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PLEC NEWS AND VIEWS

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A Newsletter of the United Nations University Project of Collaborative Research on Population, Land Management and Environmental Change (PLEC

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Produced in the Department of Anthropology, Division of Society and Environment, Research School of Pacific and Asian Studies, The Australian National University for the United Nations University

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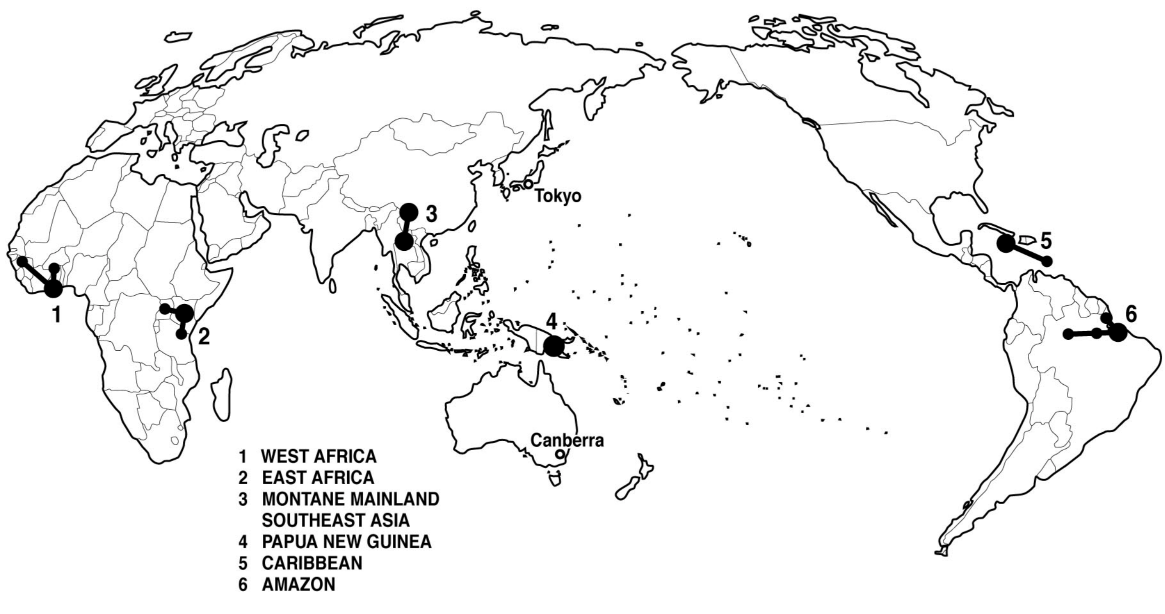

The Clusters of PLEC

P L E C   N E W S   A N D   V I E W S   **No. 4, March 1995**

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ABOUT THIS ISSUE

This fourth issue of *PLEC News and Views* has been delayed more than two months by preparation of a full draft GEF Project Document for submission to UNEP. This document, preparation of which has been supported by funds provided from UNDP through UNEP, has occupied most available time since October 1994, and all time in January and February 1995. After report on this and other news, and news from two Clusters, this issue consists mainly of two articles written by members of the project. Both focus on the study of biodiversity in an agrodiversity context. The first and longer of these, by Daniel Zarin of the Amazonia Cluster, is on methods for the measurement of diversity, and is presented as a guide for Clusters in this area of work. The second is by a student member of the Montane Mainland Southeast Asia Cluster. It presents some important considerations that should be taken into account in viewing a form of agroforestry that is not unique to Southeast Asia, and also introduces the height-interval aspect of diversity sampling. Other matter, including a further piece on 'Selected References', is held over to the following issue.

As PLEC moves increasingly into its research phase, *PLEC News and Views* will carry more articles on methodology, and on encouraging (or cautionary) findings. *PLEC News and Views* No.3 carried a methodological paper by Michael Stocking, and the next issue (No.5) will hopefully have articles on the classification and mapping of agricultural systems, presenting the method developed and used by the Papua New Guinea Cluster, and on the transect method employed by the West Africa Cluster in their pilot surveys.

There is one change in style in this issue, which will be permanent. The Department of Anthropology, where *PLEC News and Views* is produced, also produces a regular refereed journal, *Canberra Anthropology*. After some inconsistencies in our earlier issues it seems best to adopt the clear referencing style of *Canberra Anthropology*, modified slightly to suit double column-format. While there are comparatively few references in this issue, all have been put into this style, which will from now on become the style employed in this Newsletter.

THE DRAFT GEF PROJECT DOCUMENT

As reported in *PLEC News and Views* No.3, the July 1994 meeting of the GEF Council endorsed a proposal by UNEP that PLEC be given feasibility study funding, of $100,000, for the preparation of a full draft GEF Project Document. It was decided by UNEP that the contract to prepare this Document should be made with the Australian National University rather than with the United Nations University. After a preliminary presentation was prepared and approved by UNDP and in ANU, the contract was signed at the end of September. Meantime, arrangements had been made for a series of Cluster meetings, each assisted by a Coordinator or Scientific Advisor, in order to design **Cluster Annexes** to the main Document. Small contracts were made with Clusters, through UNU for speed but funded from the ANU contract, to facilitate these meetings.

The first meeting, in **West Africa**, was appended to the already-arranged Regional Meeting at Legon, from 25 to 27 October, described below. This was attended by both Uitto and Brookfield. Brookfield then went on to Nairobi, where he was joined by Padoch and Stocking for discussions in UNEP, and for the **East Africa Cluster** meeting which Stocking principally assisted. Participants from Uganda and Tanzania were present together with their Kenyan colleagues. The meeting included an excellent field excursion to Cluster research sites in Kiambu, Laikipia and Embu districts. After this, Brookfield joined a meeting of the **Montane Mainland Southeast Asia Cluster** in Chiang Mai, Thailand. Comprehensive draft documentation came from the week-long East African and Southeast Asian meetings, but the short and hastily arranged West African meeting produced only preliminary papers. Once documentation was complete in early January, therefore, Gyasi took it to Norwich, U.K., for detailed discussion with Stocking.

The newly formed **Caribbean Cluster** was unable to come together until November, when its meeting was attended by Momsen both as Scientific Advisor and as participant. In **Amazonia**, the PLEC Cluster meeting was appended to a conference on Diversity, Development and Conservation of the Amazonian Floodplain, at Macapá from 12 to 15 December, attended by Padoch and most Cluster members. With good time for advance preparation, a lot was achieved and a complete document was brought to Japan. For **Papua New Guinea**, an intended Cluster meeting in November-December had to be deferred because of other commitments, and was finally held in the University of Tokyo on 14-18 January. Brookfield attended this meeting of the Papua New Guinean, Australian and Japanese joint leaders. This was immediately before an intended meeting of SAG and some other PLEC members that was to have followed a UNU Global Environmental Forum, in Osaka on 19 January.

The Kobe earthquake early on 17 January also affected Osaka, and later that same day it was decided in UNU to postpone the **Global Environmental Forum**, abruptly halting the travel of all who were to have come except such as were already in Japan or en route. In these circumstances a reduced meeting, of Uitto, Brookfield, Padoch and Stocking only, was held in Tokyo, mainly in UNU, between 19 and 24 January. This meeting reviewed all the available material, which included a draft of the main Project Document as well as all the Annexes and their budgets. A large number of substantive as well as editorial changes were drafted or proposed. These were taken back to Canberra by Brookfield, and over the four subsequent weeks the **final draft Project Document** was prepared, involving further exchanges with most Cluster leaders. The whole documentation left Canberra for UNEP and UNU on 23 February. Copies of the draft, as supplied to UNEP, have since been sent to all Cluster leaders and joint leaders, and to all SAG members.

What has gone to Nairobi is this final draft, which now has to be reviewed in UNEP, and amended there. Brookfield is visiting Nairobi to participate in discussions from 19 to 28 March, while this issue of *PLEC News and Views* is being produced and printed. **A report on the Nairobi meetings will come to all Cluster Leaders in April, and a summary will appear in the next issue of *PLEC News and Views*.** What then happens to PLEC's proposals is in UNEP's hands, but we hope they will be submitted to the Scientific and Technical Advisory Panel of the GEF (STAP), and to the GEF Council, within the coming few months. Whatever the outcome, however, the project now has a full and comprehensive statement of its plans, intended methods, and proposed outputs, both generally and for each Cluster. This will be valuable for a range of purposes, including the search for co-funding, and as a guide to the developmental work already commenced in several Cluster areas. Not least importantly, even though some recent Cluster enlargements still have to be developed in terms of work plans, production of the draft GEF document brings the planning phase of PLEC to an end.

THE UNFPA FUNDS

In 1993, PLEC submitted a proposal for funding to the United Nations Population Fund (UNFPA). After hearing nothing for a long time, we received notification in September 1994 that $240,000 was allocated to PLEC for research support in 1994 and 1995, in two tranches of $120,000 in each year. It was quickly decided to use these funds to offer new research-support contracts to Clusters on expiry of their 1993 contracts, and on this occasion to allocate $240,000 equally between the six Clusters. Because it was necessary to commit the 1994 tranche within 1994, the four Clusters most advanced in their use of the 1993 funds were each offered $40,000 contracts before the end of 1994. These were West Africa, East Africa, Montane Mainland Southeast Asia and Amazonia. Similar contracts are being issued to the Papua New Guinea and Caribbean Clusters early in 1995. Contracts have been prepared against short proposals in which the population aspect of work is stressed, as a part of the first-year research proposals prepared for the GEF submission.

There is no prospect of an extension of these UNFPA funds into 1996, though we may well make a new submission. Although long-term research is planned through 1996 and 1997, therefore, the end-of-year reports on the 1995 contracts have to be fairly substantive in nature, with stress on the role of population parameters. It is intended to edit these Cluster reports to make a presentation of PLEC progress, for UNFPA in particular, and this must be done as early in 1996 as is possible. The form of this report is not yet determined. It could be a small UNU publication, and another possibility is a special issue of *PLEC News and Views*.

CHANGES IN PROJECT MANAGEMENT

As PLEC has grown larger, it has become less and less possible to manage its affairs in the informal manner used in the preliminary phase. Communication across many time zones became a particularly acute problem. The Tokyo Co-Coordinator and Administrator became more heavily committed to a whole range of project and other work in UNU, and were less able to respond readily to requests. In Canberra, even all correspondence came to a halt whenever the Scientific Co-Coordinator was away, the project files fell into disarray, and Brookfield's other work suffered increasingly. It became apparent that too much depended on one person, and that this could not continue.

In October 1994 it was decided to appoint two members of SAG as 'principal'

Scientific Advisors, with specific responsibility to advise, represent and back-stop the Scientific Co-Coordinator. Padoch and Stocking agreed to accept this responsibility, which has now become formal. Although there will be no strict geographical division of responsibility, and should not be, logistics determine that Padoch and Stocking will be concerned particularly with the western hemisphere and Africa. There will, however, be substantial overlap, already envisaged in plans for 1995.

At the same time it was also decided to enlarge the basic SAG. Professor Janet Momsen has been joined as Scientific Advisor by two others. **Dr E. Adilson Serrão, of EMBRAPA, Belém, first leader of the Amazonia Cluster, is now an Advisor on tropical agriculture, and Dr Bede Okigbo, Director of UNU/INRA at Legon, Ghana, is Advisor on biodiversity and ethnobotany**. At the time of writing, negotiations to appoint a fourth Advisor, in tropical plant ecology, were still in progress.

In the course of preparing the draft GEF Project Document, some decisions have also been taken about the management group of the project. This is now envisaged as comprising the Co-Coordinators, the principal Scientific Advisors, the leaders of each Cluster, and other members of SAG. It will rarely be possible to assemble this whole group at one time. In the GEF draft proposal, we have budgeted for annual meetings that will bring most of them together, coinciding with general project meetings when these take place. The continuous participation of Cluster leaders in project management is particularly important and we intend to find means of making this real through both consultation and meetings. We had, for example, expected to have three joint Cluster leaders from the Asia-Pacific region present in Osaka, and when the UNU Global Environmental Forum is reconvened there on 25 May, this will then happen.

A small problem arises in the two remaining Clusters where there are equal joint leaders of Subclusters. These people will need to agree among themselves who, in any given year, will represent their Clusters, be primarily responsible for Cluster reports and arrangements and, from the end of 1995 onward, receive and be invited to comment on the reports of others. While it may not be feasible to centralize financial management, we want to consider this simplifying possibility. Responsibilities may be shared, alternate or rotate, but in each year there must be one person to whom others can refer. The two Clusters now concerned, Montane Mainland Southeast Asia and Papua New Guinea, will shortly be approached for help on this question.

One significant by-product of the special funding received for GEF Project Document preparation was the creation of a small project office in Canberra, with **Ms Margaret Forster** as Secretary (Administrator in ANU parlance), for three days in each week, an innovation of enormous help to the Scientific Co-Coordinator. Her employment, on secondment from a post in another part of ANU, will continue to the end of 1995 but funding is not presently available beyond that time. She shares her office with Ms Helen Parsons, part-time Research Assistant paid from an Australian Research Council grant to Brookfield, and with Ms Muriel Brookfield who is a consultant paid from the same source. While the two latter are engaged primarily on work that is tangential to PLEC, the three joined together to make an impossible job possible, in getting the draft Project Document together between late-January and late-February 1995.

INTER-CLUSTER VISITS

Using the basic UNU-provided budget, in part released this year by the UNFPA funding, we also propose to begin an important PLEC networking activity in 1995. We discussed inter-Cluster visits at Chiang Mai, and they are an important element in our GEF proposal as a major supplement to meetings, and to visits by Scientific Advisors and Coordinators. Mainly, these will be South-South visits although 'northern' project members are not excluded. In 1995 and, if we are funded, in 1996 as well, most inter-Cluster visits will have the specific purpose of exchanging methodologies between Clusters. One of the riches of PLEC is the range of methodological experience that is brought together in the project, and one of our main objectives is to use this range and build on it. The visits should rarely be less than about one week in duration, and can be up to three times this length. Most visitors will go into the field. In order to spread the funds, local rather than UN per diem rates will apply, and it will be easier to arrange visits if participants are willing to find and use cheap fares. There will be some payment toward hosting costs for the Clusters receiving visitors.

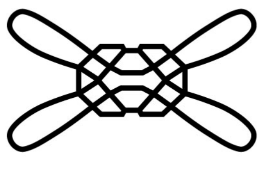
We will start this programme in two ways. Opportunistically, we will take advantage of separately-funded travel by Cluster members to, or close to, the areas of other Clusters, and see if it is possible to 'tag-on' an inexpensive inter-Cluster visit to such travel. We plan to do the same with SAG meetings and visits to Clusters. More purposively, however, we will be corresponding with Clusters and with individuals, to try to arrange visits that will have specific purpose in exchanging methodological experience. By the time the next issue of *PLEC News and Views* appears, we will have something to report.

THE SPECIAL ISSUE OF *GLOBAL ENVIRONMENTAL CHANGE*

Apologies are due to everyone, as well as to the journal editors, for the delay in getting the papers for this issue to the journal. The apologies need not be too defensive. For most of the time since December all resources have had to go into preparation of the draft GEF Project Document. By chance, Brookfield met the journal editor at Nairobi airport in November and used the opportunity to broach the likelihood of a delay, a likelihood which quickly became a certainty. There has been some benefit, because several papers needed major revision in the light of referees' comments, and some also after editorial work. At the time this is written all final revisions are in hand, and progress toward completion of the editorial task is well advanced. However, given the time required at the journal office in England, as well as by the Guest Editor and his assistants, the special issue cannot now appear until much later in 1995 than was envisaged.

A NUPTIAL ANNOUNCEMENT

All project members, and certainly all those who know our Co-Coordinator, Juha Ilari Uitto, will be pleased to learn that he is getting married with traditional Japanese rites, on 22 April in the small town of Mizusawa, in Iwate Prefecture, northern Honshu. Everyone will want to congratulate him on his good fortune, especially the few of us who have met his fiancée, Yoko Takahashi. For most of us, the one downside is that we can expect to hear little from him between Easter and early May.



REPORTS ABOUT GENERAL AND CLUSTER ACTIVITIES

PLEC AMAZONIA: A MISSION REPORT

Juha I. Uitto
The United Nations University

In February 1995, I undertook a two-week mission to Brazil to visit the PLEC Amazonia Cluster and a number of related institutions. Among the main reasons that prompted the mission were the recent developments within the Cluster and its management.

The new management structure

The management structure of the Cluster has hitherto been somewhat complicated due to the several institutions, including the Nucleo de Altos Estudos Amazônicos (NAEA) of the Federal University of Pará (UFPa), Museu Paraense Emilio Goeldi, the Agroforestry Research Centre for the Eastern Amazon (CPATU) of the Brazilian Agricultural Research Corporation (EMBRAPA) and the New York Botanical Garden, which are involved through pre-existing projects. In recent shifts, it was agreed to move the coordination of the programme to UFPa where most of the large scale *várzea* (floodplain) projects are based. This change was accompanied by the transfer of **Cluster leadership** from Dr. E. Adilson Serrão, Director of Research and Development at EMBRAPA/CPATU, to **Dra. Deborah Lima Ayres** of the Department of Anthropology at UFPa. The deputy Cluster leader continues to be Prof. David G. McGrath of NAEA.

Dr. Serrão will remain as a Scientific Advisor to the entire PLEC programme. EMBRAPA/CPATU will also have an important role in the programme viz. agricultural and agroforestry development. Warm thanks are offered to Adilson Serrão for his efforts on behalf of PLEC in forming the Cluster, arranging its first meeting in 1993, and leading it through the first two years

What is very encouraging is the observed commitment, even enthusiasm, towards PLEC. It is felt that PLEC can play an important role in Amazônia by providing a framework for bringing together the scattered *várzea* projects and putting them into a broader regional perspective. Furthermore, a strongly perceived advantage of PLEC is the international collaboration it allows. PLEC gives the opportunity for unforeseen South-South cooperation through the inter-Cluster meetings, exchange of information, technology and research results, visits to other Clusters, and possible exchange of researchers and students.

Field visit to Projeto Várzea

A field visit was made to one of the main participating field projects, Projeto Várzea in Santarém, Pará, with the project coordinator Prof. McGrath (for other PLEC-related work on the *várzea*, see Hiraoka 1993; Serrão 1994). The project is concerned with sustainable community-based management of *várzea* resources on Ituquí island. It is implemented in close collaboration with the fishermen's union, Colônia dos Pescadores Z-20 (McGrath 1994).

Projeto Várzea was commenced in 1994. During the first months, a spacious and well-equipped office has been set up in Santarém under the supervision of the Project Administrator, José Maria Brito Moreira de Azevedo. The project has major external funding, but PLEC is seen as an important complementary activity that enables the interaction between the various *várzea* projects in the Amazon region, as well as internationally between regions of the humid tropics.

Ituquí is a large *várzea* island located some 60km down the river from Santarém on the Amazon river separated from the mainland by the Paraná do Ituquí canal. The landscape is characterized by the natural levees, or *restingas*, on which the settlements are concentrated, the *paranás* and the shallow *várzea* lakes on the inside of the islands. During the dry summer season from July to November the *restingas* are high above the river level and the size of the lakes is reduced. With the winter rains, the water level rises significantly and only the trees and houses built on stilts on the *restingas* stick out from the water.

Ituquí island contains a number of small *ribeirinho* communities of which São Benedito, which we visited, is one. These communities, and the *várzea* environment, are increasingly under pressure for three main reasons: the collapse of commercial agriculture in the region (jute having been the main cash crop), the expansion of cattle ranching, and the increase in commercial fisheries (McGrath *et al*. 1993). Conflicts are escalating between the local fishermen, who depend on the *várzea* lakes for their livelihood, and commercial fishermen based in the urban centres.

Projeto Várzea is concerned with sustainable management of the *várzea* resources, on the one hand, and the strengthening of the fishermen's union in Ituquí, on the other. At São Benedito, the team, including McGrath and the fisheries biologist Marcelo Martinelli, explained the project objectives to the members of the local fishermen's union and called for their cooperation. The participatory nature of the project was emphasized. The project does not promise to bring solutions to the problems of the community; these will have to be worked out in a cooperative manner. Following the meeting, we proceeded through the canal to the *várzea* lake with its remarkable vegetation and bird life.

Related activities

Discussions were held at NAEA with a view to establishing cooperation in higher education. NAEA has recently announced a doctoral programme on Sustainable Development of the Humid Tropics, which will be international in scope. Established 21 years ago, NAEA is one of the first inter-disciplinary institutions focusing on research and post-graduate education in Latin America. It is concerned with socio-economic development in the Amazon region (not only Brazil, but also the seven other countries sharing Amazonia). NAEA's students come from as varying backgrounds, including sociology, geography, agriculture, forestry, geology, engineering and medicine. Another partner in these ventures is the Association of Amazonian Universities (UNAMAZ), with whom UFPa, as well as UNU, already cooperates.

I also visited INPE, the Brazilian Space Agency, in São José dos Campos in the southern part of the country where I gave a lecture on PLEC to the faculty and graduate students of the Remote Sensing Division. Considerable interest was expressed in the work of the programme. INPE also has a research programme focusing on population and environmental monitoring of the Amazonian floodplains, led by Dra. Evlyn Márcia Leão de Moraes Novo.

Since 1985, INPE organizes an annual International Training Course on Remote Sensing, which UNU has been supporting for the past six years with computer equipment and through fellowships to trainees from other Latin American (and some African) countries. It is felt that cooperation with INPE could strengthen the remote sensing/GIS capacities within the various PLEC Clusters.

What PLEC is about is communication and collaboration. In a large country, such as Brazil, these are very important. It is hoped that the programme can successfully promote networking both within the region, as well as internationally.

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WEST AFRICAN REGIONAL WORKSHOP

From 25 to 27 October 1994, a West African Regional Workshop was held in Legon, Ghana, to make public the findings of the Cluster's pilot project, identify strategies for extending Cluster work into other areas and, not least, enhance cooperation between PLEC and UNU's Institute for Natural Resources in Africa (INRA), in the West African context. INRA had only recently moved to permanent quarters in Legon, from temporary quarters in Nairobi. The meeting, which was funded by UNU separately from PLEC (and was also supported by the Third World Academy of Sciences), had the partial purpose of increasing the visible presence of this Institute in Ghana and elsewhere in West Africa. Two days of paper presentations and discussion were separated by a field excursion. Over 80 people attended the meeting, including government ministers, representatives of various Ghanaian government and non-government organizations, visitors from other parts of West Africa and abroad, and six farmers from the PLEC study sites. From the comments of official representatives, and the farmers, on the third day of the meeting, it was evident that the research report of the Cluster was widely appreciated, and that the Cluster is seen to be making an important contribution.

The second day of the meeting was an excursion which, like so many, had to be abbreviated as night fell well before the itinerary was complete. Thirtyfive participants visited the principal field areas studied in 1993, and an additional village where a piece of forest is preserved and with it a small area of the old system of farming mixed crops in partial shade. At this village (Gyamfiase, in the Yensiso area), the chief and people welcomed the visiting party in a colourful 'durbar' marked by traditional drumming and dancing, together with prestations.

The meeting had a number of visitors from outside Ghana, although only a minority of those invited from regional countries were able to attend. One significant visitor from further afield was Dr R.M. Kiome from Kenya, leader of the East Africa Cluster. Jan Nibbering, coordinator of the Université de Ouagoudougou / Universiteit Wageningen Antenne Sahélienne Savanna Research Project in Burkina Faso, subsequently wrote an informative report and review about the meeting. James Fairhead (School of Oriental and African Studies) and Melissa Leach (Institute of Development Studies), from England, gave valuable advice to the Cluster on contacts in Guinea and on other matters. Together with Uitto, Okigbo (Director of UNU/INRA) and Brookfield, all three participated in the smaller meetings which followed the end of the Workshop, to discuss future directions and set up a design for wider regional research. One major recommendation was for close collaboration between PLEC and UNU/INRA in areas of ethnobotany, home gardens, indigenous African food and useful plants, and environmental policy and management research. Postgraduate training and research capacity building will also be important areas for collaboration.

Most of the papers were made available in mimeographed form, and it is intended to investigate means through which at least a selection can be published, with the assistance of UNU. A Report on the meeting is available from **Prof. E.A. Gyasi, Department of Geography and Resource Development, University of Ghana, P.O. Box 59, Legon, Ghana.**

Enlargement of the West Africa Cluster

Following the Workshop described above, and in time for preparation of the Cluster input to the draft project document, the West African Cluster has formed three small sub-groups outside the core in the University of Ghana at Legon. Two are in Ghana, based at the University of Science and Technology, Kumasi, and at the University of Development Studies, Tamale. The third, a link with francophone West Africa, is based at the Université de Conakry in Guinea. A meeting was held at Kumasi in February, and another meeting is planned for about May. A fuller report will appear in the next issue of *PLEC News and Views*.

E.A. Gyasi, and the editor

REPORT FROM MONTANE MAINLAND SOUTHEAST ASIA

In the four months from November 1994 to February 1995, the MMSEA Cluster has made a number of moves toward consolidation of its network, and the start of field research activities. Both Subclusters have taken steps to link their research activities with other regional initiatives and programmes. The Thailand Subcluster is now part of the 'Chiang Mai University Consortium', a network of CMU groups involved in regional mountain resource management and development. The Yunnan Subcluster has formed links with the Xishuangbanna Tropical Botanical Garden, the Yunnan Academy of Forestry, the Yunnan Institute of Geography, the Yunnan Academy of Social Sciences, the Chinese Academy of Sciences/Kunming, and Baoshan Nature Reserve.

The Cluster meeting on 14-19 November was attended by three members of the Yunnan Subcluster (one from the Yunnan Institute of Geography, currently an MSc student at Chiang Mai University), one from Agricultural University Number 3 of Vietnam (Bacthai), and seven from Thailand, as well as by the Scientific Co-Coordinator of PLEC, Harold Brookfield. Subsequently, on 1-2 December, as part of methodology development and public consultation, a dialogue on highland resource management and conservation was conducted with villagers of Tissa (one of the villages selected for in-depth research), in collaboration with CARE International.

Laxmi Worachai visited groups in Vietnam on 17-24 December. She discussed the possibility of forming a Subcluster in Vietnam with the Centre for Natural Resources Management and Environmental Studies (CRES) in Hanoi, and Agricultural University Number 3 (Bacthai). Presently, two Vietnamese MSc students at CMU are conducting research in the mountainous northern region of Vietnam, and a third student, from Bacthai, has recently been admitted to the programme. Two Vietnamese participants were identified to join a planned Cluster Field Research Workshop, a first major research and training activity of the Cluster as a whole.

This Workshop, termed **Field Workshop on Field Research Methodology: Testing and Verification of Rapid Appraisals**, will be held from **30 May to 4 June 1995** in Chiang Mai and at a Hmong village designated as a Cluster research site, Pah Poo Chom. Participants will then move to Xishuangbanna in Yunnan, working in and around two selected study villages, a Jinuo community, Baka, and a Dai village, Mansuoxin, from 5 to 13 June.[1]

1 More information on Baka will be found in the

Methodologies will be examined and tested in the field, and at the present stage of planning will include Agroecosystem Analysis (AEA), Participatory Rapid Appraisal (PRA), Rapid Biodiversity Assessment (RBA), and methodology for determining quickly the extent of soil erosion. Participants in Thailand will include two from Vietnam, five from China and ten from Thailand. In Xishuangbanna there will be two from Vietnam, four from Thailand and twelve from China, representing all groups involved in the Subcluster. In addition, Geoff Humphreys from Macquarie University, Australia, will participate to advise on the study of soils, soil degradation and soil erosion.

Kanok Rerkasem, leader of the Thailand Subcluster, has recently introduced the PLEC concept of agrodiversity in reviewing some preliminary results of Cluster research at two international meetings. At the Regional Conference on Sustainable Development of Fragile Mountain Areas of Asia, organized by ICIMOD in Kathmandu, Nepal (December 12-16 1994) he presented a paper entitled 'Management of shifting cultivation in montane mainland Southeast Asia: an era of change'. At the Regional Dialogue on Biodiversity and Natural Resources Management in Mainland Southeast Asian Economies, in Kunming, China, on February 21-24 1995, he gave an opening lecture on 'Agrodiversity and natural resource conservation in northern Thailand'. The latter meeting was organized by the Thailand Development Research Institute, the Kunming Institute of Botany, and the Chinese Academy of Sciences/Kunming.

A further major initiative of the Cluster and its cooperating organizations at Chiang Mai University, for later in 1995, will be described in the next issue of *PLEC News and Views*

Kanok Rerkasem

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paper by Guan Yuqin, Dao Zhiling and Cui Jingyun, which appears in this issue at p.22.

UNU BOOK NEWS

New or forthcoming books from the United Nations University.

Agroforestry in the Pacific Islands: Systems for Sustainability
William C. Clarke and Randolph R. Thaman (eds)

Based on extensive field observations and a wide range of published sources, this is a study of agroforestry systems and their hundreds of component trees in Polynesia, Micronesia and Melanesia. It shows how these systems have contributed to environmental stability and have been widely utilized by Pacific Island societies since earliest times. The book argues for the wisdom of protecting and using the existing systems and trees in current forestry, agricultural and agroforestry development projects.

W.C. Clarke is an independent consultant and editor and former Professor of Geography at the University of the South Pacific. R.R. Thaman is Professor of Pacific Islands Biogeography at the University of the South Pacific, Fiji.

Sustainable Management of Soil Resources in the Humid Tropics
Rattan Lal

This book focuses on conversion of humid tropical forest to agricultural land use, and soil and crop management systems that allow for the sustained use of soil and water resources.

Rattan Lal is Professor of Soil Science in the School of Natural Resources at the Ohio State University, Columbus, Ohio.

The Fragile Tropics of Latin America: Sustainable Management of Changing Environments
Toshie Nishizawa and Juha I. Uitto (eds)

The dilemma confronting Latin American countries aiming at utilizing their tropical resources to improve local living standards is set against a growing concern about the ecological fragility of the Tropics. There is urgent need for sustainable alternatives to prevailing models of economic development.

Toshie Nishizawa is Professor of Geography and Library Director at the Tokyo Seitoku University. Juha Uitto is Academic Officer and PLEC Co-Coordinator at the United Nations University.

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PAPERS BY PROJECT MEMBERS

DIVERSITY MEASUREMENT METHODS FOR THE PLEC CLUSTERS

Daniel J. Zarin
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[EDITOR'S NOTE] This paper was commissioned by PLEC to accompany the GEF Project Document, where it appears as Annex VII. It was intended that a shorter version be printed here, but abbreviation of an already taut document seemed to generate more loss than gain so the full version is printed. All Clusters are asked to consider this methodology carefully, and try to use it as a standard cross-Cluster means (adapted according to local conditions) for the measurement of diversity. Dr Zarin will be glad to respond to questions.]

INTRODUCTION

Biodiversity has come to mean many different things to many different people. At present, the principal focus is on taxonomic diversity, most often at the species level, although recent inquiries have suggested that higher order diversity (genera, family) is perhaps more significant in evolutionary terms. Diversity of horticultural and agricultural varieties is also of obvious significance in many agroecosystems. Wayne and Bazzaz (1991), among others, have suggested that non-taxonomic characteristics are more appropriate measures of ecological diversity, which they define as 'a measure of the degree of biotic and/or abiotic dissimilitude within a community that is perceivable and utilizable by organisms'. Barkman (1988) has developed a plant classification system based on growth form, while Grime et al. (1988) utilized a functional classification system based on plant responses to various environmental stresses. Here, we adopt a practical, empirical approach, bearing in mind the caveat of Hurlburt (1971):

> Communities having different species compositions are not intrinsically arrangeable in linear order on a diversity scale. Diversity per se does not exist. There are many statistical properties relating to species composition and species-numbers relations and each one may give different ordering of the communities.

For the purposes of the current proposal, diversity studies will focus on three issues:

- agrodiversity, defined by Brookfield and Padoch (1994) to mean the variety of recognizably distinct resource management types;
- vascular plant species density and distribution;

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- landscape complexity (also known as ‘pattern diversity’, ‘mosaic diversity’), defined by Scheiner (1992) as ‘a function of the variation in species richness among communities and the variation in commonness or rarity among species (evenness)’.

A growing body of work indicates that indigenous agricultural practices have been and continue to be important elements in the maintenance of local and regional biodiversity (McNeely 1994). Bush and Colinvaux (1994) report that the modern species richness of the celebrated Darien region of Panama was maintained throughout 4000 years of indigenous agriculture. Atran (1993) argues that agroforestry cultivation practices among the Itza of Peten, Guatemala, which are tied to preconquest Lowland Maya systems, continually regenerate the native biodiversity of regional forests. Altieri (1993) suggests that the maintenance of biodiversity in traditional farming systems is a rich resource for integrated pest management research.

PLEC presents an opportunity to explore further the relationship between traditional agricultural systems and biodiversity in a comparative and inter-disciplinary context. The approach outlined below will produce rigorously collected and analysed data on agrodiversity, vascular plant species density and landscape complexity in the range of agricultural systems represented by the PLEC Clusters. Data will be archived and accessible for additional studies and analyses. Although the emphasis will be on vascular plants for the purposes of this proposal, sample plots will be permanently marked in order to facilitate future complementary studies of other taxa (e.g. arthropods, soil microbes, etc.) and for follow-up studies.

SCALING UP AND DOWN

By a combination of design, logistical necessity and tradition, diversity studies have often centred on the task of inventorizing indicator taxa within a plot that has not been selected randomly. If this plot itself is the unit of greatest interest, this does not create problems. Where the area of interest is larger, however, it is important that the investigator should integrate plot-level studies with information which will allow explicit extrapolation of the raw data to the scale(s) of greatest interest. The systematic approach outlined below calls for several scales of analysis. These are in order:

1) regional;
2) site;
3) intensive study area;
4) air-photograph-interpretation (API) - or remote-sensing-imagery-defined ecological landscape unit;
5) investigator- or population-defined resource management type.

All of these should be mapped, at least in a preliminary fashion, before the initiation of intensive field sampling. That exercise will allow an initial assessment of resource management type diversity, and will determine the placement of sampling plots for species density and landscape complexity studies.

Even if some PLEC study areas were selected opportunistically, any assessment of biodiversity must be able to relate the results of on-site investigations to broader spatial scales. Experience has shown that such an exercise is a highly worthwhile endeavour even when undertaken after sites have been selected, because it allows scaling up of research results and can provide information about related sites which may be otherwise inaccessible.

Efforts at scaling up must recognize and attempt to assess the limitations imposed by the scale of variation, germane to the study sites and within the region. In some areas fine-grain variation in resource management systems may be the most interesting determinant of on-site differences in species composition. Where such variation is present at very small spatial intervals, interpretation of remotely-sensed imagery is unlikely to provide a sufficiently informative representation of the true situation on the ground. The simple fact that an enormous amount of variation in resource management systems (agrodiversity) may be unaccounted for even by API is itself interesting, and overlaying resource management maps of the intensive study areas with the remote-sensing-defined landscape designations will permit some quantification of that loss of information.

The approach outlined below emphasizes quantitative estimation of several measures of diversity on a per unit area basis. This approach is a response to questions which are spatially bound. How large an area is represented by site *a* in Cluster tract *b*? How many different resource management types are contained within landscape *x*? How many species are contained within a hectare of resource management type *y*? How much between and within resource management type variation in species is present within the *z* number of resource management types present in landscape *x*?

Additional techniques which emphasize the population unit (e.g. individual, family, village) as the basis of measurement may also be appropriate for pursuing related questions. The knowledge of biota among rural people is usually profound and comprehensive, and can be used as a major source of information.[1]

[1] As in other areas of PLEC research, the active involvement of local people should be encouraged. The ecological knowledge base of rural inhabitants forms part of their cultural heritage. As such, investigators have an obligation to inform local participants about the purposes of the research and the products which may have an impact upon them. Local participants should be encouraged to suggest additional products which may be of use to them and their communities. To the extent feasible, investigators should follow up on those suggestions, even when such products lie outside of the main line of inquiry.

A practical, empirical approach

I. Location of Cluster sites using available interpretive geographical information systems (GIS) maps, especially biome or plant-community classification schemes.

The principal question to be addressed here is: What does the study area represent?

This is a fundamental question which must be addressed if the data collected and analysed are to have any meaning outside of the context of the specific study sites. Even if detailed site selection has already taken place, it is essential to place the sites in regional context, and thus to proceed 'as though' the sites remained unselected. The level of available relevant documentation, whether or not in GIS, will certainly vary from Cluster to Cluster. Every Cluster, however, will be able to ascertain, at a minimum, a designation of biome type and climatic zone, and an estimation of how much area, regionally, is included under those designations. Data from the most recent human population census can be cross-referenced with the regional biome and climate maps, and a few selected areas of similar human population density can be visited in order to gain an overall sense of how applicable data from the study area may be to supposedly similar sites. An assessment of how much area (km^2), and how large a human population, is reasonably well-represented by the sample selected as a study area can be qualitatively estimated even with these most basic reference points. Where available, better data such as plant-community classifications, will likely produce better estimates.

PRODUCT:
a regional map which identifies the areal extent of the type of environment which the study site is thought to represent. This should be presented with a description of the information used to delineate the area.

II. Timely interpretation of the most recently available remotely-sensed imagery, or recent aerial photographs, of the Cluster research sites, including all field areas where diversity assessment is required, followed immediately by on-the-ground mapping of intensive study areas.

The principal questions to be addressed here are: What are the remote-sensing-defined operationally distinct landscape units of the area under study? What are the investigator- or population- defined distinctive resource management types?

Interpretation of current remotely-sensed images or aerial photos is essential to our ability to discuss quantitatively the diversity of environments present at each study area, and the amount of land occupied by each. Detail can be adequately mapped up to a scale of at least 1:50,000 from remotely-sensed images, and up to larger scales using aerial photographs. It is, however, important that the images or photographs used be very recent. This task can form the backbone of much subsequent on-site work. Photos taken and interpreted currently, or images interpreted in a timely fashion, will provide an exceptional baseline for quantitative monitoring of successional patterns of land use and ecosystem recovery, based on comparisons with images and photos taken in the future. Comparisons with past images and, over a longer time period, aerial photographs, can also provide invaluable insight into environmental change at the study areas.

Individual landscape unit types must be clearly distinctive from one another on the ground and on the images. In general, it is more important that the interpretation be exceptionally accurate (reliable) rather than exceptionally precise (fine-grained). The fact that some different types of agricultural and agroforest fields will be lumped in the same category may be unavoidable at the remote sensing or API level of inquiry. An interpretive map based on analysis of images or aerial photos should be further refined within the area of intensive study, to reflect investigator knowledge of different resource management types contained within each landscape unit. Transects, a commonly used method in which soils as well as land use and biota can be studied, may have an important role at this stage.

The definition and identification of landscape units is essentially a question of delineating boundaries. For operational purposes, those boundaries must be visible and readily identifiable on the relevant remotely-sensed images. Furthermore, the boundaries between landscape units must make sense in the field. However, not all distinct phenomena in the field will be visible on the remote images. Such phenomena, by our definition, do not represent landscape units, but may represent distinct investigator- or population-defined resource management types. The landscape unit, therefore, is obviously sensitive to the scale applicable to the remote sensing imagery utilized by each cluster. Nonetheless, inclusion of this unit of study is necessary because, while many analyses of natural resources and their management are made based upon remotely-sensed data, the ability of that data to tell us useful things about landscapes within complex management systems is largely untested. Collecting and analysing data across several scales of analysis will permit quantitative assessment of the amount of information gained and/or lost at each level.

PRODUCTS:

1) a map of the sites delineating remote-sensing or API-defined landscape units;
2) a map of the intensive study areas, delineating remotely defined landscape units and investigator- or population-defined resource management types.

III. Field measurement of replicate plots within each landscape unit type.

The principal question here: How diverse is each landscape unit type?

After making a map of the study area delineating the boundaries of the various landscape unit types, appropriate field measurement methods can be selected. Here, a great deal of local adaptation will be necessary because some Cluster areas may be characterized by a large number of small landscape units and others by a smaller number of larger landscape units. The latter case presents a more straightforward sampling problem.

Number, size and type of sample plot will necessarily depend upon number and size of landscape units, and the type of vegetation present. Equal-sized plots should be used for all landscape units, although nested sub-sampling may be used for certain vegetation types as necessary (e.g. grasses, shrubs, saplings). No landscape unit type should be represented by only one plot. All plots and sub-plots should be randomly located within the landscape units leaving a buffer-strip at unit edges, which require separate measurement.

Kenkel et al. (1989), among others, have forcefully argued that there are no generally applicable principles for making sampling decisions in ecological studies. All decisions must be specific to the objectives and, for practical purposes, tailored to the realities present at any given research site. Nonetheless, there are a few rules which must be observed if valid intra- and inter-site comparisons are to be made about diversity.

- Plots to be compared must be the same size and shape;
- Plots must be replicated;
- There must be a random component to plot location;
- Plots must be well-marked for data validation and future re-sampling.

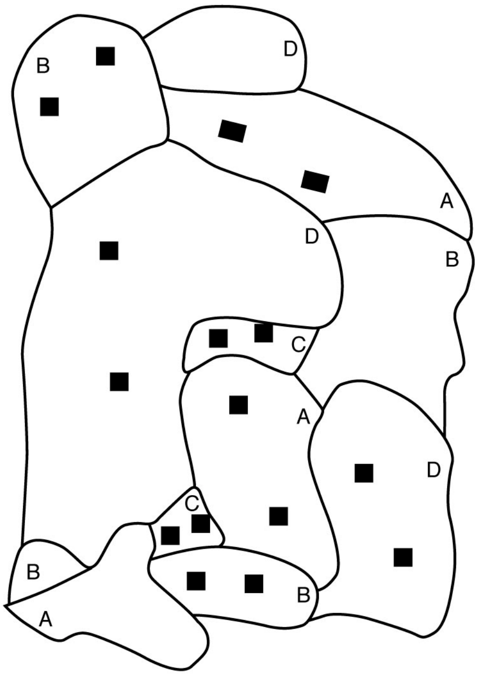
There is no standard plot size. Forest ecologists, among others, have noted that the number of species always increases with plot size, up to a point where the 'species-area curve' flattens out. The location of that point on the curve is impossible to determine a priori. At one end of the spectrum, conventionally planted monocultural fields require selection of small plots for accurate estimation of the number of individuals present in the larger population; a few square metres may be all that is necessary to predict accurately the density of rice in a large pond field. At the other end, in a complex agroforest, it may not be possible to record all the plant species present unless the entire area of the agroforest is inventoried. Common quadrat (plot) sizes to consider in relation to requirements and conditions would be 33.3 x 33.3 m (0.1 ha), 10 x 10 m (0.01 ha), 3.33 x 3.33 m (0.001 ha) and even 1 x 1 m (0.0001 ha). Other sizes sometimes used include 4 x 4 m (0.0016 ha) and, for forest sampling, 20 x 15 m (0.03 ha). Larger areas, of 100 x 100 m (1.0 ha) and more, may be required for measuring resource management types.

Even if plot replication is minimal, it should be consistent. In the minimal example, two landscape units within each landscape unit type would be randomly selected from the remote-sensing or API map for sampling, and two plots would be randomly located within each of the selected units. Note that these plots need not fall within the intensive study areas, and that the collection of data here is on the basis of interpretatively-defined landscape units, not resource management types.

There are three questions related to the variability of landscape unit diversity which are worth addressing. Figure 1 illustrates the suggested sampling strategy. Figure 2 presents a prototype of a field data sheet.
The questions are:

- how much variability is inherent in a single contiguously mapped individual landscape unit? This question can be addressed by measuring subsamples within contiguously mapped individual landscape units;

Figure 1



KEY: A, B, C and D identify different API-defined landscape unit types.
Solid squares represent a minimally replicated sampling design.

Figure 2

SAMPLE DATA SHEET

PLEC CLUSTER ______________________

NAME ______________________ DATE ______________________

LANDSCAPE UNIT TYPE ______________________ LANDSCAPE UNIT No. ______________________

Plot No. ______________________ PLOT AREA (m x m) ______________________

Subplot area (each m x m) ______________________

species	SP1	SP2	SP3	SP4	SP5	SP-TOTAL	occurrence outside subplots
			within subplot occurrence				
______	___	___	___	___	___	______	______
______	___	___	___	___	___	______	______
______	___	___	___	___	___	______	______
______	___	___	___	___	___	______	______

- how much variability is there between non-contiguous landscape units of the same designation? This question can be addressed by sampling replicates distributed among several landscape units with the same designation;
- how much variability is there among the different landscape unit types? This question can be addressed by sampling replicates distributed across the landscape unit types.

Measurements should be made in the same number of plots of the same size within each comparison. Plot locations within the landscape units should be determined randomly. Note again that the operational unit in this section is the landscape unit, and not the resource management type.

PRODUCTS:

1) permanently marked inventory plots within the intensive study areas;
2) archived data on number of individuals of each species recorded for each plot measured.

IV. Data analysis

Data collection methods, outlined above, will permit determination of a wide variety of diversity indices, which focus on the number of species present (species richness or species abundance) and the evenness with which individuals are distributed among those species (relative abundance). One major reason for the diversity of diversity indices is the absence of any objective method for determining the relative weight which should be given to each of those variables (Hurlburt 1971; Cousins 1991; Wayne and Bazzaz 1991).

Nonetheless, PLEC field data should be collected and archived in an accessible computer database available to other investigators who may wish to use it for other purposes than those with which the current proposal is principally concerned, namely agrodiversity, species density, and landscape complexity. Analytical methods are suggested below for each in turn.

Agrodiversity

Brookfield and Padoch (1994) define agrodiversity as the variety of resource management practices.

One measure of agrodiversity is simply a count of the number of different resource management types identified by the investigators at each study area. This is a site-specific measure, e.g. 'The inhabitants of the village we studied practised 12 kinds of agriculture'. As such, the measure is perhaps most useful for inter-village comparisons (e.g. Padoch 1987) but does not allow for spatially explicit comparisons because area and variety are generally not independent variables.

One way to overcome this is to place a grid over the resource management map of the intensive study area and simply record the resource management types present in each box of say 1 ha in area. The average number of resource management types per ha will then be readily calculable, along with an estimate of variance (e.g. standard deviation). Another useful ranking may be the number of hectares in which each of the various resource management types is present.

Both assessments may be carried out for the intensive study area as a whole, and also for each of the landscape units as defined from interpretation of remote sensing images or aerial photographs. The latter exercise will provide an explicit estimate of the amount of variation, and the type of variation for which the images provide insufficient information.

PRODUCTS:

1) estimate of the number of distinct resource management types on a per ha basis both within the intensive study area as a whole and per landscape unit;
2) ranking of resource management types by frequency of occurrence within the intensive study areas.

Species density

Although technically only one portion of diversity, the number of species present (species richness) is commonly the variable of greatest interest in assessing 'biodiversity'. Species richness has been clearly shown to correlate with the size of the sample area, and is therefore, like agrodiversity, usefully dealt with on a per area basis. The sample plots discussed above provide that areal component.

For species density comparisons, a list of all species recorded in each of the units to be compared is assembled. Presence or absence in each sample unit is noted and an analysis of how many species are common to both units and unique to either is easily computed. When the units of comparison are plots within a single delineated landscape unit, this analysis provides information about how much within-unit variation exists. By grouping all data from one delineated landscape unit and comparing it to all data from another landscape unit of the same type, within-unit-type variations can be assessed. To determine whether within-unit-type variation is significantly different from within-unit variation, all pairwise comparisons of the representative sample plots can be analysed.

The same procedures apply to between landscape unit comparisons. Table 1 illustrates the procedure, which is also useful for determining which species are rare, and which are common.

Table 1

SAMPLE 1		SAMPLE 2	
species	no. of Individuals	species	no. of individuals
1	37	1	94
2	24		
3	62	3	31
4	41	4	23
5	12		
6	3		
7	49	7	12
8	118	8	87
9	1		
10	74	10	42
		11	3
		12	31
		13	25
		14	9
		15	16

SUMMARY ANALYSIS

common species	#	species unique to Sample 1	#	species unique to Sample 2	#
1	131	2	24	11	3
3	93	5	12	12	31
4	64	6	3	13	25
7	61	9	1	14	9
8	205			15	16
10	116				

Comments: This type of simple analysis allows for straightforward, quantitative assessment of which species are common and which are rare both within each sample and between the samples. In this example the samples share their most common species, yet are differentiated by a significant number of species which are unique to one sample or the other.

PRODUCTS:

1) species density estimates on a per plot, per landscape unit and per landscape unit type basis;
2) estimates of within landscape unit, within landscape unit-type and between landscape unit-type variability in species density;
3) lists of species distributions.

Landscape complexity

Scheiner (1992) has introduced the use of affinity analysis to compare pattern diversity between ecological communities. This type of analysis allows quantitative identification of common versus rare types of species compositions within the cluster sites. Dimensionless estimates of the mean similarity and mosaic diversity of sample plots and/or landscape units can be objectively assessed and compared with other sites within PLEC or with any other data set. Mosaic diversity is a function of 'the existence of common and rare species, the extent to which sites differ in species richness, and their interaction' (Scheiner 1992).

There are three steps involved in the affinity analysis:

1) all pairs of landscape units are compared and pairwise similarities are determined based on presence/absence data;
2) pairwise affinities among all landscape units are computed;
3) the mean affinity of each site is plotted against the mean similarity of each site and the slope is computed. Figure 3 illustrates such a plot, and provides an interpretation of the data contained therein. The slope (m) is a measure of landscape complexity where:

m = r(sA/sS);
r = the correlation coefficient;
sA = the standard deviation of mean affinities;
sS = the standard deviation of mean similarities

Scheiner (1992) presents the following interpretation of the range of possible values for *m*:

> Values of *m* < 1 indicate a disconnected landscape consisting of groups of sites that are similar within groups but with very little species sharing among groups. Values of *m* in the range of 1-3 indicate a simple landscape dominated by one or a few gradients. Values of *m* < 3 indicate a complex landscape with either many ecological gradients or no particularly strong gradients.

Scheiner further notes that these values are guidelines, rather than rules, and that the most notable utility of this variable is the potential for comparisons between landscapes:

> In general, the landscape with the smaller value of *m* can be interpreted to be less complex and dominated by fewer, more-pronounced gradients.

This type of analysis, while non-standard from a population or community ecology point of view, is particularly appropriate for PLEC studies because of the effects of complex resource management systems on species richness. This analysis is among the most useful currently available for quantifying those effects.

Other techniques may become available during the time-frame of the project, as this area of inquiry is currently very fertile and UNEP is shortly to be forthcoming with the *Global Biodiversity Assessment*, which will contain a state-of-the-art methodology section.

PRODUCTS:

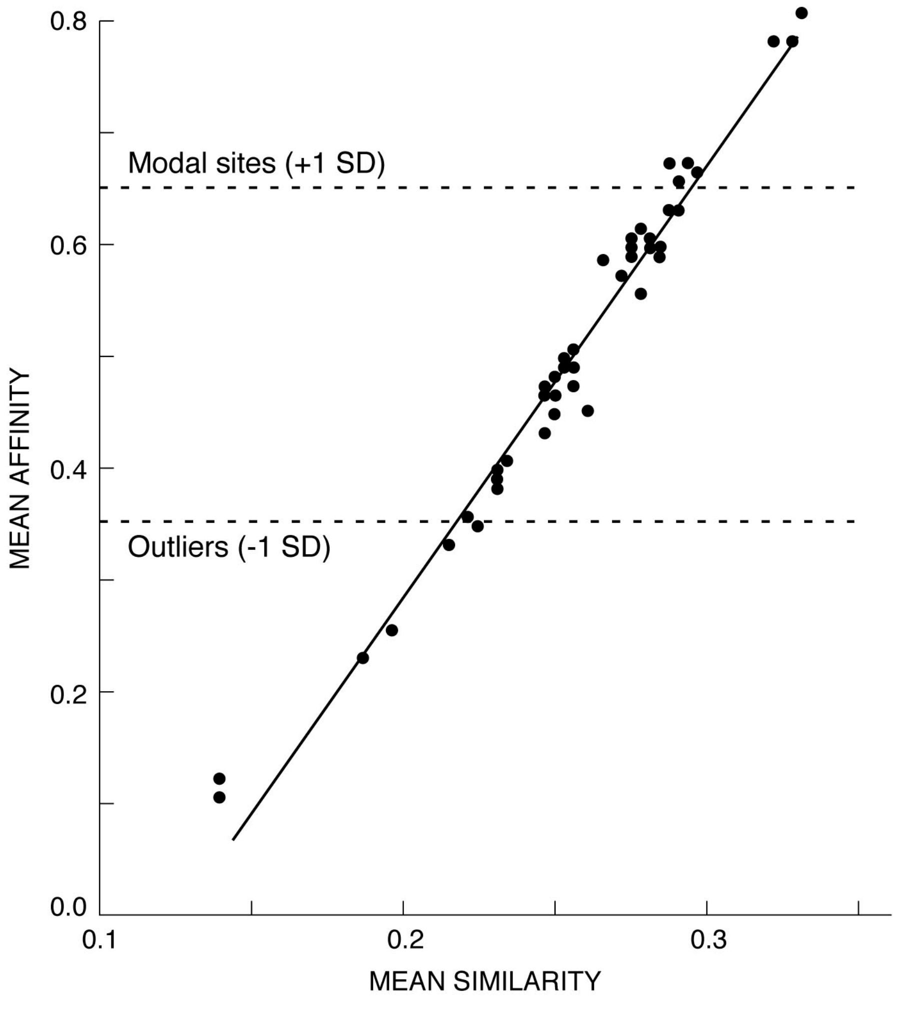
1) estimates of mosaic diversity on a per site basis.
2) within and between Cluster area comparisons of mosaic diversity.

Addendum

It should be noted that PLEC's approach to diversity measurement, outlined above, is deeply rooted in biodiversity theory, at least

Figure 3

Sites in the upper right hand corner of the graph have high mean similarities and high mean affinities. These...'modal sites' ...are rich in species that are common throughout the landscape, even though they do not necessarily have the greatest total number of species. In contrast, sites in the lower left hand corner of the graph have low mean similarities and low mean affinities. These ...'outlier sites' ... are either species poor, or rich in rare species ... mean affinities of 0.5 ± 1 standard deviation objectively define those sites that are either modal or outlier. The floristic differences between modal and outlier sites determine the variance in affinity values and the slope of the line. Thus, mosaic diversity is affected by the variation in species richness among communities, the variation in commonness or rarity among species, and how those factors interact to create an overall amount of complexity [Quotation and Figure from Scheiner (1992)].



Affinity analysis graph for presence/absence data on vascular plants from 42 sites in northern lower Michigan. The slope of the line estimates mosaic diversity (m = 3.96 ± 0.05, r^2 = 0.97). Sites with affinity values > 1 SD above the mean (which equals 0.5) are defined as modal; sites with affinity values < SD below the mean are defined as outliers. (Data from S. M. Scheiner and C. A. Istock, *unpublished manuscript*). Reproduced with permission of the Ecological Society of America since Whittaker (1965) suggested the division of diversity into *alpha, beta* and *gamma* components. *Alpha* (species) diversity is the diversity within a specific habitat. *Beta* (habitat) diversity is the diversity between habitats. *Gamma* (landscape) diversity is the total diversity of a landscape or region. This proposal represents a potential application of those basic ecological principles in the context of a quantitative approach to the assessment of diversity in anthropogenic ecosystems subject to long-term management by indigenous populations.

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A long-running UNU research project on **Critical Zones in Global Environmental Change**, implemented jointly with Clark University and the International Geographical Union (IGU) commission, is coming to fruition. PLEC members, including Prof. Harold Brookfield and Dr. E. Adilson Serrão, have been active in the project. The first three volumes emanating from the project research will be published around July-August 1995. They are:

Regions at Risk: Comparisons of Threatened Environments
Jeanne X. Kasperson, Roger E. Kasperson and B.L. Turner II

This volume provides an overview of the project, which analyses and develops the concepts of 'environmental criticality' and 'endangerment' in varying ecological, socio-economic and political contexts. It examines nine regions that are particularly endangered and where large-scale environmental degradation threatens sustainability. *cont. on p.28*

EVALUATION OF THE CULTIVATION OF *AMOMUM VILLOSUM* UNDER TROPICAL FOREST IN SOUTHERN YUNNAN, CHINA

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[EDITOR'S NOTE]. This short paper, by Guan Yuqin and two of her supervisors, came to my attention during the Montane Mainland Southeast Asia Cluster meeting in Chiang Mai in November 1994. Ms Guan attended the meeting. I sought its inclusion in this issue for three reasons. First, it is primarily a student member's paper and the first we have published. Second, it fits into the general 'biodiversity' theme of this issue. Third, it points to a problem with a type of agroforestry that is not unique to Yunnan, and also demonstrates that farmers' adaptations are not always either conservationist or sustainable, at least in the fairly short term of 20 years. It thus offers a 'cautionary tale'. The paper has been comprehensively but not heavily edited. An edited version has been seen by the principal author.]

Introduction

As a method of forest resource management, the cultivation of cash crops under tropical forest is increasingly popular in tropical areas of Yunnan. Some of them such as tea, *Calamus* spp. and *Baphicacanthus cusia* have been planted under natural forest for a long time by the indigenous minority nationalities, i.e. Jinuo, Hani. Others are more recent, and include *Amomum villosum, A. tso-ko,* and *A. kravanh.* At the beginning of the 1970s, *A. villosum* (a Chinese or Indo-Chinese species of cardamom, usually known as Chinese Cardamom, and a member of the family of *Zingiberaceae*) was newly introduced to this area. *A. villosum* is an important tropical medicinal plant with high value. Nowadays there are more than 3,700 hectares of *A. villosum* in Xishuangbanna, which has been one of the largest growing areas of *A. villosum* in China. In Jinuo district, in the area administered from Jinghong city, there are more than 15,270 mu (about 1016 hectares; one ha = 15 mu) of *A. villosum* and the annual product is 81.5 tons, which is one-fourth of the whole country's total. *A. villosum* has become the major cash income source of the local people because of its high value. But more than 3000 mu of this *A. villosum* are being cultivated in Xishuangbanna natural Reserve, some even planted very close to the core zone of the reserve. *A. villosum* has been cultivated on a large scale before the ecological and social effects of this kind of cultivation are well known. To evaluate such effects, we conducted a series of ecological and social surveys in Baka, a village very close to the natural reserve. Social and economic research involved RRA, PRA, and participatory observation. The relationship between cultivation of *A. villosum* and the development of the village is analysed. The ecological effects are examined by sample survey methods. Based on the results of these two research tasks, problems of resource utilization and protection are discussed.

General situation of Baka village

Baka is a village of Jinuo township in Xishuangbanna Prefecture. There are 255 Jinuo people and two Han Chinese living in the village. The Xiaomengyang-Mengla road passes through the village and wanders along the Manka river. The village is 6 km from Xishuangbanna Tropical Botanical Garden. The agricultural land grows upland and wet rice, most of the latter along the river bed. The mountains on the south of the river belong to the Menglun natural reserve, the main goal of which is preserving seasonal rain forest and monsoon rain forest. At the foot of the mountains close to the river there are odd plots planted with tea, pineapple and bananas.

The first twelve households moved to the present village site from the old village, 10 km away, in 1971, with the mobilization and help of Xishuangbanna Tropical Botanical Garden. There were two main reasons for the move. One is that the old village's population was growing rapidly, the other was bad transportation at the old site. Under the help of the Botanical Garden, some wet rice land was reclaimed through building irrigation channels. It was anticipated that destruction of the surrounding forest could be reduced through wet rice cultivation. But, because of the slash-and-burn tradition and wrong policies during the Cultural Revolution, extensive areas of natural forest were destroyed in order to plant food crops and rubber trees. Only a part of the forest survives at the foot of mountains; this is reserved for *A. villosum* cultivation and water supply.

Since 1971 the population of Baka has increased. but at a declining rate in recent years. A further thirty households moved from the old village in 1972. There were 164 people in Baka in 1973, and 241 in 1983, but only 257 in 1993. The area of farm-land per household became smaller. Before 1978, each villager had access to more than 24 mu of swidden land, but the amount was reduced sharply to 8 mu in 1978 when about 3000 mu (200 hectares) of the village's land were put under natural reserve. Although the government allocated 400 mu of other types of forest land to the village in 1990, each villager owns less upland than the average level for Jinuo township, which is 23 mu per person. There are 100 mu of wet rice land and about 2,340 mu of upland in Baka. In addition, each family owns one mu of land for fuelwood planting. The natural forest of the village, owned by the community, is not accurately measured but is about 500 mu by estimation.

Food and cash income both depend mainly on crops. Animal husbandry is undeveloped because of disease. The major cash crops are *A. villosum* and corn. More than 50 per cent of the villagers' cash income comes from *A. villosum*. There are other cash and non-cash crops such as rubber, tea, pomelo, passiflora (*Passiflora quadrangularis*) and some vegetables. Rubber is a large potential cash resource of some households. At present, there are 413 mu of rubber plantation but most of the trees are too young to be tapped. Pomelo and passiflora have been introduced only in recent years, and their area is limited. Vegetable cultivation for sale also started in recent years, and now contributes 10 per cent of the households' cash income. The area of tea is only 7 mu and the production is usually consumed by the villagers themselves. *A. villosum* remains by far the most important cash resource.

Crop cultivation techniques are indigenous. No fertilizer or pesticide are used. The per mu yield of wet rice is 300 kg, but the area is small. More than half of the grain is obtained from the upland. But the upland area is limited and some swidden lands have been used to plant rubber, pomelo and passiflora. So the number of years of cultivation period increases, while the fallow period becomes shorter. In the past, the cultivation period of swidden land was said to be usually one year, never more than three years, but now it is usually five to seven years, or even longer. The second cultivation circle began after thirteen years of fallow in the past, but now after only five to seven years or even less. Because of the long cultivation and short fallow, the soil has become degraded and impoverished.

Cultivation and management of *A. villosum*

The area of *A. villosum* in Baka is divided into two parts. One is in the natural reserve, the other in the community-owned forest. The official data gives the total area as 202.5 mu, but this is only the area which should pay tax. The actual area is about one thousand mu. The procedures of *A. villosum* cultivation are usually as follows. A flat, fertile, moist place in the forest is chosen. Then shrubs and grasses are cleared. If the tree cover is too dense, some high trees are cut until the forest cover is about 70 per cent. Then, when the rains begin in April or May, seedlings of *A. villosum* are planted with one metre spacing between the rows. In the next year, farmers only need to hoe up weeds twice, or three times. In the third year, fruits of *A. villosum* can be harvested. Because *A. villosum* is a semi-perennial plant, it can be harvested for more than ten years. The highest yield is in the fourth, fifth and sixth years, then the yield declines gradually. If the environment is unsuitable or management is poor, the per mu yield of old *A. villosum* will be very low, even less than 1 kg. Besides age, rainfall is another factor that influences the yield. *A. villosum* blooms in April, and if the rainy season comes early and the rain is sufficient, the villagers can reap a good harvest.

The cultivation of *A. villosum* began in 1974 and seedlings were provided by the governmental agricultural officer. From then on, the area of *A. villosum* increased year by year, at first quickly and then more slowly as suitable planting sites became more difficult to find. For example, in 1984, the area increased by 140 mu, but recently, though the price of *A. villosum* rose from 45 Yuan (1 USD = 8.7 Yuan) to 60 Yuan per kilogram, there was little expansion. Only three mu of new *A. villosum* were being cultivated at the time of field work in 1993. But the benefit of *A. villosum* is so attractive that it was planted in some unsuitable places, especially in the natural reserve.

Most of *A. villosum* has been planted more than ten years in Baka and the management is extensive, so the yield is low. The highest record of per mu yield is 85.7 kg. But now the average per mu yield is about 5 kg. The same problem exists in the whole Jinuo area. There were 11,000 mu of *A. villosum* in 1986 and the harvested area was 6,000 mu; production was 81 tons. In 1993, there were 15,000 mu of *A. villosum* and the harvested area was 12,000 mu, but the production was only 81.5 tons. The per mu yield in 1993 is half that of 1983. Consequently, the urgent problem is how to improve the per mu yield by regeneration techniques and better management. The area of land and forest is limited.

The influence of *A. villosum* planting on Tropical Forest

In order to study the effects of *A. villosum* invasion on the tropical forest community, two sample areas were chosen in Baka. Sample area A is a forest where *A. villosum* is grown, while Sample area B is without it. For convenience, they will be called forest A and forest B, instead of forest with *A. villosum* and forest without. Both areas are at about 650 metres, and the large quadrats are 50 x 50 m (0.25 ha). The native vegetation type on both sites is seasonal rain forest in gullies and dominated by *Terminalia myriocarpa* and *Pometia tomentosa*.

Survey of the two sample sites has yielded the following results:

1. Both individuals and species of trees are reduced greatly in the different height intervals in forest A compared with those in forest B. The reduction is shown in Tables 1 and 2. The number of individuals with crowns in height interval **a** in forest A is only 40 per cent of that in forest B, and the number of species is about 57 per cent. In height interval **b** the numbers are 30 per cent and 75 per cent respectively.

Table 1
Number of tree individuals rising to different height intervals

	Height intervals*			
Site	a	b	c	d
A	6	7	33	> 163
B	15	21	37	> 250

* Height interval: a: > 30 m c: 5 < 15 m
b: 15 < 30 m d: 1 < 5 m

(Height intervals a, b, c, d have the same definition in Tables 2, 3,4, 5)

Table 2
Number of tree species in different height intervals

	Height intervals			
Site	a	b	c	d
A	4	6	12	23
B	7	8	15	42

2. The normal regeneration of the forest has been affected because of the cultivation of *A. villosum*. Comparison between Table 3 and Table 4 shows this. We find that in forest A there is a total absence of upper tree layer crowns in height interval **c**. The number of trees in all strata except height interval **a** is less in forest A than that in forest B. In forest B the individuals of the upper tree layer have a continuous distribution from the highest stratum to the lowest one, which is almost a pyramid. But in forest A this pyramid disappears. The frequency of young upper stratum trees in the understory is reduced. This situation is especially obvious in the case of *Pometia tomentosa*. The counts of *Pometia tomentosa* in Forest A are respectively 3, 0, 0, l and 0 in the four height intervals and in the small quadrats, whereas in Forest B they are 3, 5, 1, 20 and 17. There are plenty of young trees and seedlings in forest B, but they are scarce in forest A. *Pometia tomentosa* is a third grade rarity plant and it is also a characteristic species of seasonal rain forest. The regeneration situation in forest A is a cause for concern.

3. Species and individuals of rare and endangered plants have also been reduced since *A. villosum* has been cultivated under the forest. Table 5 reveals this change. There are 10 species of rare and endangered plants in forest B while there are only 7 species in forest A. And, more important, the plants of these 7 species only occasionally appeared in the height interval counts. The number of their young trees is much less than in forest B. In the shrub height interval, from two to five metres, there are only 3 species, one individual of each. In forest B, there are 7 species and 31 individuals in the same height interval. These rare and endangered plants should be carefully protected. There are doubts about their future existence in forest A.

4. We also found that the components of the community have greatly changed in forest A. Not only is the undergrowth cleared, but the trees are also partly cleared for the cultivation of *A. villosum*. The forest cover is reduced, and some light-demanding plants have invaded the shrub and herbaceous strata. In forest A the shrub stratum was dominated by plants with large leaves such as *Musa acuminata, Colocasia gigantea, Alocasis macrorrhiza*. The counts of these three plants are respectively 45, 45, 20. They constitute 67.4 per cent of the total plant individuals in the shrub stratum. In the herbaceous stratum of forest A, the proportion of young trees is reduced while that of grass is increased. A large number of *A. villosum,* accompanied by *Eupatorium coelesticum, E. odoratum and Elatostema macintyrei*, have appeared. In the same stratum of forest B, most of plants are the young individuals of taller-growing trees. For

example, in two small quadrats (2 x 2 m), 91 per cent of individuals and 87.5 per cent of species are young trees, but the respective percentages in forest A are 50 per cent and 33.3 per cent. More seriously, this 50 per cent of young trees will be cleared in the next hoeing season.

Table 3

Distribution of trees higher than 15 metres in different height intervals (sample plot A)

Height intervals Species	a	b	c	d	Small quadrats (2 x 2m)
Treminalia myriocarpa	1				
Pometia tomentosa	3			1	
Litsea liyuyingi	1				
Bischofia javanica	1				1
Polyalthia cheliensis		1			
Cinnamomum chartophyllum		2		1	4
Adenanthera yunnanensis		1		1	5
Allophyllus cobbe		1			1
Ficus oligodon		1		2	
	6	6		5	11

Table 4

Distribution of trees higher than 15 metres in different height intervals (sample plot B)

Height intervals Species	a	b	c	d	Small quadrats (2 x 2 m)
Ailanthus fordii	1		2	6	1
Pometia tomentosa	3	5	1	20	17
Dalbergia obtusifolia	6	12	12	15	11
Gironniera subaequalis	3			1	
Antiaris toxicaria	1			2	
Mitrephora thorelii	1			18	2
Albizia crassiramea		1			
Myristica yunnanensis		1	3	2	
Macaranga denticulata		1	3	67	34
	15	20	21	131	65

There is also great change in the inter-strata plants. In forest B, there are many big woody vines i.e. *Acacia pennata, Combretum yunnanensis, Tetrastigma planicaulum*. In forest A, however, the common vines are small herbaceous species such as *Thunbergia grandiflora.* The big vines have disappeared and only their seedlings can be seen occasionally. There are probably also changes in the microflora, and in the fauna and microfauna, as well as in the soil and hydrology. Further study of these aspects is needed.

Collectively, cultivation of *A. villosum* under natural forest has brought significant changes in the structure, species composition, and regeneration capacity of the community. The survival and development of some rare and endangered plants are threatened. It seems clear that planting *A. villosum* under forest, at least as it is now done, is incompatible with retaining the forest over the long term.

Table 5
The rare and endangered plants in the two sample sites

	Forest A					Forest B				
Height intervals Species	a	b	c	d	Small quadrats	a	b	c	d	Small quadrats
Horsfieldia tetratepala			1					1		
Myristica yunnanensis							1	3		
Homalium laoticum				1					1	
Pterospermum menglunense								1	4	
Tetrameles nudiflora			5							
Antiaris toxicaria						1			2	1
Laportea urentissima				1			3			
Pometia tomentosa	3			1		3	5	1	20	17
Terminalia myriocarpa	1				1					
Toona ciliata			2						1	
Mangifera sylvatica									2	
Magnolia henryi									1	
	4	0	8	3	1	4	9	6	31	18

Discussion and suggestions

The social and ecological surveys reveal that the cultivation of *A. villosum* in natural tropical forest raises complex issues about the relationship between resource conservation and utilization. Our conclusion is that it should cease in the natural reserve, because the tropical forest is influenced greatly in its structure, components, characteristic and ability of regeneration. The main purpose of Xishuangbanna natural reserve is to protect the seasonal rain forest and monsoon rain forest, but now only 6 per cent of the area in the reserve still has these two forest vegetation types. The rich species resource of the tropical forest should be conserved, and the natural reserve should provide sanctuary for many rare and endangered species. Cultivation in the buffer zone of the reserve should also not be permitted, because most of the forest in the zone has already been destroyed to different degrees, and is now in the regeneration phase. Interference by human action should be minimized, so that forest can regenerate rapidly and well.

In areas surrounding the reserve, like Baka village, *A. villosum* should continue to be planted, but cautiously. Cultivation under community-owned forest has to continue in the short term, because of the present economic and social situation. But some positive measures should be taken and techniques that are more advanced and conservationist, as well as more productive, should be studied and adopted. We make the following suggestions. Farmers should keep enough young individuals of the taller-growing trees when they plant *A. villosum*, or hoe up the weeds. This should not be difficult to do because the peasants have a very rich knowledge of plants in the local forest, one which even surprises a taxonomist. Only if enough seedlings are conserved can the regeneration of forest be ensured, and the fundamental functions and structure of the forest be conserved. Then the forest can be sustainably utilized.

Second, a comprehensive plan for the cultivation of *A. villosum* needs to be made at village level. Only appropriate sites should be chosen to plant *A. villosum*. It should be possible to sustain market production without further increasing the area of *A. villosum* if the per mu yield can be raised, especially by the renovation of old *A. villosum* areas. Our last suggestion is to improve the techniques of food production so that villagers can be self-sufficient in food, and to develop other cash crops. Only after the cash income ceases to depend so heavily on *A. villosum* will the pressure on the remaining forest be reduced.

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In Place of the Forest: Environmental and Socio-economic Transformation in Borneo and the Eastern Malay Peninsula

Harold Brookfield, Lesley Potter and Yvonne Byron

The authors critically examine the supposed transition from 'impoverishment,' through 'endangerment' toward 'criticality' in the environmental condition, and human-welfare condition, in Borneo and Peninsular Malaysia. The region is one of the largest remaining areas of tropical rainforest and has become the most important source of tropical timber since the end of the 1970s. It is also a major 'resource frontier' for two rapidly developing countries, Indonesia and Malaysia, a fact causing significant pressure on the resource base. A significant amount of new regional data is presented with the central purpose of focusing on the fate of the land, and its people, after interference with or removal of the forest.

Amazonia: Resiliency and Dynamism of the Land and Its People

Nigel J.H. Smith, Emanuel Adilson Serrão, Paulo T. Alvim and Italo C. Falesi

The volume is concerned with sustainability, and particularly one of its major components, resilience, in Amazonia. It is recognized that development pressures are triggering rapid ecological, cultural and economic changes in the region, which is one of the world's largest remaining forest frontiers. Driving forces behind land-use changes are identified; the emerging awareness of economic, cultural and ecological issues surrounding development is discussed; and management of natural resources is analysed. A major focus of the study is identifying resource management strategies for agriculture, particularly in agroforestry systems, silviculture and pastures.

Juha I. Uitto

ABOUT THIS NEWSLETTER

PLEC NEWS AND VIEWS is the main means of general communication within PLEC, and at the same time a principal means of telling others about PLEC. It will appear about twice a year (but not at exact intervals) through the life of the project. The first issue, published in July 1993, presented basic information about the project that will not appear again.

Editor

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