January 1999. This prototype requires considerably more work, and the initial version is expected to be available for distribution on CD-ROM in April 1999. The workshop and publication on CD-ROM was made possible with the support of DFID through FRP project R7315/ZF0104. A series of workshops in different regions is envisaged, and will provide a suite of models that can be substituted to customize FLORES to a particular situation and to test alternatives.

Who are the FLORES Society?

At the Bukittinggi workshop during which the first version of FLORES was constructed, the fifty participants voted to form the FLORES Society, a network of scientists committed to further develop and promote FLORES. Participants felt that a loose network, affiliated with several professional and scientific institutions, offered the greatest scope for FLORES to evolve and mature as an open-access platform for scientific research and land use reform. Membership of the Society is free, and is open to all those interested in FLORES and FLORES-related issues. At present (February 1999), 110 individuals participate in the Society. The Society communicates via the internet, listserv (FLORES@cgnet.com) and email.

For more information on FLORES or the FLORES Society, contact

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Or, consult <http://www.cgiar.org/cifor/research/flores>, or read

JK Vanclay (1998) FLORES: for exploring land use options in forested landscapes. *Agroforestry Forum* 9:47-52.

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T-WEST: Terrace Water, Erosion and Sediment Transport

by Albert van Dijk¹ and Sampurno Bruijnzeel²

Description:

T-WEST is a modelling software environment, integrating parts of the existing VAMPS (Vrije Universiteit Amsterdam), GUEST (Griffith University, Brisbane) and TOPOG (CSIRO) models

Purpose:

process-based but user-friendly and flexible prediction of water and sediment dynamics in bench-terraced tropical watersheds for soil conservation and watershed management purposes

Target users:

soil conservationists, watershed managers, hydrologists, agriculturists, river engineers, a.s.o.

Input:

watershed digital elevation model, rainfall intensity data, relations between slope and terrace geometry, data on vegetation, soil and sediment.

Output:

continuous series of all parts of the watershed water and sediment balance

NB: the model software package is expected to become available around 2001

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GIS-Assisted Modeling of Soil Erosion and Runoff in a Watershed

by E P Paningbatan and R L Lanuza¹

A GIS-aided methodology of modeling the spatial and temporal distribution of runoff and soil erosion in a landscape is currently being developed and validated in some sub-catchments of the Manupali watershed in Lantapan, Bukidnon, Philippines. This modeling exercise is envisioned to help study the impact of land use change and cropping systems on soil erosion, water quality and water quantity in a watershed. It is specifically designed to assist identify the erosion "hot spots" in a watershed and evaluate the effectiveness of soil conservation practices.

The inputs to run the model include time series rainfall rates, digital elevation map (DEM), soil map, land use map, cropping system map, and monitoring stations map. Slope map and local drain direction map are generated from the DEM. On the other hand, The outputs include time series maps of runoff, sediment concentration and soil erosion. Also, the water discharge, sediment concentration and amount of soil loss at the outlet monitoring stations are also predicted.

GIS-based PCRASTER that run on ordinary desktop computers which has the capability of supporting dynamic modeling is used in the simulation.

Runoff (R) in each raster cell is calculated from the difference of rainfall (P) and infiltration (I). Infiltration rate is generated as a function of soil, cropping system and land use. Surface water is routed to neighboring cells using a Local Drain Direction (LDD), a built-in subroutine of the GIS software. Water flow velocity is estimated using the Mannings equations.

Sediment concentration (C) is calculated using the simplified Rose equation;

$$C = 2700 S (1 - C_o)$$

Where: C = efficiency of sediment entrainment

S = sine of slope angle

C_o = fraction of surface area that is not exposed to erosion.

To measure discharge rates in the field, water height recorders and flow meters with data logger attachment are installed at the monitoring stations strategically located in the watershed. Rainfall rate and duration are measured using tipping bucket type pluviometer with data logging device. Likewise, sediment concentration of runoff is also measured at the monitoring stations.

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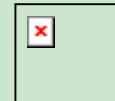
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**Sustainable Agriculture and Natural Resource
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**Southeast Asian Ministers of Education
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