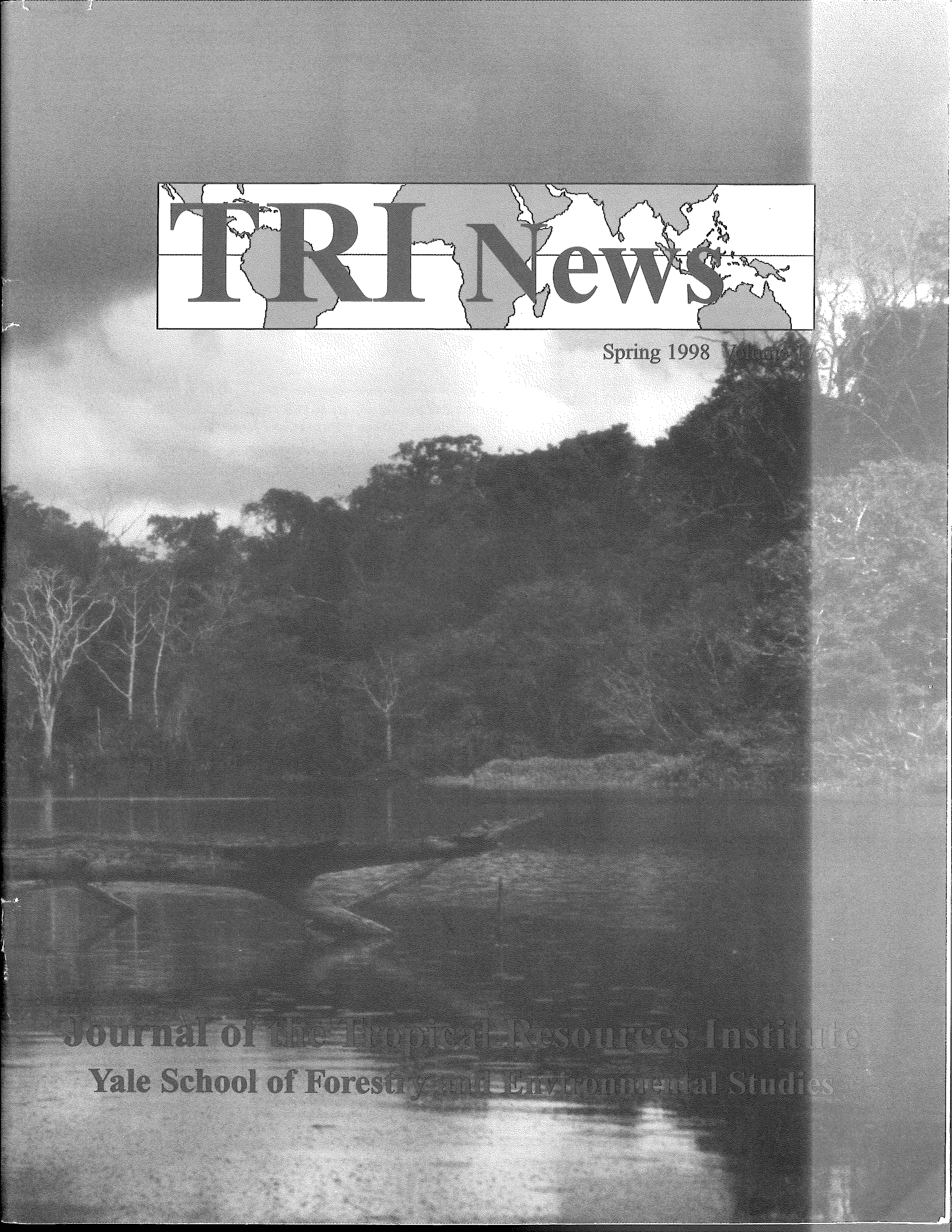
TRI News

Spring 1998 Volume [illegible]



Journal of the Tropical Resources Institute

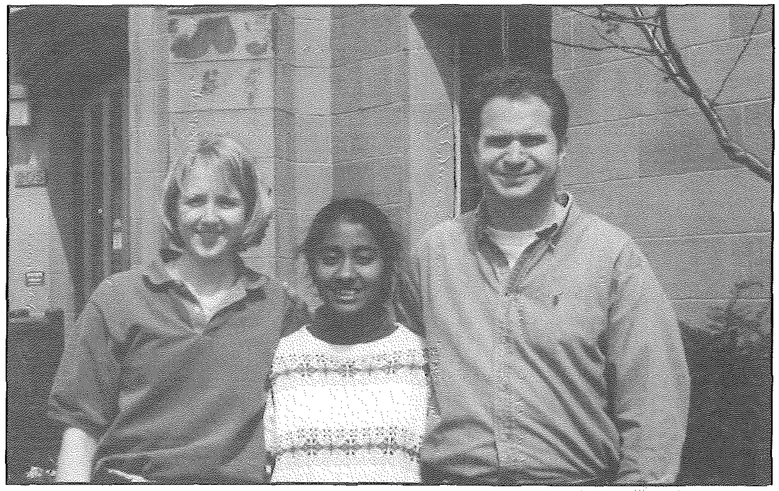
Yale School of Forestry and Environmental Studies

From the Editors...

This 1998 edition of *TRI News* highlights another group of Yale School of Forestry and Environmental Studies (FES) interns who spent last summer conducting research throughout the world.

In this issue, we have organized their stories around three major themes: *Protected Areas Management*, *Forestry,* and *Social Ecology.* Featured countries include Tanzania, Madagascar, and Ghana; Peru, Costa Rica, Mexico, and Venezuela; Nepal, China, and Ecuador.

In addition, we follow up on the Yale FES African Natural Resources Group (ANRG), which successfully hosted the Sangha River Conference here at Yale last fall. ANRG continues to support FES students with interests in Africa, an effort bolstered by the recent arrival at Yale of the African Wildlife News Service which publishes the African Wildlife Update. Finally, this issue reports on a international pesticide conference held in Cuba this year.



The 1997-98 *TRI News* team outside FES's Sage Hall, from left to right: Sally Atkins, Radikha Wijetunge, and James Shambaugh.

Also, with the help of Radhika Wijetunge (TRI News designer), TRI News has gone cyber for the first time, and can be accessed in its entirety at our website (www.yale.edu/tri). Another first, again with Radhika's help, is the addition of a world map showing where this year's authors (and upcoming TRI interns) conducted their research.

This journal represents the culmination of eight months of effort, a long but rewarding process. We want to thank the authors for their dedication, cooperation, and patience with us. Lastly, we would like to thank Jim Bryan, who gave us guidance and support through it all.

Sally Atkins James Shambaugh

--1997-98 *TRI NEWS* EDITORS

A Message from the TRI Program Director

Throughout its history the Tropical Resources Institute has made efforts to bring Yale students together, in their education and their research, with students, managers, educators, and a great variety of residents of the rural tropics, for studies of natural resources and resource management. We have made attempts, not always successful, to communicate the results of these studies with the many people involved. Since our beginning, we have tried to consider both social and biophysical aspects of the environment in our studies, and to engage our collaborators in these multi-faceted considerations. The combination of academics with practical problem-solving and management has always been a goal of the TRI program. To me, the work reported in this edition of the *TRI News* provides impressive examples of collaborative efforts in practical environmental research worldwide.

As we approach the end of the 20th century, and incidentally, the end of Yale's own first century of work in tropical forestry, we are faced with many of the same challenges that led to international work in forestry in the early decades of the century; in many respects, the challenges have intensified. The challenges to tropical environments now extend far beyond the forests, and include the most important problems we face: limits and overexploitation of resources; new, diverse, and abundant wastes; rapid urbanization; the loss of habitat; the loss of genetic resources; and the loss of many environmental buffers. This edition of *TRI News* represents some of our expansion in these research directions.

We now need to improve several of the combinations that have been our specialties: students now entering our program know they will need to surpass present capabilities in combining biophysical insights with social understanding. Human-dominated landscapes will need to be more fully accepted as valid subjects of ecological study. The rural-urban interfaces need attention for their social, economic, and biological importance. The interactions of participation, education, and environment need more careful attention. Several of the studies reported here attempt to advance such combinations. Our present goal in TRI, as we continue our work in environmental research and training, is to make our advances cooperatively: we hope to improve our communication and collaboration with our many and diverse co-workers -- past, present, and future -- in the many regions where we work.

James A. Bryan

James A. Bryan, Ph.D.

Table of Contents

Community-Based Natural Resource By-Laws: Working Collaboratively for Sustainable Land Use in Tanzania

By Ben Gardner
Candidate for Master of Environmental Studies

It is necessary for any person or company wishing to use village lands or exploit natural resources to meet with the village government and the Environment and Natural Resources Committee before they carry out any activities. A contractual agreement must be arranged with the village and it may not exceed five years in length. In this specified Wildlife Management Area it is illegal to carry out any activity other than tourism, hunting and livestock herding.

Village By-Law, Loliondo, Tanzania. 1997.

Introduction

In northern Tanzania, village land claim discrepancies between Maasai communities and the national government have led to poor management decisions and to the absence of a 'responsible' party to oversee the use of local natural resources (Neumann 1992). This situation, and its resulting environmental degradation and social marginalization, has necessitated a policy change. One of the alternatives is closer collaborative management between the Tanzanian government and local communities concerned with natural resource rights on village lands. The project described in this article addresses this institutional change by facilitating an official understanding between these parties, and by delegating responsibility for the long-term stewardship and use of natural resources (Wiley 1995). This change is occurring as Tanzanian government authorities are beginning to recognize the advantages of increased community participation in sustainable resource use and rural development.

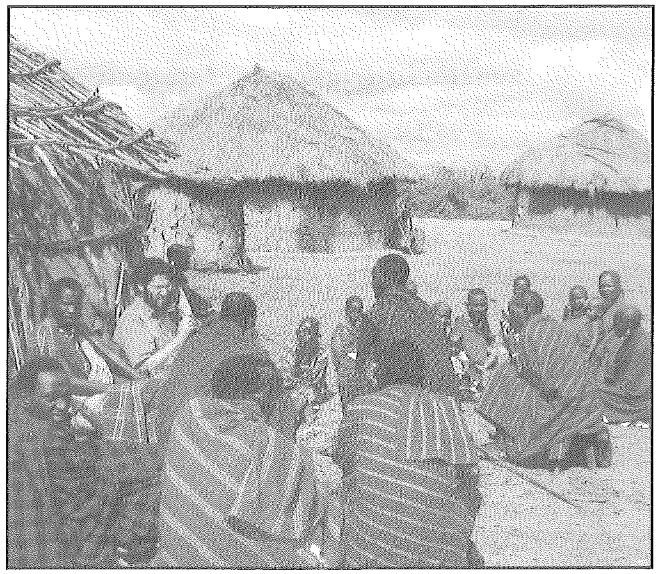


Figure 1: The Dorobo Fund team meets with sub-village members in Emporeet, Simanjiro.

The Dorobo Fund for Tanzania (Dorobo Fund)[1] is working with four Maasai communities and state authorities to draft village by-laws concerning rights over, and responsibilities toward, natural resources. The project's objective is to achieve a mutually beneficial agreement regarding land use through new legislation and collaborative management (Peterson *et al.* 1995). Specifically, it aims to help address the local communities' ambiguous status which results from the poorly defined property rights in the village land title deeds.

I was a member of the Dorobo Fund team, which spent three months conducting research and drafting by-laws with Maasai collaborators, village committee members, and district officials in the four project communities. The team also consisted of Maanda Ngoitiko, a Maasai woman working in community development, and Daniel Olengoitiko, a Maasai man working in livestock extension and husbandry. Both Tanzanian collaborators were from the local area, but not specifically from the project villages.

Site Description

The project took place in the Simanjiro and Loliondo districts of northern Tanzania. Both districts contain some of the richest and most spectacular wildlife habitat in East Africa, including the wet season dispersal zone for animals from Tarangire National Park in Simanjiro, and the primary corridor between Ngorongoro Conservation Area and Serengeti National Park in Loliondo. The unique bio-diversity in these districts is unparalleled among "non-protected" areas in Africa. Although the main towns in each district are ethnically diverse, the rural areas are primarily inhabited by Maasai agro-pastoralists, who practice small-holder mixed agriculture and raise livestock. The four project villages are Emporeet in Simanjiro District, and in Loliondo District: Magaiduru-Olorien, Oloipiri, and Maaloney-Loosoito.

Background

Maasai Traditions

Maasai pastoralists first came to control the plains of northern Tanzania approximately three hundred years ago. Living in a predominately non-arable and marginal landscape, the Maasai depended almost exclusively on products provided to them by their livestock, which were grazed rotationally. Although the landscape was semi-arid with variable precipitation, the Maasai found and claimed relatively fertile rangelands which had good herbaceous and woody cover, seasonal and permanent water sources, and fewer diseases affecting either humans or livestock compared to other rangelands (Kjekshus 1977).

Maasai resource management systems allowed disparate groups of Maasai to utilize resources over a large area. The variable seasonal conditions often rendered certain areas useless for specific periods and necessitated access to alternate, usually distant, rangelands (Homewood and Rodgers 1991). While success with resource management varied, these systems provided Maasai communities with access to a broad natural resource base and barring stochastic ecological disturbances, the maintenance of herds large enough to support their families.

Throughout their tenure in northern Tanzania, Maasai population and range has fluctuated due to a variety of factors, but primarily from drought, disease, and warfare. Under both colonial and independent Tanzanian governments, the Maasai lost access to a significant amount of their land and natural resources. Large tracts of land were expropriated for national parks, while smaller tracts were converted to large-scale agriculture (Anderson and Grove 1987). With a significantly reduced land base, and external interests competing for the use of available natural resources, the traditional Maasai management system was effectively supplanted by the mid-1900s. An ad-hoc system has prevailed since then, with communities exerting their rights only occasionally.

Contemporary Situation

Over the past decade, tensions concerning both the use of natural resources on Maasai village land and the rights to revenues generated by their use have risen significantly. Although Maasai villages have official land title deeds which give them authority over activities on their land, Maasai rights to the natural resources on that land are often superseded by the state.[2]

The state's exclusion of communities from decision making over land use practices on village lands has led to large-scale land sales, and leases to private companies and individuals. Consequently, this practice has reduced the rangelands and water resources available to local people. Some of these private interests carry out large-scale agricultural activities, often on the most productive lands. The loss of this pastoral resource increases pressure on the fragile rangelands that provide the primary food source for both livestock and wildlife populations (Spear and Waller 1993).

The area's current resource paradigm cannot be attributed solely to the tense relations between individual communities and state authorities. Many Maasai village leaders have negotiated illicit agreements between themselves and land buyers, personally profiting at the expense of the community. Although community leaders often do not represent the community as a whole, their actions are seen by the government and others as being representative.

Over the past ten years, several efforts have tried to address the inequitable and environmentally destructive relationship between Maasai communities and the state. Between 1986 and 1996, the Maasai villages of Simanjiro and Loliondo districts obtained official land title deeds, demarcating boundaries that fell within the authority of a local elected village government. With these documents, several village headmen negotiated contracts with the private sector to generate revenue on village lands. Many of these contracts were concessions for tourism or hunting, activities that are compatible with the area's primarily pastoral economy. Some of these agreements, however, involved large-scale farms or ranches that excluded local access and limited the available rangeland and water sources. Community members have increasingly contested these 'land sales'. By interpreting village leader activities as being irresponsible and ignorant, the government further justifies its control and management of village land.

Methods

To address competing local, regional, and national interests in village resources, the four project villages each established representative committees called the Environment and Natural Resources Committee. They were responsible for drafting natural resource by-laws and devising strategies for their implementation. The Dorobo Fund team worked with these committees on their expectations and understanding of the project. Together with committee representatives, we then interviewed community members throughout each sub-village (*kitongoji* - a cluster of homesteads within a village). Members from the district government authorities later joined the team. Together, the team drafted by-laws that were acceptable to all parties and led to a clearer understanding of natural resource and land rights. By working closely with sub-village representatives, who are often excluded from village political decisions, the project was able to increase participation and accountability. This method allowed direct engagement with 15-20% of the community members. Drafts of by-laws were circulated to each sub-village representative to be reviewed by his or her constituency.

Results and Discussion

Many community members were not aware of their right to prevent elected village officials from negotiating on their behalf. As the Maasai system of pastoralism depends on communal land with sparse resources utilized over a large area, one of the most problematic scenarios, according to village members, is the division of land into private parcels by village leaders. This division of land with neither clear use agreements, nor the participation of all community members, represents one of the largest threats to the Maasai land management system.

To address this problem, participatory community-based natural resource by-laws were created that nationally recognize local rights to resources. They also provide the basis for a clearer understanding between communities and the state by providing a comprehensive land management and zoning plan, and outlining appropriate uses of various land areas held under village title deeds. Drafted by-laws include restrictions and limitations on: land sales or transfers; the appropriate size of agricultural development; immigration; water use for humans and livestock; charcoal burn-ing; use of trees and non-timber forest products; hunting; tourism; and, leadership roles and responsibilities. This restructuring of resource tenure forms a foundation for village authority as it concerns local land use decision making.

Beyond the natural resource management component, the project aims to help the communities address fiscal responsibility, as the mismanagement of funds is a significant impediment to the program's success. The project's strategy includes engaging women's groups and sub-village leaders for wider participation in fiscal decision making and community monitoring of the project. Also, the fees and taxes paid by villages to District Councils and other state agencies must be reasonable for all parties.

Conclusions

The overall goal of achieving collaborative management is a long-term endeavor. Current indicators, however, are quite promising. The by-laws are being finalized and will soon be put forward for approval by village assemblies and District Councils. Each village has drafted a comprehensive plan outlining land use zoning, regulations concerning natural resource use, and penalties for improper activities or behavior. Recent legislation outlined by the country's Wildlife Department will allow communities to demarcate specific areas for the protection of wildlife habitat, within which revenues generated will go directly to the village. Furthermore, it states that such an area must fall within a broader plan outlining resource use behavior and land use zoning. The four villages involved in the project are the first to utilize the new law, and will serve as models for other villages to adopt similar strategies.

The Dorobo Fund is committed to working with local communities and government officials, as it recognizes that the drafting of new legislation is only the beginning and the implementation phase will determine the project's success or failure. While enforcement and implementation of the by-laws will be a joint effort by the community and the government, the main responsibility will rest with the villages.

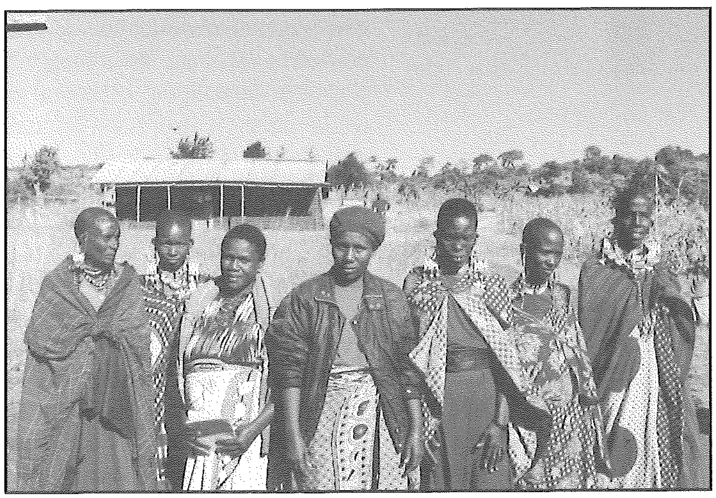


Figure 2: Maanda Ngoitiko (center) with women from the Magaidurs-Olorien Environment and Nature Resources Committee.

The strongest lessons learned from the process concern the overall framework and collaborative approach between communities and government officials. This approach aims to increase an understanding of their respective roles and responsibilities concerning natural resource use and management. A legal document conceived at the village level and combined with broader community participation, will provide communities with more authority. It will also provide safeguards to help revitalize and strengthen resource management systems.

The project has received attention from local, national, and international organizations for its approach and methodologies, and appears well suited to the Tanzanian government's shift toward community-based natural resource planning and management. Although much work remains to be done, and many obstacles to be overcome, this case study provides invaluable lessons for community-based planning and management in East Africa.

Acknowledgments

I would like to thank the Tanzanian district authorities and project village community members for forging this unique partnership and allowing The Dorobo Fund team to participate in the process. I also extend heartfelt thanks to my collaborators, Maanda and Daniel, for their enthusiasm and sincere desire to find constructive solutions to complex issues. Finally, I could not have carried out this project without the overwhelming and fun-spirited support of Dave, Thad, and Mike Peterson: Directors of the Dorobo Fund for Tanzania. The Dorobo Fund, and grants from the Tropical Resources Institute and the Coca-Cola World Fund at Yale supported my research. Their support is gratefully acknowledged.

References

Anderson, D. and R. Grove. 1987. *Conservation in Africa: People, Policies and Practice.* Cambridge University Press: Cambridge, Massachusetts.

Homewood, K.M. and W.A. Rodgers. 1991. *Maasailand Ecology: Pastoralist Development and Wildlife Conservation in Ngorongoro, Tanzania.* Cambridge University Press: Cambridge, Massachusetts.

Kjekshus, H. 1977. *Ecology Control and Economic Development in East African History: The Case Study of Tanganyika 1850-1950.* University of California Press: Berkeley, California.

Neumann, R. 1992. Political Ecology of Wildlife Conservation in the Mt. Meru Area of Northeast Tanzania. *Land Degradation and Rehabilitation* 3:85-98.

Oloipiri Village. 1997. Natural Resource Village By-Laws (Draft).

Peterson, T., M. Peterson and D. Peterson. 1995. *Village Based Management of Charcoal Resource in Simanjiro District: Methods and Experiences from Namalulu and Landenai Villages.* SIDA, Tanzania.

Spear, T and R. Waller. 1993. *Being Maasai: Ethnicity and Identity in East Africa.* Mkuki na Nyota Publishers: Dar es Salaam, Tanzania.

Wiley, L. 1995. *The Emergence of Joint Forest Management in Tanzania: Villager and Government. The Case of Mgori Forest, Singida Region.* SIDA, Tanzania.

[1] The Dorobo Fund is a Tanzanian not-for-profit organization founded in 1997. Its mission is to "... support a facilitative process of institution building at the community level, leading to local empowerment and active management of the total available resource base. The participation of women is critical for the success of this process." Mission Statement, 1997.

[2] In several cases, the government has claimed natural resources for national interests, including gemstone mining concessions and exclusive-use contracts with hunting companies, which have no direct arrangements with villages.

Integrating Conservation and Development in Ranomafana National Park, Madagascar

By Mila Plavsic
Candidate for Master of Environmental Studies

Introduction

The international conservation community is currently addressing a critical question: when should international conservation groups transfer management of a protected area to the host country? In Madagascar, the answer appears to be now. I recently witnessed such a transition of management in Madagascar's Ranomafana National Park (RNP). The following case study, based on interviews with local people and park managers, may provide useful lessons for other protected areas undergoing a similar transition.

Site Description

The Ranomafana National Park, located in the rain forest of southeastern Madagascar, became the country's fourth national park in 1991. Covering 43,500-hectares, the park encompasses some of Madagascar's last virgin rain forest and cloud forest. Dr. Patricia Wright of the State University of New York (SUNY) at Stony Brook played a central role in the park's creation after she and others discovered a new lemur species *(Hapalemur aureus)* and rediscovered another species (*Hapalemur simus*) thought to be extinct. The peripheral zone surrounding the park contains 93 villages with a total population of approximately 25,000 (Grenfell and Robinson 1995). Cooperation among international aid agencies, scientists, the Malagasy government, and local people began a decade ago and continues today in order to protect Ranomafana's biodiversity. Together, they have striven to ensure that the local people receive benefits and an improved standard of living from the park.

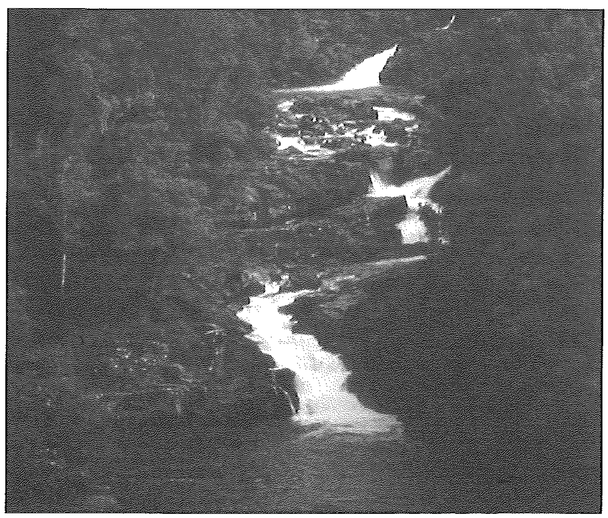


Figure 1: Ranomafana National Park contains some of Madagascar's last virgin montane rain forest.

Background

Madagascar had been called "an island, a continent, a world . . . a microcosm of the planet" (Jolly 1980). Madagascar separated from mainland Africa approximately 165 million years ago, and the resulting isolation has led to a high degree of endemism. Approximately 80% of Madagascar's biota is unique (Bradt *et al.* 1996) and the island is famous for its 32 lemur species, 30 chameleon species, and other unusual flora and fauna. Unfortunately, Madagascar is also a microcosm of the world's biodiversity crisis; its human population, with a 3% growth rate, has cleared an estimated 90% of the country's total vegetation since the arrival of the first humans approximately 1,500 years ago (Wright 1997). Soil erosion rates are so great that Madagascar has been described as an island "bleeding to death," as Landsat images depict it surrounded by pink water, dyed by its bright red soil.

Both the Malagasy and the international conservation community consider protecting Madagascar's biodiversity a top priority. In the late 1980s, international agencies such as the World Bank and United States Agency for International Development (USAID) collaborated with Madagascar to draft a 15-year Environmental Action Plan (EAP). This was the world's first countrywide EAP and has since been emulated in over 20 countries (Wright 1997). Under Madagascar's EAP, nine national parks and other protected areas (including RNP) were selected for integrated conservation and development projects (ICDPs).

During the first phase, the Institute for the Conservation of Tropical Environments (ICTE)[1] was responsible for RNP management and ICDP implementation. In June 1997, Madagascar's EAP passed into its second five-year phase. This phase shifts RNP management from ICTE to Madagascar's National Association for the Management of Protected Areas (ANGAP). However, during this transition (and perhaps beyond), ecological monitoring, health services, and education will remain under the auspices of ICTE, while development activities will continue under Cornell's International Institute for Food, Agriculture and Development (CIIFAD). If this transition proves successful, RNP could serve as a model for how multinational organizations can provide the impetus and funds to begin conservation projects, and how such projects can eventually revert to national management for effective long-term protection.

Methods

Opinions and suggestions were gathered through semi-structured individual interviews with past and present RNP managers in order to assess past successes and failures, and to provide recommendations for both the current transition and the park's future management. An ancillary project objective was to appraise relations between local villages and the park through semi-structured group interviews that would offer villagers an opportunity to voice their concerns about the management transition.

Two general questionnaires were designed: one for those in park management (Part I) and another for the villages visited (Part II). For Part I, individuals were chosen based on their management positions: three current or future ANGAP employees, an ICTE associate, and two CIIFAD employees. For Part II, four villages were selected with the assistance of a local expert: two that had received many benefits from the park's projects, and two that had received few benefits.[2] It was ensured that the two main ethnic groups of the region, Tanala and Betsileo, were equally represented among the four villages.

A local cultural guide interpreted and assisted me with village customs during visits with village elders. In Malagasy culture, elders typically speak for their villages. Therefore, this study's assessment of village sentiments was based primarily on interviews with elders, though other villagers were always encouraged to participate in group interviews.

Results and Discussion

A local woman captured the general sentiment of all four villages when she asserted that "[w]e must have a means of raising and collecting food. If the park wants to tell us to stay out of the forest and cease to do *tavy* [shifting agriculture] then they must provide and teach [us] alternatives. If the park simply forbids [traditional resource use] activities and doesn't give us some assistance, then we will be forced to 'steal' or break the laws by going into the forest to provide food for our families" (personal communication).

Village dependency on the ICDP was the most significant issue raised by both park officials and local people. While successful in some of the park's surrounding villages, the well-intentioned goal of including local people in the park's creation and its benefits has yet to result in a sustainable system of community-based conservation. Resource extraction still occurs in the park, partially because enforcement responsibilities are divided between ANGAP and Madagascar's Department of Water and Forests (DEF). While ANGAP can observe illegal activities occurring in the park, only DEF can arrest or fine violators. As DEF does not maintain a strong presence in the area, enforcement is weak. Because poaching and guns are virtually nonexistent in RNP, park managers believe that routine patrols to ensure that people are not logging, farming, or removing natural products (such as tree ferns or strangler fig vines) would be adequate enforcement. The issue of whether DEF should increase its presence or give ANGAP greater enforcement authority needs to be resolved by both agencies.

The high rate of deforestation adjacent to RNP boundaries is another potential barrier to natural resource sustainability. With the help of CIIFAD and others, a regional development program is being implemented to assist in redefining the relationship between local people and the park and to improve agricultural methods, thus decreasing the need for additional land. Although an ecological monitoring program began in 1995, it is difficult to conclude if the park is large enough to sustain the current level of biodiversity indefinitely (see MacArthur and Wilson 1967, Diamond 1972, and Newmark 1995). Therefore, it is imperative to focus more on conserving forested areas adjacent to the northern and southern park boundaries.

One of the ICDP's more successful components is the health and family planning program, which has helped many families embrace the idea of smaller families as part of its drive to reduce growing pressures on the park's and surrounding area's natural resources. However, a reduction in population growth will only take place when all villages have access to contraceptives, and achieve the security of lower infant mortality rates. Successful environmental and general education programs are helping to ensure that local youth are knowledgeable about their park, and why and how they can conserve it. Both managers and local people agree that every effort should be made to continue these programs, and to train local people to become teachers themselves.

During EAP's first phase, ecotourism development was a high priority and this emphasis continues under ANGAP. Although the park's long-term success partially depends on revenue from tourism, any infrastructure expansion must be undertaken with great care. Much of the park area's recent construction (including a scenic overlook, restaurants, and small hotels) has occurred on steep, forested slopes now prone to erosion, highlighting the urgent need for a comprehensive infrastructure plan for the RNP area. Many believe that construction within park boundaries should be kept to a minimum, and that construction surrounding the park should be well-planned and ecologically sensitive. However, any such efforts must include Madagascar's Department of Tourism, as ANGAP does not have jurisdiction outside of the park.

The consensus among ANGAP, ICTE, and CIIFAD is that improved communication and cooperation is vital to the park's success. During the transition period, they have agreed to meet monthly to coordinate efforts and collaborate more effectively. In addition, better communication between the area's villages and park headquarters is needed. Many villagers are unaware of the

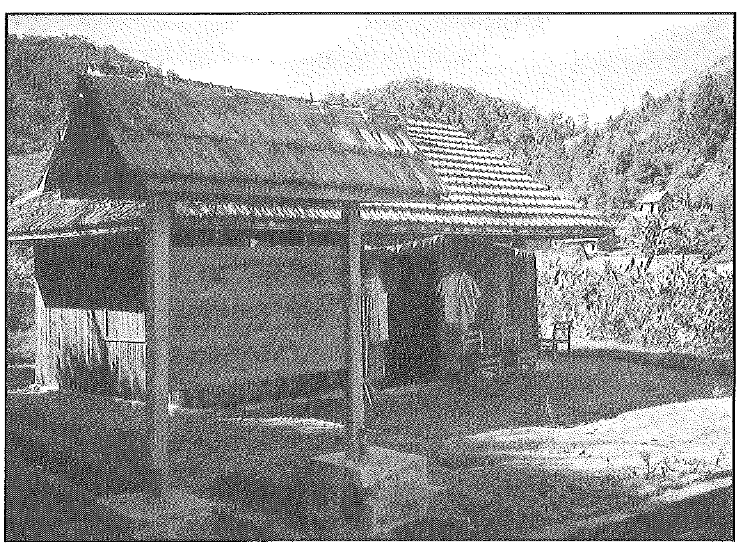


Figure 2: A craft shop built as part of the Integrated Conservation and Development Project.

existence and function of the organizations responsible for RNP's management, what is occurring during the transition, and to whom they should address their concerns. Ideally, representatives from park headquarters ought to travel to villages in the area to explain the transitional phase and respond to local concerns.

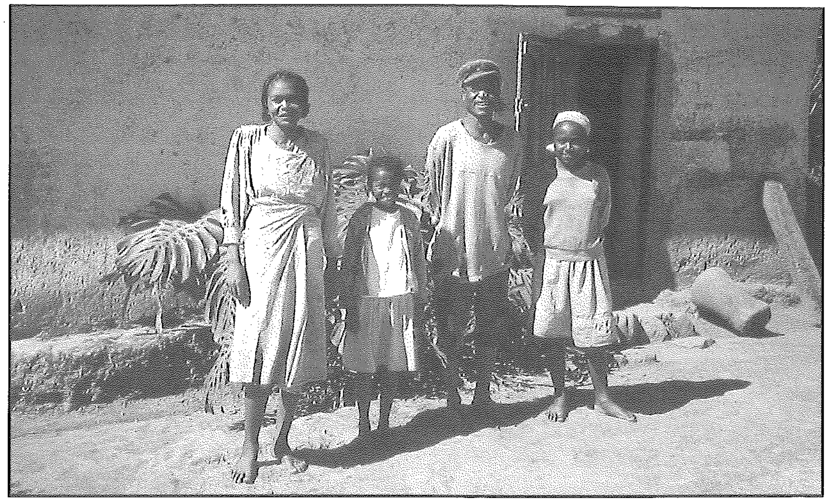


Figure 3: Residents interviewed in Sahavondronona, a peripheral-zone village outside Ranomafana National Park.

Conclusion

When attempting to place the Ranomafana National Park in a broader context, it must be noted that ICDPs around the world have met with variable degrees of success (Wells and Brandon 1992). Indeed, many conservationists have dismissed ICDPs as ineffective at conserving biodiversity. Although the implementation of Ranomafana's ICDP has not been problem-free, it appears to be working better in the short-term than many other ICDPs in Madagascar and elsewhere. Fortunately, RNP has not fallen into a common ICDP trap in which an organization tries to accomplish too much in too short a time.

Most everyone involved in taking RNP beyond the initial ICDP phase recognizes that the area's long-term economic development is inextricably linked to long-term conservation goals. The integration of conservation and development will probably be more effective as people adopt this concept individually, instead of being mandated to do so by the ICDP. Glenn Lines, an agricultural specialist with CIIFAD based in RNP, stated that "[t]he world will be watching Ranomafana [National Park] move beyond the ICDP phase. Forced integration will hopefully be replaced with cooperative collaboration" (personal communication).

During my stay, I discovered that the warmth and cooperative spirit of the Malagasy people is matched only by the beauty and biological wealth of the Ranomafana rain forest. It is crucial that future conservation and development goals complement one another, to ensure both the people and the forest a secure future.

Acknowledgments

I would like to thank Dr. Wright for providing the opportunity to conduct research in RNP and for advising me along the way. Special thanks to the wonderful RNP, CIIFAD, and ICTE staff. Thanks also to my interpreter Etienne Razafinaraboto, and to Dr. Stephen Kellert for assistance with the analysis. My sincere gratitude to the residents of Sahavondronona, Masomanga, Ambodiguavy, and Ambalavao for their patience and goodwill. I am also grateful for the support provided by the Yale Tropical Resources Institute.

Cooperator Notes

This research was conducted in Madagascar with the help of the Institute for the Conservation of Tropical Environments (ICTE), which has offices in Madagascar and at the State University of New York (SUNY) at Stony Brook. The ICTE-Madagascar office can be reached by e-mail at: micet@dts.mg or at B.P. 3715, Antananarivo 101, Madagascar. Dr. Patricia Wright, the Executive Director of the ICTE, can be reached via e-mail at: Pwright@datalab2.sunysb.edu or at: SUNY-Stony Brook, SBS Building, Fifth Floor, Stony Brook, NY 11794-4364 USA.

References

Bradt, H., D. Schuurman, and N. Garbutt. 1996. *Madagascar Wildlife*. Globe Pequot Press, Inc.: Old Saybrook, Connecticut.

Diamond, J. M. 1972. Biogeographic kinetics: estimation of relation times for avifaunas of southwest Pacific islands.*Proceedings of the United States National Academy of Sciences* 69:3199-3203.

Grenfell, S. and L. Robinson. 1995. The Ranomafana National Park Management Plan. The Ranomafana National Park Project Report.

Jolly, A. 1980. *A World Like Our Own*. Yale University Press: New Haven, Connecticut.

MacArthur, R.H. and E.O. Wilson. 1967. *The Theory of Island Biogeography*. Princeton University Press: Princeton, New Jersey.

Newmark, W.D. 1995. Extinction of mammal populations in western North American national parks. *Conservation Biology* 9:512-526.

Wells, M. and K. Brandon. 1992. *People and Parks: Linking Protected Area Management With Local Communities*. The World Bank: Washington, DC.

Wright, P. 1997. The future of biodiversity in Madagascar. In Goodman, E. and B. Patterson, Eds., *Environmental Change in Madagascar*. Smithsonian Institution Press: Washington, DC.

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[1] A nongovernmental conservation organization created by Dr. Patricia Wright.

[2] Benefits were considered to be any form of assistance from the park project, including health care, education, and agricultural aid.

Problems of Participation in Kyabobo Range National Park, Ghana

By David Bowes-Lyon
Candidate for Master of Environmental Studies

In the forest-savanna mosaic of eastern Ghana's highlands, the village of Shiare perches on a cliff face below Kyabobo Mountain. Founded centuries ago to avoid regional tribal wars, Shiare continues to be controlled by a powerful and influential cult; pilgrims from across West Africa come to consult Brukung, the traditional God. A visitor to Shiare might find women pounding cassava or yams, or making soap from locally-gathered palm nuts. The men might be resting from digging yam mounds, weeding the fields, hunting, or collecting honey — activities that often demand hours of walking in the surrounding forest. This could be any village in tropical West Africa, except that less than half a kilometer away, Ghana is creating a national park. It has the potential to change everyone's lives. . .

Figure 1: Shiare village and the proposed Kyabobo Range National Park boundary across the valley.

The initial interest for establishing a national park in the Kyabobo area stemmed from its proximity to the Fazow-Malfacassa National Park in Togo, as it could provide opportunities for international cooperation. After the Ghana Wildlife Department (WD) conducted biological surveys in 1991, it was apparent that the area encompassed a remarkable diversity of flora and fauna. In particular, there were reports of relatively high mammal populations. Until recently, the Kyabobo area could still boast about trading truckloads of bushmeat such as bushbuck (*Tragelaphus scriptus*), duiker (*Cephalophus* spp.), and bushpig (*Potamochoerus porcus*) across the country (Mertz, 1975).

Following these initial surveys, the Kyabobo Range National Park (KRNP) was demarcated in 1991. This occurred without any formal assessment of local peoples' needs and with limited communication with them. However, in response to local opposition, WD has since re-demarcated the park twice, each time reducing its size by excluding farmland. Such reconsideration stems from WD's new policy that "if protected areas are to be developed sustainably, they should aspire to meet the basic needs of local people in an equitable way" (Government of Ghana 1994). Such a policy of participation is currently selected globally to avoid the marginalization of resident peoples around national parks (IIED 1994, West and Brechin 1991).

Although a policy exists for integrating rural development with conservation needs, translating this policy into terms that are practical on a local scale is a difficult process. Indeed, frustrations and tensions persist between the government and the local people, as articulated by a local farmer: "We don't know why the government is here. We think they are here to cheat us and they want to break us from our activities" (pers. comm.). While both the area's residents and governmental organizations acknowledge that there are problems associated with land management in the Kyabobo area, these are often presented in divergent ways, depending on the party's perspective. My research examined these ongoing tensions and evaluated some of the different dimensions which are necessary to clarify the problems surrounding KRNP's development. The primary goal of this research was to first determine the participants and institutions involved in this decision-making process, and then to evaluate how decisions regarding land and resource management in and around KRNP were made.

Methods

This study analyzed the problems behind KRNP's development through the use of the Policy Sciences Framework (Lasswell 1971). This framework is a method that describes problems within a decision-making process and a social context, and clarifies them using assessments of historical, present, and future conditions.

To develop a conceptual model of KRNP's management challenges, I first worked with the wildlife officer in charge of KRNP to ascertain both the government's perceptions of the complex problems management faces and its goals for the park (Diagram 1). I then analyzed the model's assumptions through semi-structured interviews with various local people (key informants, and randomly selected hunters and farmers) and institutions (the local District Assembly, WD, and the Department of Food and Agriculture). Lastly, I assessed local perceptions towards the park's management, as well as the effect of shifting cultivation, hunting, and other natural resource uses on the area's flora and fauna. The park's impact on these activities (particularly hunting) was a focal point of discussion, since they were, and continue to be, priorities for most local people and the Wildlife Department.

Results and Discussion

All study participants agreed that farming, land tenure, hunting, and logging were the key issues affecting KRNP's establishment and long-term success. However, perceptions of the area's problems, solutions and facts varied considerably. As some social scientists have postulated, "[t]here is not a problem, but a multiplicity of contending and contradictory problem definitions, each of which takes its shape from the particular social and cultural context that it helps to sustain" (Thompson and Warburton 1986). Therefore, clarifying the true context of these problems was a crucial component of this study.

The Social Context

To assess the social and cultural context of this problem, it was essential to clarify who the players were, and to examine them from different perspectives since "observations of a higher level of organization [such as a community] ignore the distinctions embodied in the surfaces of the entities at lower levels [such as households or individuals]" (Allen and Hoekstra 1992). To avoid the pitfalls of overgeneralization, I assessed individuals' occupation, farmland location, religion, clan, gender, class, and educational background. Larger entities such as "local communities" and "the government" were also compared. In addition, the use of Venn diagrams (a graphical way of illustrating interactions between sets and subsets) allowed me to illustrate how people can be members of many informal and formal institutions simultaneously (Hidden Harvest Project 1995).

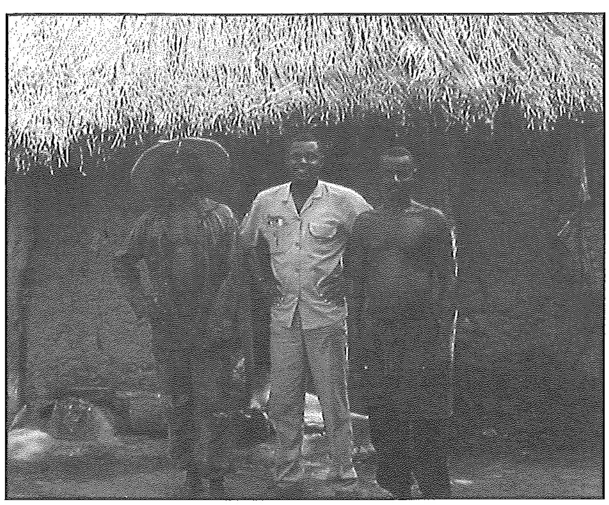


Figure 2: The park's Senior Wildlife Officer, B. L. Kanton (center), collaborates closely with farmers who are affected by the park.

The various government entities that exert influence over resource management around KRNP represent a wide range of perspectives and capacities. The local government, consisting of a District Assembly, with both elected and appointed positions, has embraced the idea of the park to "give employment, and generate funds for the District Assembly through tourism … [which] will bring us together and extend fraternity." The District Chief Executive is fully supportive of Wildlife Department and agrees with the Senior Wildlife Officer's main points. The local government viewed the primary constraint surrounding the KRNP's management as emanating from trouble-makers in Shiare, rather than from an is not shared by everyone in the District Assembly. One local assemblyman articulated the difficulties involved in the park plan when he stated, "Moving people for the sake of animals and expecting [them] to work together is like trying to force a woman to marry" (pers. comm.).

The National Government is directly involved with KRNP through the Wildlife Department, whose main objective is to conserve natural areas to the exclusion of human activity. Its policy often follows a Western scientific approach and is thus reductionist. In keeping with WD's traditional focus on wildlife conservation, KRNP's first enforced laws involved the confiscation of bushmeat and firearms, and a clampdown on the bushmeat trade. The WD also works informally with the surrounding villages, and the Senior Wildlife Officer in charge of KRNP strives to maintain effective communication between the park management and local participants (Figure 2).

The KRNP's surrounding communities are mainly of the Akyode ethnic group, whose principle village is Shiare (Figure 1). The Akyode cosmology could be described as "a body of collective representations of the world, ordered in space and time and man's place in it" (MacGaffey 1986). Despite this view, current local perceptions of the interrelationships between the human population and the area's natural resources vary. Regarding the reduction in local wildlife populations, one villager felt that "as the human populations have increased, animals have gone far away," while another believed that there are "less animals due to more guns and more need for cedis (money)" (pers. comm.).

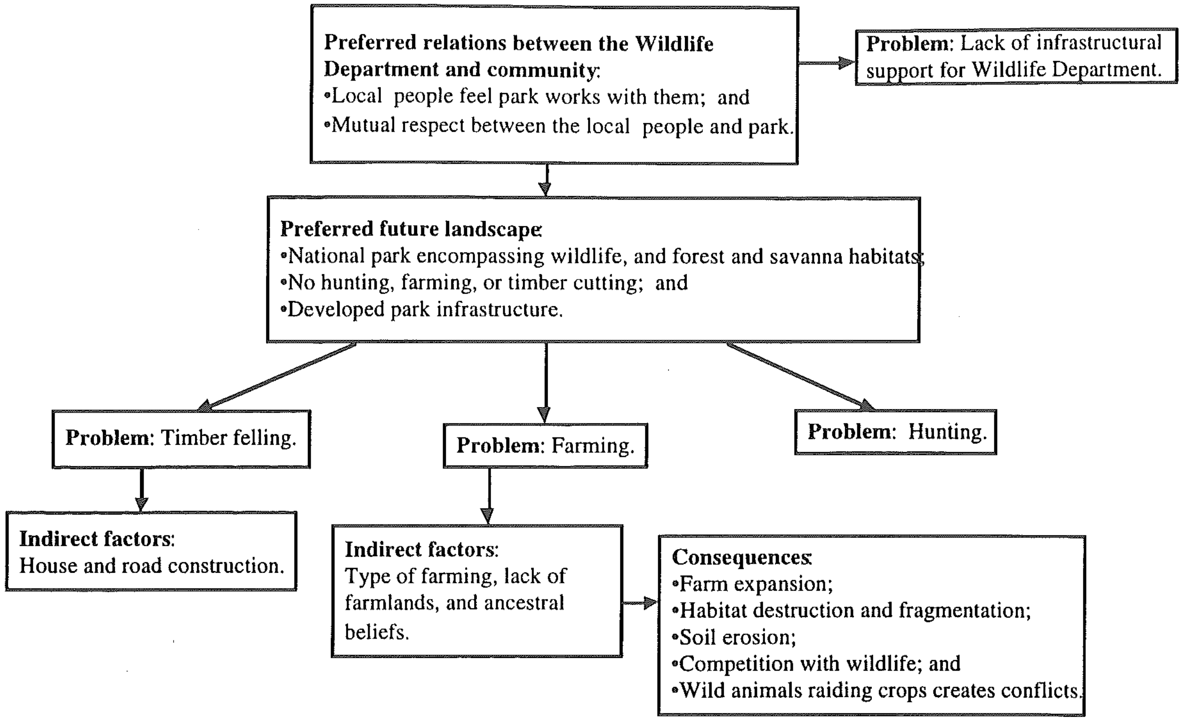
To merely describe the range of worldviews between (and among) local communities and government is insufficient. In order to understand the context completely, it is important to assess the extent to which resources are available to each participant. Even though the government institutions have the legal and executive jurisdiction, they do not have absolute power over the park's management. If local people passively resisted the park's administration, management would be difficult, if not impossible. Therefore, to implement their policies the government institutions must rely on values apart from power, such as respect, wealth, and education.

Individual local residents are generally resource poor, and hence have little input into the decision-making process. However, there is substantial internal variation. Those Akyode people considered wealthy, well-educated, well-respected, or possessing religious authority have more access to the decision-making process.

Decision making related to Kyabobo Range National Park

To institutionalize KRNP, WD gathered and processed

Diagram 1: A conceptual model of preferred goals of Kyabobo Range National Park and its problems in realizing them, from the perspective of B.L. Kanton, wildlife officer in charge of KRNP.



Main indirect factors that contribute to the problem: economic livelihoods (the need for immediate cash), lack of support for controlling activities, and attitudes of Shiares and Kyillinga villages.

In particular: a) internal politics, b) division of clans, c) power of cult, d) lack of communication, and e) inability of literates to enlighten rest of village.

data. Although easily obtained, this data had the potential to generalize this social context, since local information sources are often diffuse and difficult to quantify. This situation often results in the local population's exclusion from the decision-making process. Therefore, in conjunction with the local government, the Wildlife Department has drawn up a park policy and has begun to apply it. Local people can promote their views to the government, and these are generally acted upon when they correspond with the perceived common interest. This was the case when large tracts of farmland were removed in the park's third demarcation (O'Keefe *et al.* 1997).

In all issues regarding park management, decision-making is a complicated process with many different people trying to influence the outcomes. The use of wildlife illustrates this point clearly. Wildlife is used in a variety of ways by villagers. The most widespread use involves trapping small mammals around farms for both household consumption and crop raiding reduction. In addition, some "professional hunters" provide bushmeat to local market traders and their networks to earn more cash, more quickly, than the income received from cassava farming, for example. Lastly, traditional hunters continue to hunt for respect and religious reasons.

While many villagers acknowledged that "formerly there were more animals", they also stated that "there is no way for full local control as we do hunting for our own consumption" (pers. comm.). Thus villagers viewed declining wildlife populations with a different type of concern than the Wildlife Department stated (Chart 1). Instead, the villagers were primarily concerned with their lack of monetary resources, land availability, and various threats to their livelihood, such as wildlife raiding their fields. Many people complained that "we have to use our own strength for farming as we can't get laborers" and "we have to protect the farming areas from animals" (pers. comm.). As a result of potential government control of local natural resources (land and wildlife), the communities viewed the park as a threat to both their culture and their future income-generating possibilities.

Conclusion

The problem-oriented and contextual approach used in this study helped to clarify some of the uncertainties and complexities regarding KRNP's management. With certain issues, such as wildlife exploitation, it was evident that the study participants framed the issue in varying terms. Therefore, rather than attempt to generalize and find a "solution" to the "problem," it became apparent that clarification of the party's various desired outcomes, and the necessary issues for reaching a compromise, was more important.

This study highlighted several key issues that require resolution if a participatory park strategy is to be successful. The varying perceptions of the meaning of development need to be clarified, made mutually comprehensible, and ultimately integrated. Further thought needs to determine how general policies can be applied in different local contexts where multiple interests are at stake, and information is insufficient. Specifically, how should the Wildlife Department apply a policy that to date no one knows how to implement effectively? Perhaps most importantly, the issue of local land management needs to be understood in order to successfully work with, and not against, local practices. There needs to be a heightened awareness of the factors causing local people's vulnerability. Lastly, to fully understand the problem requires an historical perspective; for example, this may shed light on why local people often distrust national government representatives or foreigners.

Despite many complexities and uncertainties, it looks promising that "a good neighborhood between the [local] community and protected area authorities" (Bahian, 1997) may be created . Therefore, it is essential that varying perspectives on pertinent issues be continually clarified and mutually understood in order to permit compromises to be reached, and conflicts avoided. As the chief of Pawa village (adjacent to KRNP) said, "We want to be sure that we do not get a scorpion as an in-law."

Acknowledgments

I would like to thank everyone who made this study possible. Kanton Luri Bahain (the wildlife officer in charge of KRNP) provided considerable guidance and was the source of many of the discussions regarding the park and its future. Jonathan Dente and Augustine Ntinke worked as research assistants. Edward O Keefe, Paul Chambers provided assistance both before and during the study. Finally, Jen Hurst's endless patience and interest helped to ensure the success of this study.

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Cooperator Notes

This work was facilitated by the Ghana Wildlife Department (WD) and the Kyabobo Conservation Project (KCP), a British non-profit organization which works in and around the National Park. KCP may be contacted via e-mail at kyabobo@aol.com, or Jen Hurst, (KCP), Deepdene, Wadhurst, East Sussex, U.K. The WD is responsible for national parks (and other protected areas) and wildlife management. The WD counterpart was Bahian, Luri Kanton. We obtained permission from the Chief Wildlife Officer (Mr. Ankudey). They can be contacted at Ghana WIldlife Department, P.O. Box M239, Ministries Post Office, Accra, Ghana. Fax: 233-21-666476, or via e-mail: wildlife@ghana.com

References

Allen, T.F.H. and T.W. Hoekstra. 1992. *Toward a Unified Ecology*. Columbia University Press. New York.

Bahain, K.L. 1997. *Proposed Community Based Conservation Program in Ghana, A Case Study of Kyabobo Range National Park.* Diploma Thesis, College of African Wildlife Management, Mweka, Tanzania.

Government of Ghana. 1994. *Policy for Wildlife and Protected Areas.* Revised Policy, Unpublished Report.

Hidden Harvest Project. 1995. *The Hidden Harvest: The Role of Wild Foods in Agricultural Systems. Local level economic valuation of Savanna Woodland Resources: Village Cases from Zimbabwe.* Compiled by the Hot Springs Working Group. IIED Research Series, Vol. 3, No. 2.

IIED. 1994. *Whose Eden: An Overview of Community Approaches to Wildlife Management.* IIED, London.

Lasswell, H.D. 1971. *A Preview of Policy Sciences.* American Elsevier: New York.

MacGaffey, W. 1986. *Religion and Society in Central Africa: The Bakogo of Lower Zaire.* University of Chicago Press: Chicago, Illinois.

Mertz, A. 1975. *Unpublished report of trip to north Volta Region.* Unpublished Report.

O'Keefe, E.O.K., K.L. Bahian, D.V. Bowes-Lyon, and A. Tordoff. 1997. *An assessment of the boundary of Kyabobo Range National Park.* KCP Report Number 1.

Thompson, M. and M. Warburton. 1986. *Uncertainty on a Himalayan Scale. An institutional theory of environmental perception and strategic framework for the sustainable development of the Himalaya.* Ethnographica.

West, P.C. and S.R. Brechin, (eds.). 1991. R*esident Peoples and National Parks: Linking Protected Area Management with Local Communities.* The World Bank: Washington, D.C..

Investigating the Management of *Calycophyllum spruceanum* in the Peruvian Amazon

By Robert D. Hauff
Candidate for Master of Forestry

Introduction

Calycophyllum spruceanum (Rubiaceae), locally known as capirona, is a fast-growing, multiple-use species that thrives in the *várzea*, the extensive floodplains of the middle- and upper-Amazon. The local population of European-Amerindian descent cultivates a diversity of crops on the nutrient-rich, alluvial soils.

Local uses of capirona include fuelwood for household cooking and producing manioc flour, charcoal, construction beams for dwellings, and various medicinal applications. The wood can also be sold as firewood to city dwellers, fuelwood to sawmills, and boardwood on the export market for parquet floors.

In the early 20th century, capirona was over-exploited to fuel the steam-powered boats which were once the primary form of long-distance transportation in Amazonia. Although stands of capirona still exist along the Amazon and many of its tributaries, local management would help safeguard this economically valuable species while raising local living standards. A better understanding of how to manage capirona is needed to ensure its sustained future production to meet the growing demand for its products.

Capirona management can be incorporated into local agricultural systems as an agroforestry swidden-fallow phase. Capirona's silvical traits make it an excellent candidate for small-scale sustainable production as it naturally colonizes swidden fields with its abundant, wind-dispersed seed crop. Capirona grows to pole-size diameters within six to eight years, maintaining a narrow crown while devoting its resources to rapid height growth. The species often dominates *várzea* forest stands forming near-monocultures locally referred to as capironales. As a self-pruner, capirona avoids damage by lianas and produces high quality wood. Perhaps most importantly, capirona is adapted to survive and flourish during the large annual floods characteristic of the *várzea.*

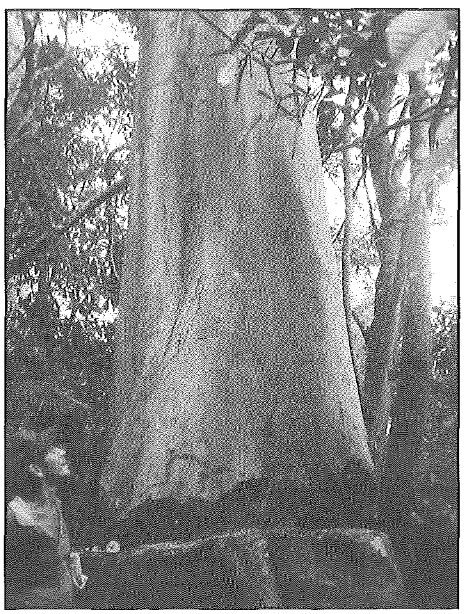


Figure 1: An adult capirona tree that has been girdled and left to dry for firewood.

Although the natural regeneration of capirona in farmers' swidden fields is often quite dense, it occurs in highly dispersed clumps. If an adult tree is not proximate to the field, regeneration is absent. Therefore, for the most effective management of capirona production in swidden-fallow systems, artificial regeneration would be advantageous. This six-month study investigated the potential for incorporating capirona into agroforestry systems as a swidden-fallow management phase, thereby bolstering natural regeneration where it already exists and establishing plantations where it is absent. This article discusses the preliminary results of the study's first two months of data.

Site Description

The experiment was conducted in Tapirillo, a rural village in a floodplain of the Amazon River (4°05' S, 73°15' W) approximately 60 km south (upstream) of Iquitos, in the Department of Loreto, in northeastern Peru. Monthly average temperature ranges between 24° and 27°C, and mean annual rainfall is 2,800 mm; the dry season occurs from July through September with monthly rainfall averages between 150 and 200 mm (Chibnik 1994).

Annual floods are the driving force of seasonal variation in the várzea and can extend 15 to 25 km in width (Chibnik 1994). The difference between the high and low water levels can be as much as 11 m (Lamotte 1990), with the high-water level occurring in May and the low in August. The high fertility of the annual sediment deposition supports prolific vegetative growth.

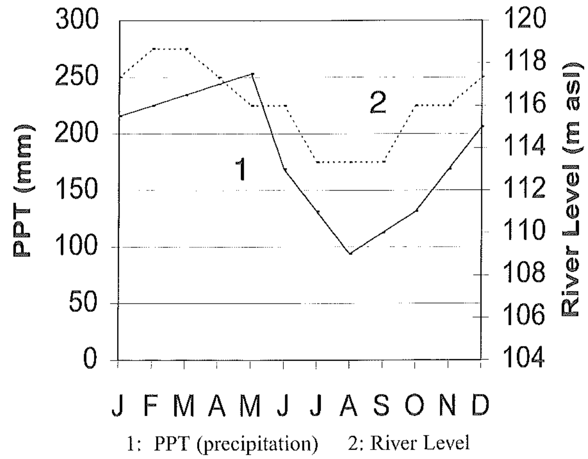
In July 1997, an experimental plantation about 250 m^2 was established on a low levee adjacent to the river. Previously, the site had been under cultivation for manioc (*Manioc esculenta*) and papaya (*Carica papaya*), and had been abandoned for six months. A semi-aquatic grass (*Panicum purpurens*) covered most of the plot and was cut down with machetes. No canopy cover existed, and although a secondary forest along the northwest border provided late-afternoon shade, the plot was in full sunlight for the remainder of the day.

Methods

Naturally regenerated capirona seedlings[1] were found in an abandoned swidden field approximately five km from the planting site. Two methods of lifting were used to remove the seedlings. Approximately one-half of the seedlings (132) were lifted by loosening the soil around the plant with a machete and gently removing the soil from the roots (bare-root method). The remainder (110) were removed with the soil intact around the roots by using a machete to dig up the rain-moistened soil surrounding the seedling (soil-intact method). The soil-root masses were transported in plastic bags to the plantation site, where they were planted the following day.

The roots of the bare-root seedlings were kept in water overnight prior to their replanting the following day. All but a few leaves were pruned on each of the seedlings to prevent desiccation of the remaining foliage. The seedlings' leaves retained their turgor between lifting and transplanting.

Observations were made to determine if the transplanted seedlings had retained turgidity or had wilted, both immediately after planting and one week later. Monthly tree height measurements were taken beginning in July 1997 through January 1998. Seedling heights were measured only when leaves remained on the plant, and weeding of the seedlings was performed at this time. Leaf turgor and wilt were used to measure the response to transplant shock. The influence of thedifferent transplant methods and seedling heights on both transplant shock and growth was assessed.



Graph 1: The river level is low enough for planting between approx. June and December, but the dry season water stress lasts from July to September. These two temporal scales are important when planting capirona seedlings.

Preliminary Results

The first day following replanting, none of the bare-root seedlings had retained their leaf turgidity, while 51.8% of the soil-intact seedlings lifted had retained turgidity in some of their leaves. One week later, only 3% of the bare-root seedlings had gained turgor, while the number of soil-intact seedlings with turgid leaves increased to 74.5%. After one month, turgid bare-root plants had increased to 9.5%, while turgid soil-intact plants had increased to 75.5%.

The soil-intact seedlings were analyzed to correlate plant size to turgor retention. Although there was a trend for larger seedlings (greater than 80 cm) to wilt more than smaller seedlings, the difference was not significant. Height growth during the first month averaged only two cm among the surviving soil-intact seedlings (standard deviation of 2 cm).

Discussion

Leaf turgor was used as an indicator of recovery from transplant shock. While many seedlings transplanted by both methods lost their leaves following post-planting wilt, they retained the capacity for sprouting new buds. (This was also observed on seedlings that lost their leaves due to submergence during the annual flood.) The leaves formed by these sprouting buds would typically not survive in direct sunlight. While sprouting gives the plant an opportunity to recover temporarily, growth can not be sustained without foliage, and the plant could quickly be out-competed. Therefore, the retention of healthy leaves is a critical variable in capirona's ability to recover from transplant shock and survive to maturity, facilitating the rapid-growth strategy that young capirona seedlings utilize to cope with the annual floods and to out-compete other vegetation.

The difference observed in leaf retention between the two transplant methods is probably due to the differences in root system capabilities to supply water to the seedling. While the root-soil contact zone was broken in the bare-root method, it was largely preserved in the soil-intact method, thus allowing the seedlings to absorb moisture with their intact root hairs. Following the transplanting, the soil remained moist from repeated rainfall, and soil moisture levels were sufficient to allow for the recovery of several plants from both transplant methods.

The sensitivity of capirona seedlings to post-transplant water stress implies that a tradeoff is necessary when considering the best conditions for transplanting capirona seedlings. Planting at the onset of the dry season (July) exposes seedlings to stressful conditions (heat and drought), necessitating a longer period to recover from shock before the annual floods. Whereas planting after the dry season (September) subjects the seedlings to more favorable (cooler and moister) conditions, there is less time to fully recover before the floods. Height growth is necessary to effectively tolerate the floods and quickly attain maturity[2], but transplant shock will be more severe in the seedlings planted before the dry season as a result of water stress. Transplanting must occur while water levels have receded beyond the lifting and planting sites (roughly June through February).

By increasing capirona yields, this more aggressive (labor-intensive) management could have higher economic profits than the more passive management of selective weeding and thinning typically seen in the region. However, the additional labor required for lifting, transporting, planting, and weeding the seedlings may render such management impractical. For example, if the optimal transplanting period were to coincide with more important economic activities such as rice cultivation, then the economic returns may not warrant such intensive management.

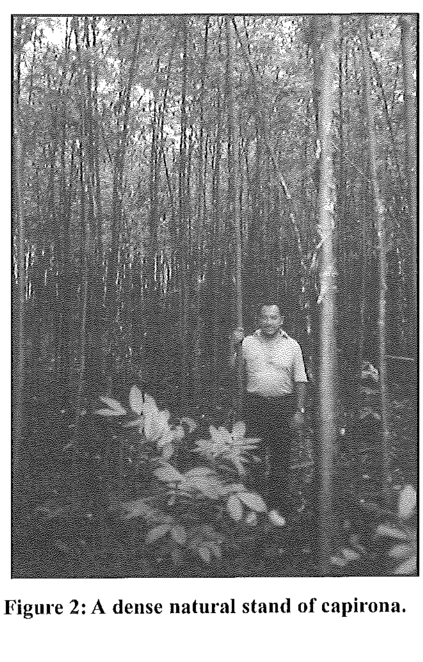


Figure 2: A dense natural stand of capirona.

Conclusion

The study's preliminary results indicate that using the soil-intact transplanting method could be a potential tool for managing capirona in swidden-fallow agroforestry systems due to the seedlings' high transplant shock recovery rate (75.5%). Further research in the Iquitos area to investigate the social context (such as economic cycles, seedling transportation costs, villagers' perceptions and values) and benefits of capirona management would lead to a better understanding of how this economically valuable, multi-use species could be managed sustainably. In a region where better economic opportunities for small-scale farmers is needed, artificial regeneration appears to be a technically feasible management option that merits recognition and further research attention.

Acknowledgments

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Cooperator Notes

My summer research in Peru was facilitated by Miguel Pinedo-Vasquez who works at the Center for Environmental Research and Conservation, 1200 Amsterdam Avenue, New York, NY 10027-5557. His e-mail is map57@ columbia.edu. In Peru, I worked with Compania Amazonica de Produccion Forestal (CAMPFOR), a private Iquitos-based Peruvian company which supplies agricultural and forestry assistance to rural communities. Mario Pindeo of CAMPFOR can be contacted via e-mail at: campfor@telematic.edu.pe

References

Chibnik, M. 1994. *Risky Rivers: The Economics and Politics of Floodplain Farming in Amazonia*. University of Arizona Press: Tucson, Arizona.

Lamotte, S. 1990. Fluvial dynamics and succession in the lower Ucayali River Basin, Peruvian Amazon. *Forest Ecology and Management* 33/34:141-156.

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[1] The seedlings ranged from 4 to 108 cm high, with an average height of approximately 42 cm.

[2] The necessary height for survival varies with location (elevation) within the floodplain and between years due to variability in flood levels. The greater the seedling height before the floods, the more quickly it will reach maturity.

Mixed-Species Tree Plantations in the Humid Tropics: an Alternative for Carbon Sequestration

By Daniel Shepherd
Candidate for Master of Environmental Studies

Introduction

Increasing levels of greenhouse gases in the atmosphere have emerged as a major global environmental concern. Although debate continues over the environmental ramifications of these higher levels, it is widely accepted that the amount of carbon dioxide (CO_2) in the atmosphere has increased from a mid-19th century pre-industrial concentration of approximately 270 ppm to a current concentration of approximately 350 ppm (IPCC 1995). To offset escalating atmospheric CO_2 levels, the amount emitted can be reduced, or captured from the atmosphere and stored in terrestrial and maritime ecosystems (Andrasko 1990).

The practice of using tree plantations as a CO_2 sink has gained momentum over the last decade (Andrasko 1990, Cairns and Meganck 1994). With increased interest in this practice, proper design and management of these systems becomes paramount. Improved techniques need to be tested to determine the most effective and productive land use option for carbon sequestration, particularly for degraded lands.

In addition to its carbon sequestering characteristics, well-planned mixed-species stands can provide more diverse forest products than monospecific stands and thus help decrease the farmer's risk of unstable markets (Wormald 1992). In nutrient poor soils, mixed-species stands can sometimes improve one species' survival and growth potential when planted with other suitable species (Binkley *et al.* 1992, Burkhart and Tham 1992). Furthermore, Perry and Maghembe (1989) found that species diversity decreased the likelihood of epidemics compared to monospecific stands. However, there is currently a lack of experimental evidence regarding the effects of mixed- and single-species stands on plantation yields in the tropics or sub-tropics (Wormald 1992, Kelty 1992).

This paper reports results on the biomass production for twelve indigenous tree species after six years of growth in three experimental mixed- and pure-species plantations in Costa Rica. Results from previous research on these plantations had indicated the capacity of mixed-species stands to produce relatively high biomass and carbon sequestration levels (Montagnini and Porras 1997). The results of this study were expected to be consistent with previous research findings. Although it is difficult to extrapolate over an entire rotation, recent results suggest design and management options which would enhance the tropical plantations' value as carbon sinks. Potentially, this could also make them economically attractive to local farmers.

Study Site

The experimental tree plantations were established on flat, uniform terrain in an abandoned pasture at the Organization of Tropical Studies' La Selva Biological Station. La Selva is located in the Atlantic humid lowlands of Heredia Province, Costa Rica (10°25'N, 86°59'W, 50 meters mean elevation, 26°C mean annual temperature, and 4,000 mm mean annual rainfall) (Sanford *et al.* 1994). The Fluventic Dystropepts soils are deep, well-drained, and stone-free, with low or medium organic matter content (2.5 - 4.5%), moderately heavy texture, acidic (pH < 5.0) and infertile, derived from alluvially deposited volcanic materials (Sancho and Mata 1987). Before planting, the site was manually cleared of shrubs and early successional trees. The slash was left on the floor to inhibit soil erosion and weed growth.

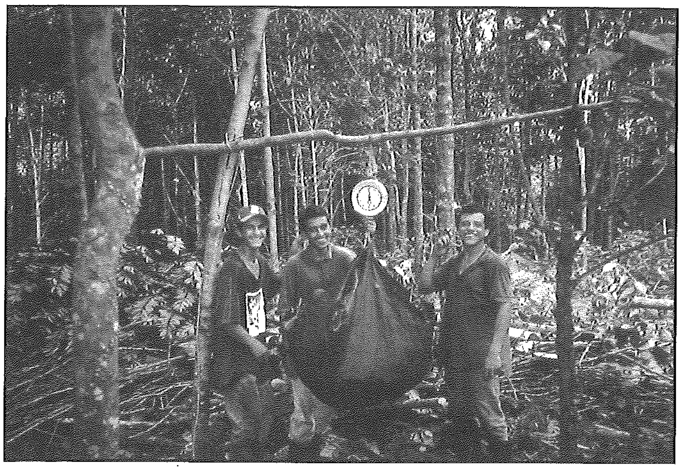

Figure 1: Field assistants demonstrating the hanging field scale used to weigh biomass.

In 1991-92, twelve indigenous tree species of economic value were planted in three plantations, each with four species. These species were selected according to growth rate, economic value, preference by farmers, nutrient cycling characteristics, and seedling availability (González *et al.* 1990, Montagnini and Sancho 1990). Plantation One (established in July 1991) consisted of: *Jacaranda copaia, Vochysia guatema-lensis, Calophyllum brasiliense* and *Stryphnodendron micro-stachyum*. Plantation Two (established in November 1991): *Terminalia amazonia, Dipteryx panamensis, Virola koschnyi* and *Albizia gua- chapele*. Plantation Three (established in November 1992): *Hyeronima alchorneoides, Pithecellobium elegans, Genipa americana* and *Vochysia ferruginea*.

Each plantation was divided into four replicates (64 m x 96 m) of six randomly assigned treatments (32 m x 32 m, each) containing four pure plots of each species, a mixed-species plot (with all four species) and a fallow plot. Each mixture of four tree species had at least one nitrogen-fixing tree, and each species had different architectural structures and growth rates (Montagnini *et* al. 1995). The trees were planted in a 2 m x 2 m grid to speed canopy closure. Following closure three years after planting, half of each plot was thinned by removing all of the trees in alternate rows, leaving a distance of 2 m x 4 m between each tree (1,250 trees/ha).

Methods

In the present study, the plantations were thinned again by removing half of the trees in each plot. This second thinning left a 4 m x 4 m distance between the trees (625 trees/ha). Three trees from each species with diameters close to the plot's diameter mean were selected from each plot for biomass determinations. Material from each tree was separated into stems, branches and leaves, and weighed at the site using a hanging scale. Samples of each tree's material were taken and dried to a constant weight. The dry:wet weight ratios were used to correct the field weight determinations based on the subsamples for each different plot and species type. The average biomass per tree was multiplied by the number of trees per plot, corrected for tree mortality and extrapolated to one hectare. A statistical probability analysis (T-test, α=0.05) was run to compare mean biomass of tree parts for each species for both the mixed- and pure-species plots.

Carbon accumulation was calculated for each plantation species using stem biomass values. Total carbon content was then calculated by assuming that the stem biomass is approximately 50% carbon (Brown and Lugo 1982). Lastly, average annual carbon increments were calculated by dividing the carbon accumulation per hectare by the respective plantation age (five to six years) to determine each species' ability to sequester atmospheric CO_2.

Results

Biomass per hectare in pure- and mixed-species plots

In Plantation One, the *V. guatemalensis* stand had the highest total biomass, followed by the mixed-stand and *J. copaia* stand, respectively, while *C. brasiliense* only had approximately half the highest total biomass (Table 1). *S. micro-stachyum* was barely found in these plots because of disease. The total biomass of the mixed stand with these four species (90.1 Mg ha^{-1}) was much larger than the sum of one quarter hectare of each species in the pure stands (10.8 + 21.0 + 22.8 + 0 = 54.6 Mg ha^{-1}).

In Plantation Two, the highest total biomass per hectare was found in the four-species mixture, followed by pure stands of *D. panamensis, T. amazonia, V. koschnyi,* and distantly by *A. guachapele* (Table 1). The mixed-species plot also had the highest values for tree parts, except foliage, for which *V. koschnyi* had slightly higher levels. Again, the sum of one quarter hectare of each species in the pure stands (7.06 + 13.7 + 12.8 + 12.4 = 46.0 Mg ha^{-1}) was lower than the total biomass of the mixed stand (57.0 Mg ha^{-1}).

In Plantation Three, the pure stand of *H. alchorneoides* had the highest total biomass per hectare, followed by *V. ferruginea*, the mixed-species stand, and the pure stands of *P.*

Table 1. Aboveground biomass per hectare of tree species in pure plots and four-species mixed plots for the three different plantations in La Selva, Costa Rica (means and standard errors).

	Aboveground Biomass (Mg ha-1)			
	Foliage	Branches	Stem	Total
Plantation 1[1]:				
Calophyllum brasiliense	9.39 (0.72)	13.1 (1.25)	20.9 (0.92)	43.3 (1.55)
Jacaranda copaia	2.51 (1.12)	1.03 (0.56)	82.3 (7.54)	83.8 (7.68)
Vochysia guatemalensis	4.68 (0.77)	6.09 (1.12)	80.5 (4.07)	91.2 (9.76)
FOUR-SPECIES MIXED PLOT	4.90 (1.26)	7.04 (1.92)	78.1 (7.37)	90.1 (8.13)
Plantation 2:				
Albizia guachapele	1.76 (0.60)	5.08 (1.04)	21.4 (4.12)	28.2 (5.65)
Dipteryx panamensis	4.75 (0.45)	10.9 (1.16)	39.1 (4.19)	54.8 (4.52)
Terminalia amazonia	4.80 (0.38)	8.7 (1.03)	37.8 (3.31)	51.2 (4.23)
Virola koschnyi	6.66 (0.89)	8.8 (0.62)	34.1 (2.59)	49.6 (2.48)
FOUR-SPECIES MIXED PLOT	5.25 (0.88)	12.0 (1.99)	39.8 (5.14)	57.0 (7.61)
Plantation 3:				
Genipa americana	0.95 (0.17)	1.21 (0.21)	7.11 (0.98)	9.27 (1.31)
Hyeronima alchorneoides	3.69 (0.54)	8.82 (1.02)	31.5 (4.36)	44.0 (5.21)
Pithecellobium elegans	1.73 (0.14)	2.76 (0.37)	19.3 (1.52)	23.8 (1.89)
Vochysia ferruginea	6.23 (0.76)	0.05 (0.76)	26.7 (1.75)	42.0 (2.93)
FOUR-SPECIES MIXED PLOT	3.88 (0.64)	9.42 (2.10)	22.7 (2.76)	36.0 (4.54)

[1] *The Stryphenodendron microstachyum were not thinned because of high mortality from disease (Montagnini* et al. *1995).*

elegans, and lastly *G. americana* (Table 1). In this plantation, the biomass values for the mixed-species plot was in the middle of the pure-species plots. As in the other plantations, the biomass sum of one quarter hectare of each species in the pure stand (2.32 + 11.0 + 5.94 + 10.5 = 29.8 Mg ha-1) was lower than in the mixed stand (36.0 Mg ha-1).

Carbon sequestration in pure- and mixed-species plantations

The mean annual carbon sequestration values for Plantation One were 1.74 - 6.86 Mg C ha-1 yr-1 (Table 2). It had three times as much carbon accumulation compared to Plantation Three, and twice as much as Plantation Two. In Plantation One, *V. guatemalensis* had the highest levels of carbon accumulation on both a per tree (36 kg C tree-1) and per hectare (40.2 kg C ha-1) basis, followed closely by both *J. copaia* and the four-species mixed stand. The total carbon accumulation in the *C. brasiliense* pure stand was approximately one quarter of the other stands.

In Plantation Two, the mixed-species plot had the highest amount of carbon accumulation compared to the pure-species plots. The mixed plot was followed by pure plots of *D. panamensis*, *T. amazonia*, *V. koschnyi,* and distantly by *A. guachapele.* On a per tree basis, Plantation Two's trees had one-third less carbon than Plantation One's. The mean annual carbon sequestration values varied less in Plantation Two (1.89 - 3.52 Mg C ha-1 yr-1) compared to the other plantations.

In Plantation Three, the pure stand of *H. alchorneoides* had the highest carbon sequestration values (15.8 Mg C ha-1), followed by *V. ferruginea*, the four-species mixed stand (11.4 Mg C ha-1), *P. elegans,* and lastly, *G. americana.* Plantation Three had the lowest overall levels of carbon accumulation, but had annual carbon sequestration (0.76 - 3.38 Mg C ha-1 yr-1) similar to Plantation Two's.

Annual carbon sequestration potential

When annual carbon sequestration was multiplied by the estimated plot rotation length, Plantation One's mean carbon storage was 44 - 117 Mg C ha-1, Plantation Two's was 38 - 69 Mg C ha-1, and Plantation Three's was 15 - 68 Mg C ha-1 (Table 2)[1]. These values are comparable to those reported for fast-growing species in humid tropical regions, such as *Acacia mearnsii*, *Leucaena* spp., *Casuarina* spp. and *Azadirachta indica* (8 - 78 Mg C ha-1) (Schroeder 1992). Because these results were obtained at an early age, rather than the plantation's time of harvest, they may represent an overestimation of carbon sequestration, as most carbon uptake occurs during the early part of the stand's rotation (Brown and Lugo 1982).

Discussion

Potential use of tropical tree plantations as a carbon sink

Forests sequester more than 92% of the world's terrestrial carbon, and store 20 - 100 times more carbon per hectare than agricultural lands (Andrasko 1990). The forestry option is not the only solution to the CO_2 problem, but a comprehensive approach should include forestation (Cairns and Meganck 1994, Brown and Adger 1994).

Based on this paper and other studies' results (Kelty 1992, Wormald 1992, Binkley *et al.* 1992), mixed-species plantations have biomass production rates comparable with pure-species stands. However, the mixed stands have additional advantages, such as greater pest and pathogen resistance, and provide multiple resource products that supply an additional source of income (Montagnini *et al.* 1995, Perry and Maghembe 1989, Wormald 1992). Furthermore, mixed stands use a variety of trees with different growth rates and timber market values. Thus, such stands provide suitable ecological conditions for the higher market valued, slower-growing species, while the stands' faster- growing species can be used for light construction and fuelwood purposes.

The use of tropical plantations as carbon sink forests has gained considerable interest since the United Nations first proposed the Joint Implementation idea in 1992 (IPCC 1995). In this strategy, a company in an industrialized country pays for a project to protect or expand forests in a developing nation in order to offset their CO_2 emissions. Although this program is thought to be a win-win situation, its actual success depends on achieving multiple objectives, including significant carbon sequestration, immediate financial rewards for local participants, future economic benefits from the use of forest resources, displaced demand on primary forests, and other environmental services (Cairns and Meganck 1994).

Conclusion

Tropical plantations can serve diverse economic, social, and ecological functions that may ultimately help reduce atmospheric CO_2 accumulation. This study provides insight into the productive potential of different tropical tree plantations to serve such functions and to demonstrate the application of mixed-species stands for small-scale farmers in the humid tropics. This study's results demonstrate that mixed-species stands can achieve production levels comparable to pure stands. If the beneficial biological properties of mixed stands were utilized and the high economic rewards were incorporated, then mixed-species stands would represent a possible development tool for tropical countries. However, for this stand management option to be feasible, further research is needed to better understand the economic factors of production in mixed- versus pure-species stands.

Table 2. Stem carbon accumulation on a per tree and a per hectare basis in pure- and mixed-species plots in La Selva, Costa Rica.

	Per Tree Stem Carbon (kg C/tree)	Per Hectare Carbon Accumulation (Mg C/ha)	Mean Annual Stem Increment (Mg/ha.yr)	Mean Annual Carbon Sequestration (Mg/ha.yr)	Estimated Rotation Length (years)
Plantation 1:					
Calophyllum brasiliense	10.3	10.4	3.48	1.74	25
Jacaranda copaia	34.2	40.1	13.7	6.86	12
Vochysia guatemalensis	36	40.2	13.4	6.71	15
FOUR-SPECIES MIXED PLOT	20.1	39.0	13.0	6.51	18
Plantation 2:					
Albizia guachapele	10.5	10.4	3.78	1.89	20
Dipteryx panamensis	18.9	19.6	6.91	3.46	20
Terminalia amazonia	23.3	18.9	6.67	3.34	20
Virola koschnyi	16.2	17.0	6.02	3.01	15
FOUR-SPECIES MIXED PLOT	17.2	19.9	7.03	3.52	18.75
Plantation 3:					
Genipa americana	5.1	3.56	1.53	0.76	20
Hyeronima alchorneoides	13.3	15.8	6.76	3.38	20
Pithecellobium elegans	8.1	9.6	4.13	2.07	20
Vochysia ferruginea	13.0	13.4	5.73	2.86	15
FOUR-SPECIES MIXED PLOT	9.9	11.4	4.87	2.43	18.75

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References

Andrasko, K. 1990. Global warming and forests: An overview of current knowledge. *Unasylva* 41:3-11.

Binkley, D., K.A. Dunkin, D. DeBell and M.G. Ryan. 1992. Production and nutrient cycling in mixed plantations of *Eucalyptus* and *Albizia* in Hawaii. *Forest Science* 38:393-408.

Brown, K. and W.N. Adger. 1994. Economic and political feasibility of international carbon offsets. *Forest Ecology and Management* 68:217-229.

Brown, S. and A.E. Lugo. 1982. The storage and production of organic matter in tropical forests and their role in the global carbon cycle. *Biotropica* 14:161-187.

Burkhart, H.E. and A. Tham. 1992. Predictions from growth and yield models of the performance of mixed-species stands. Pages 21-34, in: Cannell, M.G.R., D.C. Malcolm and P.A. Robertson (eds.). *The ecology of mixed-species stands of trees*. Blackwell Scientific: Boston, Massachusetts.

Cairns, M.A. and R.A. Meganck. 1994. Carbon sequestration, biological diversity, and sustainable development: Integrated forest management. *Environmental Management* 18(1):13-22.

González, E.J., R. Butterfield, J. Segleau, and M. Espinoza. 1990. Primer encuentro regional sobre especies forestales nativas de la zona norte y Atlantica, Memoria, Chilamate, Costa Rica, 28-29 de Julio, 1989. Instituto Tecnólogico de Costa Rica. Cartago, Costa Rica. Pp. 46.

Intergovernmental Panel on Climate Change (IPCC). 1995. *Climate change 1995-Impacts, adaptations and mitigation of climate change: Scientific-technical analyses.* Contributions of Working Group II to the Second Assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Pp. 878.

Kelty, M.J. 1992. Comparative productivity of monocultures and mixed species stands. Pages 125-141 in: M.J. Kelty (ed.), *The Ecology and silviculture of mixed species forests*. Kluwer Academic Publishers, Amsterdam.

Montagnini, F. and F. Sancho. 1990. Impacts of native trees on tropical soils: A study in the Atlantic lowlands of Costa Rica. *Ambio* 19:386-390.

Montagnini, F., González, E.J., Porras, C. and R. Rheingans. 1995. Mixed and pure forest plantations in the humid neotropics: A comparison of early growth, pest damage and establishment costs. *Commonwealth Forestry Review* 74(4): 306-314.

Montagnini, F. and C. Porras. 1997. Evaluating the role of plantations as carbon sinks: An example of an integrating approach from the humid tropics. *Environmental Management*. In press.

Perry, D.A. and J. Maghembe. 1989. Ecosystem concepts and current trends in forest management: time for reappraisal. *Forest Ecology and Management* 26:123-140.

Sancho, F. and R. Mata. 1987. Estudio detallado de suelos. Estación Biologica La Selva. Organización para estudios tropicales. San Jose, Costa Rica. Pp. 162.

Sanford, R.L., Jr., P. Paaby, J.C. Luvall and E. Phillips. 1994. Climate, geomorphology and aquatic systems. Pp. 19-33 in: L.A. McDade, K.S. Bawa, H.A. Hespenheide and G.S. Hartshorn (eds.). *La Selva: Ecology and natural history of a neotropical rainforest.* University of Chicago Press: Chicago, Illinois.

Schroeder, P. 1992. Carbon storage potential of short rotation tropical tree plantations. *Forest Ecology and Management* 50:31-41.

Wormald, T.J. 1992. *Mixed and pure forest plantations in the tropics and subtropics.* FAO Forestry Paper 103. FAO Technical Papers. Food and Agriculture Organization of the United Nations: Rome. Pp. 152.

Fruit and Seed Production by Mahogany (*Swietenia macrophylla*) Trees in the Natural Tropical Forests of Quintana Roo, Mexico

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Introduction

Mahogany (*Swietenia macrophylla* King) has been the most valuable timber species of the Neotropical forests since the arrival of the Europeans (Record 1924, Lamb 1966). In the state of Quintana Roo, southern Mexico, mahogany still represents a major source of timber-derived revenue for 44 of the state's forest communities. These communities control 956,000-hectares of land, of which 380,000-hectares are in forest reserves (Arguelles 1993). Mahogany is selectively harvested from these reserves using a minimum diameter at breast height (dbh) limit, and a 25-year cutting cycle derived from past transformation technology and concession agreements, rather than from insight into the species' ecology (Snook 1998).

Quintana Roo's forests are frequently affected by catastrophic events, such as hurricanes and the fires that often follow them. Such events have favored mahogany regeneration in essentially even-aged, mixed-species stands (Snook 1993, 1998). Since most mahogany trees in an area tend to reach commercial size simultaneously, selective harvesting to a minimum dbh limit often removes all seed sources from large cutting areas (Snook 1998). Since mahogany seeds lose their viability within six to nine months (Rodriguez and Barrio 1979, Parraguirre 1994), and seedlings do not survive for long under the forest canopy (Stevenson 1927, Lamb 1996), the current harvesting regime does not provide for mahogany's natural regeneration (Snook 1998).

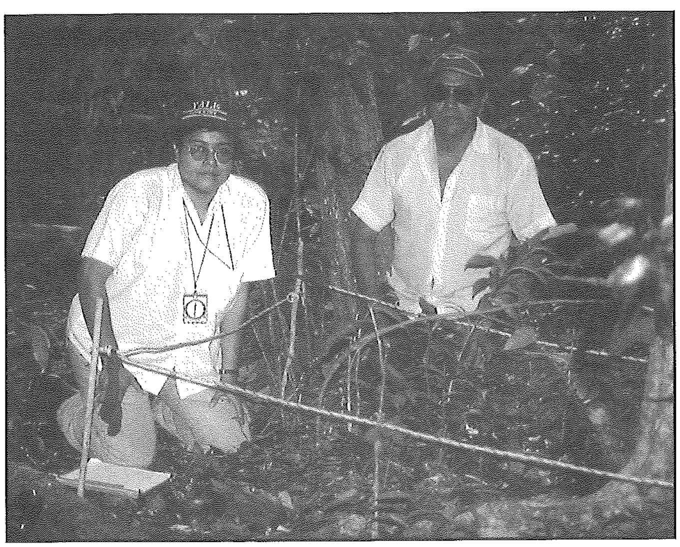


Figure 1: Fruit segment sampling in 2 m^2 plots under tree crown.

Mahogany regeneration must be established in each cutting area following every harvest to sustain mahogany harvests over the long-term. The least costly way to provide mahogany seed is to retain seed trees on site. This study was conducted to determine the rate of seed production of different-sized mahogany trees. The objective was to identify the densities and size classes of seed trees to be retained in order to provide for the best natural regeneration.

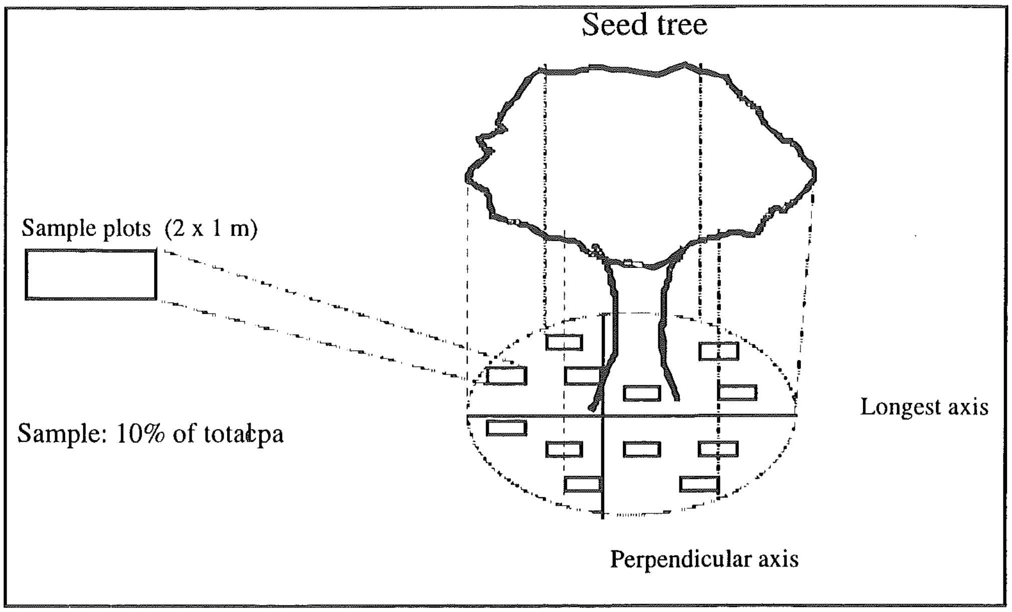
Site Description

Quintana Roo is characterized by seasonal dry forest (Holdridge 1971), in which many tree species lose their leaves for three to four months of the year (Lamb 1966, Pennington and Sarukhan 1968). In the mahogany forest of central Quintana Roo, annual rainfall is between 1,200 - 1,500 mm, with a marked rainy season between May and October, and a dry season from February to May (in Snook 1993). Mexico's National Institute of Information and Geography (INEGI 1994) classifies the soils of the three sample sites as *rendzinas.*[1]

Methods

Sample mahogany trees were found on forest reserves in several different areas of Quintana Roo, including forest reserves

Diagram 1: Methodology for crown projection area (cpa) and sampling fruit production



of the *Organizacion de Ejidos Productore Forestales, Zona Maya*, (OEPF-ZM)[2]. Fifteen trees were sought in each of five dbh classes. Three of these size classes (15 - 34.9 cm, 35 - 54.9 cm, and 55 cm or more) were derived from the classification used in the forest management plan (regeneration, reserve, and commercial, respectively) (Arguelles 1991). Because a previous seed production study in Bolivia (Gullison *et al.* 1996) had found that very large mahogany trees produced many more fruit than medium-sized trees, commercial trees were subdivided into dbh classes of 55 - 74.9 cm, 75 - 94.9 cm, and 95 - 115 cm.

Mahogany fruits are heavy, woody capsules that break into five segments while in the tree's canopy. The capsule segments then drop to the ground, and winged seeds (40-50 are packed into each capsule) (Pennington and Sarukhan 1968) are gradually blown off of a central core to a distance of 60 m or more (Rodriguez *et al.* 1994). Seed production was determined by sampling 10% of the area under each tree's crown, counting the number of fallen capsule segments in a minimum of five 2 m^2 (2 m x 1 m) plots randomly laid out within each of four quadrants around each tree). Whole fruits (aborted or blown off before maturity) were not counted. Each tree's crown projection area (cpa) was determined by measuring the crown's width using a surveyor's tape: first along the longest axis and then along a perpendicular axis from a central point (Diagram 1). Crown projection area was then determined using the formula for an ellipse.[3] The mean number of capsule segments (per m^2) was then calculated for each tree and multiplied by its cpa to determine the total number of capsule segments beneath the canopy. Next, that number was divided by five to yield the number of fruits produced by the tree. The number of seeds produced was obtained by multiplying the number of fruit by 45 (the average number of seeds per capsule). In addition, each tree was measured with a diameter tape at dbh or above the buttress, and tree height was measured using a clinometer and surveyor's tape.

Results and Discussion

Mahogany fruit production varied from an average of 8.8 fruits/tree (with a maximum of 41.6 fruits/tree in the 15 - 34.9 cm dbh class) to an average of 87.2 fruits/tree (with a maximum of 258 fruits/tree in the 75 - 115 cm dbh class) (Table 1). The only other seed production study carried out in this region evaluated a single tree of 80 cm dbh which was determined to have produced 121 fruit, based on a visual fruit count from the ground using binoculars (Rodriguez *et al.* 1994).

ANOVAs (analyses of variance) of the dbh classes revealed that while per tree fruit production was not significantly different among the three size classes < 75 cm dbh ($p < 0.05$), the fruit production by trees in these classes was significantly different from that of trees with ≥ 75 cm dbh ($p < 0.005$). This signified a 99.5% probability that the trees of the ≥ 75 cm dbh class produce more fruit (and thus, seeds) than smaller dbh classes (Figure 2). This result parallels the pattern observed by Gullison *et al.* (1996) in Bolivia. They found that among trees 30 - 80 cm dbh, fruit production was very low. However, this increased as dbh got larger, and peaked at about 130 cm dbh.

Gullison *et al.* proposed that mahogany trees allocate more resources to regeneration late in their lives. However, an evaluation of the rate of fruit production per m^2 of cpa revealed that larger trees do not produce significantly more fruit per unit crown area than smaller trees (Figure 3).

When fruit production was plotted against diameter, the largest trees showed markedly greater fruit production (Figure 4).

Table 1 : *S. macrophylla* fruit and seed production by dbh class.

DBH Class (cm)	Seed Production			Fruit Production			Fruits / m² cpa
	Mean	Standard Error	Range	Mean	Standard Error	Range	
15.0 - 34.9	380	123	0 - 1871	8.8	2.7	0 - 42	0.185
35.0 - 54.9	584	138	0 - 2722	12.3	3.1	0 - 61	0.200
55.0 - 74.9	597	193	0 - 3560	13.3	4.3	0 - 79	0.120
75.0 - 94.9[1]	2420	545	270 - 7145	54.0	12.0	6 - 139	0.260
95.0 - 115.0[1,2]	3923	1541	0 - 11609	87.2	34.0	0 - 258	0.434

1 The difference between these two dbh classes and the other dbh classes was statistically significant at p-value 0.05.
2 The difference between this dbh class and the other dbh classes was statistically significant at p-value 0.005.

Figure 2: Seed production by mahogany trees of different diameter classes.

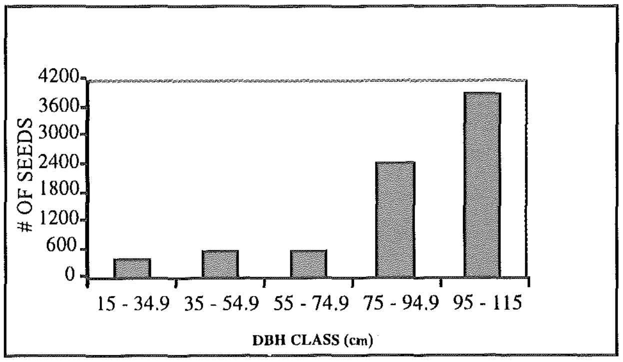


Figure 3: Crown projection area (cpa) and fruit production of mahogany trees of different diameter classes.

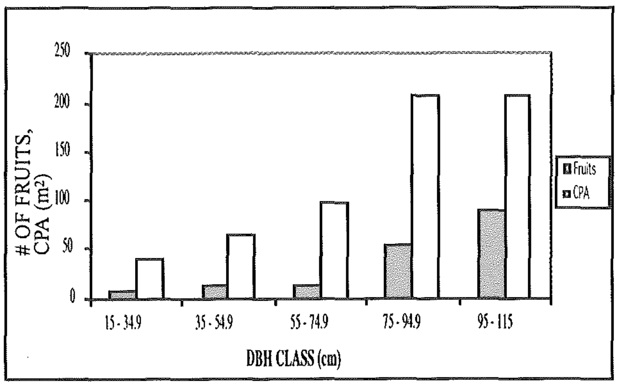
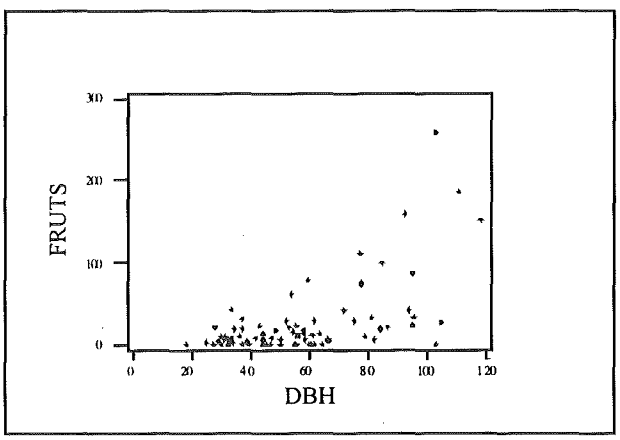


Figure 4: Fruit production by mahogany trees of different diameters.



Of 80 trees observed, six were found to have lost large branches, giving them unusually small cpa's for their diameters. When these trees were excluded from the analysis, dbh was closely correlated with cpa ($p < 0.005$) and predicted log fruit production to the same degree as cpa ($r^2 = 38\%$ for dbh and 37% for cpa). Because large-diameter trees are also taller than smaller trees, their seeds are likely to be dispersed further than those of smaller trees.

Conclusion

If natural regeneration for mahogany is to be integrated into the silvicultural management plans for these forests, large trees (> 75 cm dbh) shoud be retained as seed trees whenever possible. On average, one such tree will produce as many seeds as six trees of smaller dbh size classes. Many large mahogany trees are partially rotten, and felled only to be left in the forest because they are not worth transporting (Arguelles, 1991). For this reason, leaving these trees behind represents little or no loss of commercial volume. Furthermore, very large, old trees play an important structural role. They provide substrates for large epiphytes, as well as favored sites for cavity-nesting birds such as toucans, which are important fruit dispersers. Therefore, the sustainability of forestry would be enhanced by leaving standing mahogany trees ≥ 75 cm dbh.

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References

Arguelles, S. A. 1991. *Plan de Manejo Forestal para el Bosque Tropical de la Empresa Ejidal NohBec*, Tesis UACH, Departamento de Bosques, Texcoco, Mexico. Pp. 125.

Arguelles S. A. 1993. Conservacion y manejo de selvas en el estado de Quintana Roo, Mexico. unpublished document, Plan Piloto Forestal, Chetumal, Quintana Roo. Pp. 12.

Gullison, R E., S. N. Panfil, J. J. Strouse, S. P. Hubbell. 1996. Ecology and Management of Mahogany (*Swietenia macrophylla* King) in the Chimanes Forest, Beni, Bolivia. *Botanical Journal of the Linnean Society* 122(1): 9-34.

Holdridge, L. R., W. C. Grenke, W. H. Hatheway, T. Liang and J. A. Tosi. 1971. *Forest environment in tropical life zones: A Pilot Study.* Pergamon Press: Oxford, England.

INEGI, 1994. Anuario Estadistico del Estado de Quintana Roo. *Instituto Nacional de Estadistica Geografia e Informacion*, Chetumal Quintana Roo, Mexico. Pp. 245.

Lamb B. F. 1966. *Mahogany of Tropical America. Its Ecology and Management.* The University of Michigan Press: Ann Arbor, Michigan.

Paraguirre Lezama, C. 1994. Germinacion de las Semillas de Trece Especies Forestales Comerciales de Quintana Roo, pp. 67-80. In Snook, L. K. and Barrera de Jorgeson A. (eds). *Madera, Chile, Caza y Milpa. Contribuciones al Manejo Integral de las Selvas de Quintana Roo, Mexico.* PROAFT, INIFAP, USAID, WWF-US.

Pennington, T. D. and J. Sarukhan. 1968. *Arboles tropicales de Mexico.* INIF/FAO: Mexico.

Record, S.J. 1924. Timbers of Tropical America. Yale University Press: New Haven, Connecticut. Pp. 348-356.

Rodriguez Pacheco, A. A. & J. M. Barrio Chavira. 1979. Desarrollo de Caoba (*Swietenia macrophylla* King) in Diferentes Tipos de Suelos. *Ciencia Forestal* 4(22):45-64.

Rodriguez-Santiago B. J., Chavelas-Polito, and X. Garcia-Cuevas. 1994. Dispersion de Semillas y Establecimiento de Caoba (*Swietenia macrophylla* King) despues de un Tratamiento Mecanico del Sitio, pp. 81-90. *In*: Snook, L. K. and Barrera de Jorgeson A. (eds). *Madera, Chile, Caza y Milpa. Contribuciones al Manejo Integral de las Selvas de Quintana Roo, Mexico*. PROAFT, INIFAP, USAID, WWF-US.

Snook, L. K. 1993. *Stand dynamics of mahogany (*Swietenia macrophylla *King) and associated species after fire and hurricane in the tropical forest of the Yucatan Peninsula, Mexico.* Doctoral Dissertation. Yale School of Forestry and Environmental Studies: New Haven, Connecticut. Pp. 254.

Snook, L. K. 1996. Catastrophic disturbance, logging, and the ecology of mahogany (*Swietenia macrophylla* King): grounds for listing a major tropical timber species in CITES. *Botanical Journal of the Linnean Society* 122:35-46.

Snook, L. K. 1998. Sustaining harvest of mahogany (*Swietenia macrophylla* King) from Mexico's Yucatan Forests: past, present and future. In: Primack, Bray and Galletti (eds): *Timber, Tourists and Temples: Conservation and Development in the Mayan Forest of Belize, Guatemala and Mexico.* Island Press: Washington, D.C.

Stevenson, N. S. 1927. Silvicultural Treatment of Mahogany Forest in British Honduras. *Empire Forestry Journal* 6:219-227.

1 Rendoll in the USA soil taxonomy.

2 Organization of Forestry Ejido Producers, Maya Zone. *Ejido* is a communal land tenure system instituted through Mexico's Agrarian Reform program..

3 Ellipse formula: $L/2 * W/2 * \pi$.

Tropical Cedars (*Cedrela* spp.): New Management Perspectives

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Introduction

Within the New World Meliaceae family, tropical cedars (*Cedrela* spp.) are the most valuable timber tree species after mahoganies (*Swietenia* spp.) (ITTO 1997). Tropical cedars are light demanding, early successional trees that can achieve high growth rates (Lamb 1969). Despite this characteristic, the planting of *Cedrela* in its natural range has often failed due to attacks of the mahogany shoot borer *Hypsipyla grandella* Zeller (Lepidoptera: Pyralidae). The *Hypsipyla* larvae feed on the sapling's pith and phloem which reduces the saplings' chances of developing with the surrounding vegetation and can eventually cause mortality (Yamazaki *et al.* 1992). Although the saplings can resprout, repeated larvae attacks reduce the cedar's growth height and produce crooked, valueless trees (Newton *et al.* 1993). The difficulty in establishing *Cedrela* spp. plantations has thus discouraged their use in reforestation programs. As logging continues though, tropical cedars will decrease in importance as an income source for local people.

The currently accepted advice for establishing *Cedrela* spp. is to plant at low densities, in mixtures, and on fertile sites (Newton *et al.* 1993). However, reports from both the Atrato province in northwest Colombia and the Manu Biosphere Reserve (MBR) in the Peruvian Amazon suggest that at least *Cedrela odorata* can be grown successfully at higher densities (Guevara 1988 and Flores 1990a, 1990b). This paper presents preliminary pre-dissertation results that describe the distribution and densities of *Cedrela odorata* L. and *Cedrela fissilis* Vell. in the MBR's lowlands. The main research objective was to determine if *Cedrela*'s distribution pattern is suggestive of site partitioning between these two species.

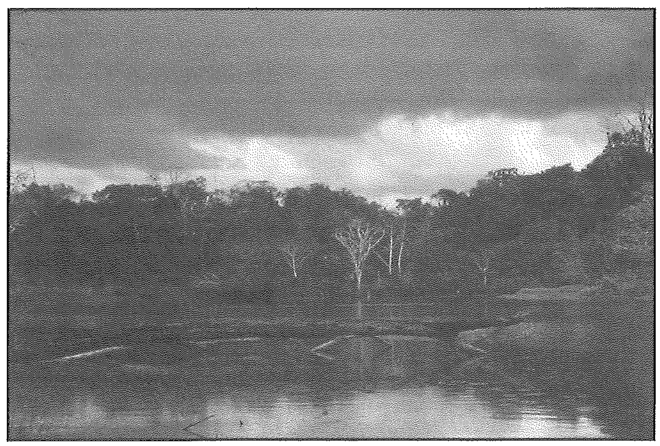

Figure 1: Cocha Cashu Oxbow Lake is the base camp for most of the researchers in the lowlands of Manu National Park, Peru.

Study Site

The study was conducted in the recently formed floodplains and Pleistocene alluvial terraces within Manu National Park,

Table 1: Density and size characteristics for Cedrela spp. in riparian and Pleistocene terrace forests in Manu National Park, Peru.

Stands	Surface	Cedrela density	Diameter above buttress (cm)		Basal area	Height of dominant trees (m)		*C. odorata*[2]	*C. fissilis*[2]
	(ha)	(tree/ha)	Mean	(SD)	(m2/ha)	mean	(SD)		
Riparian 1	2.8	45.4	68.1	(19.0)	18.80	46	(2.6)		
Riparian 2	1.8	6.70	87.2	(24.7)	4.20	-	-	X	
Riparian 3	5.8	17.20	82.8	(20.4)	10.00	48	(4.7)	X	
Riparian 4[1]	4.5	18.40	89.7	(27.0)	13.20	-	-	X	
Pleistocene Terrace 1	16.0	0.25	57.5	(11.4)	0.11	35	(6.1)	X	
Pleistocene Terrace 2	10.0	0.50	66.3	(16.2)	0.07	-	-	X	X

1 Data reanalyzed from Flores (1990b) *2 "X"= pressure of that species in the evaluated stand*

the core zone of the MBR, in southeastern Peru. The mean annual temperature is approximately 24°C, and the annual rainfall is 1,700 - 2,500 mm. Detailed descriptions of the site's flora, fauna, fluvial dynamics, and riparian succession have been described elsewhere (Terborgh and Petren 1991, Foster *et al.* 1986, Salo *et al.* 1986). Its soils are mostly of fluvial origin and vary across the landscape depending on deposition age and topography. The geologically young entisols are fine-textured silty loams, with pH values of 7.0 - 7.5, and relatively high levels of fertility. On the other hand, Pleistocene terrace ultisols are coarse-textured sandy loams, with pH values of 3.9 - 5.0, and relatively low fertility levels (Flores 1990a and Riley 1994). Gap dynamics is the major disturbance pattern in the terrace sites, in contrast with the fluvial dynamics that dominate the riparian zone. As a result of these contrasting disturbances, the light in the riparian areas is greater than in the newly formed gaps (Losos 1993).

Methods

Five mature *Cedrela* spp. stands (1.8 - 16 ha) were evaluated for the total number of mature *Cedrela* trees, the diameter above buttresses, and the height of the three most dominant individuals (Table 1). Three of the stands were in the *Cedrela - Ficus* stage of riparian succession (Terborgh and Petren 1991), while the others were in the Pleistocene terraces. Three young fluvial deposits with *C. odorata* saplings were assessed for visible *Hypsipyla* larvae damage. In addition, these saplings' crowns were assessed using Dawkin's Crown Illumination Index (CII) which assigns a numerical value to each crown depending on the amount of direct radiation exposure (Dawkins 1958). A value of one indicates a full crown exposure, while a maximum value of five indicates a minimally exposed crown.

Figure 2: Cedrela seedling morphological differences are evident between *C. odorata's* subspecies (A) "riparian" and (B) "interior."

Results and Discussion

C. fissilis and *C. odorata* have a distinct distribution pattern in MBR's lowlands (Table 1). *C. fissilis* is restricted to the Pleistocene terraces at very low densities (0.1 trees/ha), while *C. odorata* occurs in both the terraces and the floodplains. Interestingly, there seems to be two *C. odorata* allopatric phenotypes (or subspecies) which differ in distribution, abundance, morphology, and seed dispersal timing. One phenotype grows mostly in the mature forests of both the floodplains and Pleistocene terraces, at densities of 0.25 - 0.4 trees/ha. This forest phenotype seldom reaches more than 80 cm in diameter (above buttresses), and seed dispersal occurs from July to September. There is no known data on its flowering time. The other phenotype, restricted to recent alluvium deposits, can reach maximum densities of 45 trees/ha. Adult trees have diameters greater than 90 cm (above buttresses), with maximum basal areas of 19 m2/ha (Table 1). Flowering occurs from July to August, when the interior forest phenotype is in the dispersion phase, and seed shedding occurs from March to May. Morphological differences also extend to seedling and sapling sizes. Furthermore, these phenotypes differ in leaflet number and in pubescence, the latter of which is only found on the interior phenotype's upper leaf surface (Figure 2).

Saplings of the riparian *C. odorata* were found at densities of 165 - 1,330 saplings/ha (Table 2). These riparian cohorts are a component of mixed-species stands, with maximum total sapling densities (less than 11 m high) of 18,000 saplings/ha (Flores 1990a). Although sapling densities may appear high (the suggested densities for a *Cedrela* plantation are 20 -100 seedlings/ha), these dense *C. odorata* cohorts are mixed among a dozen or more species which adds a complex vertical structural diversity not generally found within plantations. In these mixed riparian stands, *Hypsipyla* accounts for less than approximately 40% of all *Cedrela* sapling attacks (Table 2). However, this percentage may overestimate the damage, as scarred saplings may reflect other phenomena such as shoot dieback.

Cedrela spp. is generally considered to be light demanding. However, the CII (mean value = 3.5) indicates that riparian *C. odorata* sapling crowns receive partial direct overhead solar radiation. During the first 20 years of riparian stand development, *Tessaria integrifolia* (Asteraceae) and then *Cecropia membranacea* (Cecropiaceae) overtop *C. odorata*. This suggests that the riparian *C. odorata* is only moderately light demanding and that self-thinning accounts for the majority of sapling mortality. Comparatively, the interior forest *C. odorata* and *C. fissilis* may be more shade tolerant, as they seem to be found mainly in small to medium gaps (100 - 500 m2) (personal observation).

Planting trials using *C. odorata* (mostly the riparian phenotype) around Manu National Park revealed that it can be planted at high densities within its natural range. However, in some of the experimental plots *Hypsipyla* remained a problem, with an attack rate of 14 - 100% (Contreras 1997). The trial area's soil fertility was lower than the riparian Manu floodplains' but comparable to the mature forest's floodplain (Contreras 1997). As most of the planting material came from the riparian *C. odorata*, it is possible that the interior forest *C. odorata* (or *C. fissilis*) would be the best planting stock since it may be more tolerant of poorer soils.

Table 2: Values of sapling density and height, *Hypsipyla* attack, and Crown Illumination Index (CII) for three young *Cedrela odorata* riparian stands growing in recent alluvial deposits in Manu National Park, Peru.

Stand location	Surface area (m^2)	Sapling density (#/ha)	Sapling height (m)		*Hypsipyla* attacks			Height of damage from *Hypsipyla* attacks (m)				Crown Illumination Index	
								Clear[1]		Possible[2]			
			mean	SD	Clear[1]	Possible[2]	Total	mean	SD	mean	SD	mean	SD
Stand 107	4146	356.9	2.1	1.6	8.1	0.5	8.6	1.4	0.6	1.0	0.8	3.6	1.0
Stand 104	3795	1330.7	9.0	3.0	1.6	15.6	17.2	2.2	1.0	2.6	1.9	3.6	0.8
Stand 100	4720	165.2	6.0	2.7	7.7	33.3	41.0	2.1	0.7	2.3	1.4	3.2	1.0

[1] Clear signs of *Hypsipyla* attack were hollow shoots, both fresh or old frass (feces) accumulating at the entry of the attack site, or signs of the larvae itself.

[2] In these cases, the stems showed signs of some damage. However, there was no evidence of *Hypsipyla* being the cause. I have observed shoots dying without any trace of *Hypsipyla* activity.

Conclusion

The *Cedrela* spp. distribution pattern observed in MBR's lowlands appears to follow soil and light regime differences. This result supports the hypothesis that *C. odorata* and *C. fissilis* have different optimal resource use ranges that promote their local allopatric distributions. This resource partitioning seems to make the locally adapted species and phenotypes more resistant or tolerant to *Hypsipyla* attack. This hypothesis will be tested as part of my research during the next few years. A better understanding of these species' site requirements, and the possibility that *C. odorata* may have two ecologically distinct subspecies, will be key determinants in developing more efficient plantation systems in the Neotropics.

It is a pleasant discovery that many tropical foresters continue to carry out experimental trials with these valuable species. Unfortunately, the results are often unpublished or in limited circulation. Until an efficient method is created to share the knowledge with both foresters and local people, information on *Cedrela* planting trials in MBR may be accessed at the Yale Silviculture Lab homepage: http//www.yale.edu/silvics/

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References

Contreras, J. 1997. Crecimiento de *Cedrela odorata* en la Reserva de Biosfera del Manu. Unpublished manuscript. Pro-Naturaleza: Lima, Peru.

Dawkins, H. C. 1958. *The management of natural tropical high-forest with special reference to Uganda.* Institute Paper No. 34. Imperial Forestry Institute: University of Oxford, England.

Flores N., C. F. 1990a. Caracterización de brinzales de *Cedrela odorata* L. en las áreas inundables cercanas a Cocha Cashu, río Manu. Tesis Ing. Forestal, Universidad Nacional Agraria La Molina, Lima, Peru.

———. 1990b. Distribución diamétrica y volumétrica de un rodal de *Cedrela odorata* en el Parque Nacional del Manu. *Revista Forestal del Perú* 17(1):41-51.

Foster, R. B., J. Arce and T. Wachter. 1986. Dispersal and the sequential plant communities in an Amazonian Peru floodplain. Pp. 357-379. In: Estrada, A. and T. H Fleming (eds.). *Frugivores and Seed Dispersal.* W. Junk, The Netherlands.

Guevara, G. 1988. Experiencias Colombianas con cedro (*Cedrela odorata* L.). Corporación Nacional de Investigación y Fomento Forestal-CONIF: Bogotá, Colombia.

ITTO. 1997. Annual review and assessment of the world tropical timber situation 1996. International Tropical Timber Organization: Yokohama, Japan.

Lamb, A. F. A. 1969. Especies maderables de crecimiento rápido en la tierra baja tropical: *Cedrela odorata. Boletín del Instituto Forestal Latinoamericano* (Venezuela) 30-31:15-59.

Losos, E. C. 1993. The influence of seed dispersal on primary forest succession in an Amazonian floodplain forest. Ph. D. dissertation. Princeton University: Princeton, New Jersey.

Newton, A. C., P. Baker, S. Ramnarine, J. F. Mesén and R. R. B. Leakey. 1993. The mahogany shoot borer: prospects for control. *Forest Ecology and Management* 57:301-328.

Riley, M. P. 1994. Soil chemical changes accompanying a primary riparian succession in Manu National Park, Madre de Dios, Peru. M. Sc. dissertation. Nicholson School of Environment. Duke University: Durham, North Carolina.

Salo, J. R. Kalliola, I. Hä-kkinen, Y. Mäkinen, P. Niemelä, M. Puhakka and P. D. Coley. 1986. River dynamics and the diversity of Amazon lowland forest. *Nature* 322:254-258.

Terborgh, J. and K. Petren. 1991. Development of habitat structure through succession in an Amazonian floodplain forest. Pp. 28-46. In: Bell, S., E. D. McCoy and H. R. Mushinsky (eds.). *Habitat structure: the physical arrangement of objects in space.* Chapman and Hall: New York, New York.

Yamazaki, S., T. Ikeda, A. Taketani, C. Vazquez and T. Sato. 1992. Attack by the mahogany shoot borer, *Hypsipyla grandella* Zeller (Lepidoptera: Pyralidae), on the Meliaceous trees in the Peruvian Amazon. *Applied Entomological Zoology* 27:31-38.

The Development of a Commercial Tree Plantation in Southern Venezuela: Integrating Socio-economic Priorities with Ecological Conditions

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Introduction

In Venezuela's southern region, the Ministry of the Environment and Natural Renewable Resources is developing multiple-use tree plantations for promoting timber and pulp production, agroforestry, and wildlife habitat enhancement. The initiative is part of a broader government strategy to stimulate economic investment and development in this sparsely populated and impoverished region. By implementing this strategy, the government hopes that it will slow the exodus from the country's predominantly rural southern regions to its more urbanized northern areas (Corpollanos 1993).

The region designated for this forestry plantation is located in the southeastern part of Apure State, between the Cinaruco and Meta Rivers. Covering approximately 850,000-hectares, this area comprises part of the municipality of Pedro Camejo, near the town of Puerto Páez. In the project's first five-year stage, a 50,000-hectare tree plantation will be established north of Puerto Páez, south of the Cinaruco River, east of the main road linking Puerto Páez and San Fernando de Apure (the state capital), and west of the Orinoco River (MARNR 1996). In the first year, 5,000-hectares will be planted, with an additional 10,000-hectares in the second and third years, and 12,500-hectares in each of the project's final two years.

Figure 1: Aerial view of the Orinoco River and neighboring savanna ecosystem where the 50,000-hectare paper pulp plantation will be established.

Initially, the Venezuelan government had designed a 50,000-hectare paper pulp plantation, with 10,000 hectares of Caribbean pine (*Pinus caribaea*) and 40,000 hectares of eucalyptus (*Eucalyptus robusta*). However, incorporating local or adapted timber species (mahogany, pink trumpet tree, saladillo [*Caraipa llanorum*], rain tree, and teak), in combination with Caribbean pine and eucalyptus, could both increase economic benefits and reduce growing pressures to exploit the rainforests east of the Orinoco River. The plantation species must be fast-growing, well-adapted to the area's low fertility, and have high economic value.

In this study, a team of local residents and I planted a variety of commercial tree species on an experimental basis to assess their adaptability to local environmental conditions, ecological sustainability, and profitability. In addition, a socio-economic study of the project was necessary to identify local communities' needs and maximize project benefits. Since local project participation is essential for the plantation's long-term sustainability, this study also investigated ways of integrating local communities into the plantation production process.

Methods

A socio-economic analysis was performed in areas most influenced by the initial 50,000-hectare plantation project, including Puerto Páez and its surrounding farms and indigenous communities, the town of Paso Real de Cinaruco, and neighboring areas along the Cina-ruco's riverbanks. Additionally, the port of entry to the states of Bolívar and Amazonas (Puerto Nuevo), as well as the communities adjacent to the plantation site on both sides of the Orinoco River, was included in this analysis.

Economic Viability Study

To determine the 50,000- hectare plantation's economic viability, two forms of analysis were applied: a timber market analysis of the project's potential tree species and a cost-benefit analysis.

Visits to sawmills in Apure and neighboring states within the plantation's local timber market area provided important information on timber prices and sawmill processing capacity. They also revealed which timber species carried the highest demand. Timber market information for adjacent areas to Colombia was also gathered, as well as data for timber transport costs between this region and the Caribbean Sea.

A cost-benefit analysis with a 25-year timber rotation period was used as a basis for comparison between the tree species. A distance of three meters was used between each tree seedling, which yielded 1,111 individuals per hectare. To account for mortality during the first stage, an additional 20% of the total seedlings were added to the cost calculations, yielding a final total of 1,333 individuals per hectare.

Biological Viability Study

Local residents and the author developed a 1.5-hectare agroforestry pilot plantation on a local farm using the five timber species (Table 1). Species selection was based on: a high demand by the local sawmills, an endemism or adaptability to local environmental conditions, immediate seedling availability, and symbiotic possibilities in agroforestry or silvo-pastoral systems. Because cattle raising is one of the area's economic mainstays, a silvo-pastoral option could contribute to the plantation project's sustainability by using plantation trees as food and shelter sources for cattle during seasonal food and water shortages. This agroforestry pilot plantation was initiated to encourage local communities to maintain their own tree plantations. Applied on a larger scale in favorable areas, such agroforestry systems could allow the local population to harvest annual crops (such as pineapple, cassava, maize, and beans) instead of waiting to reap the benefits at the end of the 25-year timber harvest rotations (Organización para Estudios Tropicales [Organization of Tropical Studies, OTS], 1986).

Table 1: Basis for economic analysis to compare plantation tree species in Apure, Venezuela.

	Growth (m^3/ha year)	Year of harvest	Harvest %
Paper Pulp Species			
Caribbean pine *(Pinus caribaea)*	7.3	7, 14, 20	30, 30, 40
Eucalyptus *(Eucalyptus robusta)*	3.9	7, 14, 20	30, 30, 40
Timber Species (native or adapted)			
Mohagany *(Swietenia macrophylla)*	2.8	25	100
Pink trumpet tree *(Tabebuia rosea)*	7.0	25	100
Saladillo *(Caraipa llanorum)*	4.5	25	100
Rain tree *(Samanea saman)*	6.0	25	100
Teak *(Tectona grandis)*	8.0	25	100

Sources: Cartillas de autoecología de especies. SEFORVEN.

Social Viability Study

Within the project area, semi-structured interviews and community group meetings were conducted using the Rapid Rural Appraisal (RRA) technique (Schoonmaker Freudenberger 1997). These interviews were designed to gather local data on: primary economic activities, work experience and education lev-els, labor availability, societal concerns and conflicts, social and economic needs, agroforestry experience, crop production costs, and ecological practices such as savanna burning (OTS 1986). The meetings also informed the local population about the plantation project and provided an opportunity for exchanging ideas. In other local villages, including small indigenous communities where Spanish was not widely spoken, calendars and economic activity matrices were used to gather similar information (Schoonmaker Freudenberger 1997).

Results and Discussion

Economic Analysis

A comparative economic analysis between the initial Caribbean pine and eucalyptus plantation, and another with the additional five timber species, revealed that the latter would

Figure 2: Local farmers measuring the plots and planting seedlings during the 1.5-hectare pilot plantation project.

increase the project's net benefits by more than two-fold (Table 2). Further, the more diverse plantation would diminish the investment risk by reducing economic vulnerability to timber market price fluctuations or pest attacks affecting a single species.

When compared on a per hectare basis, a plantation with an agroforestry component yields far greater benefits than the plantation without the agroforestry option (Table 3). Interplanting crops of maize, cassava, brown beans, and pineapple would increase the project's net benefits per hectare by approximately 15 times more than the tree-only plantation option. Regarding timber demand, visits to sawmills in the nearby states of Bolívar, Amazonas, and Apure revealed that most mills are operating well below capacity and incapable of meeting the market demand for timber. This situation is caused primarily by strict local regulations that forbid timber exploitation from primary forests and create a chronic timber shortage. Neighboring Colombia has a considerable market for timber products for the same reason.

Biological Analysis

Because this study did not complete the biological analysis, experimental results on species suitability are pending. A continual monitoring plan to compare plot treatments will consist of systematic recording of volumetric tree growth (average height and diameter at breast height [dbh] of live trees per plot as well

Table 2: Comparative economic analysis of two 50,000-hectare plantation systems in Apure, Venezuela.

	Pine and eucalyptus only[1]	Pine and eucalyptus, plus the five timber species[2]
Discount rate (%)	8.0	8.0
Costs present value (US $1000)	21,992.90	28,520.50
Benefits present value (US $1000)	63,259.40	125,635.0
Net benefits present value (US $1000)	41,266.50	97,114.50
Benefit / Cost ratio	2.88	4.41
Internal Rate of Return (%)	15.65	18.10

[1]20% Caribbean pine and 80% eucalyptus.
[2]15% Caribbean pine, 15% eucalyptus, and 14% of each of the following native or adapted timber species: mahogany, pink trumpet tree, saladillo, rain tree, and teak

Table 3: A comparative economic analysis (per hectare) between a plantation with pine and eucalyptus plus five timber species, and a similar plantation that adds an agroforestry component.

	Pine and eucalyptus plus five timber species	Similar plantation with agroforestry
Discount rate (%)	8.0	8.0
Costs present value (US$)	570.40	4,513.80
Benefits present value (US$)	2,512.70	36,229.30
Net benefits present value (US$)	1,942.30	31,715.40
Benefit / Cost ratio	4.41	8.29

as crop productivity (the weight of each agroforestry crop per plot) in mixed and pure stands. Furthermore, this plan will measure the number of living trees per plot, the number of trees attacked by pests, the severity of the pest attacks per plot expressed as an average of the approximate percentage of each plant attacked, and the type of pests.

Social Analysis

The household income data indicates considerable social and economic disparities in the area, with annual incomes ranging from US $11,000 (large landowners and ranchers) to US $600 (laborers). Many more residents are seasonally employed or unemployed. Furthermore, the education level for most of the area's population ranges from second to eleventh grade, and more than 95% of the interviewees were literate. When combined with their farming experience, the data suggests that the local capabilities exist for implementing a successful project.

The Venezuelan government recently hired agronomists from the Puerto Páez Agronomy Technical High School to work in a 30-hectare pilot plantation using the five native and adapted species that this study recommended. The success and expeditious development of both this and the 1.5-hectare pilot plantation supports the proposition that a well-trained and skilled local labor force could successfully manage the 50,000-hectare plantation.

In order to assure the project's long-term success, it will be necessary to re-orient local education programs towards developing relevant skills for farming and technical activities, and expanding environmental awareness to discourage potentially destructive practices, such as initiating fires near plantations. The project's chances of success will be enhanced as the local population becomes more integrated into the project and reaps its benefits. This integration can occur by incentives such as awarding plantation workers with a percentage of timber sale income and providing them with produce from the agroforestry systems. Generally, the local population views the 50,000-hectare project as an important economic opportunity. The remarkable enthusiasm and motivation among those who participated in the pilot plantations is essential to move the project forward.

Conclusions and Recommendations

The study's comprehensive approach determined the feasibility of the plantation project by integrating the economic, social, and biological issues that often determine the success of forestry projects. Based on the study's results, it is recommended that the five native or locally adapted timber species should be incorporated into this plantation, in addition to the project's Caribbean pine and eucalyptus trees.

Agroforestry systems should be integrated near local communities wherever environmental conditions allow, as agroforestry could provide alternative sources of food for livestock and the local people, in addition to employment opportunities. Because local people are qualified and willing to work in the project, they should be employed whenever possible, with training provided to build local capacity as needed.

This tree plantation project could help satisfy the domestic market demand for timber, while reducing growing pressures to harvest the area's primary forests. This would simultaneously increase local employment opportunities and encourage investment in this rural area, thus enhancing local social, economic, political, and environmental conditions. This regional development could potentially slow the human exodus from rural areas to overpopulated urban areas across Venezuela. If implemented properly, this project could be a model for the sustainable regional development that is crucial for Venezuela in the 21st century.

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Cooperator Notes

The Meta Cinaruco Tree Plantation Project in the state of Apure, in southern Venezuela, is part of the Meta Cinaruco Integral Environmental Project, or Proyecto Integral Ambiental Meta Cinaruco (PIAMEC). It is a large scale sustainable development project of the Orinoco-Apure Program within the Ministry of the Environment and Natural Renewable Resources. The Orinoco Apure Program welcomes individuals or organizations interested in conducting research in ecotourism, river fisheries, soils, fauna biodiversity preservation, and on the habitat of the saladillo tree (*Caraipa llanorum*) and tropical tree species native to the area.

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References

Corpollanos. 1993. *Plan Estratégico de Desarrollo Fronterizo Puerto Páez - Las Montañitas.*

Corpollanos. 1994. *Propuesta para elevar la parroquia Agustin Codazzi a Municipio Fronterizo.*

Diócesis de San Fernando de Apure. Parroquia "Nuestra Señora del Carmen". Puerto Páez Estado Apure, Venezuela. *Descripción de la Parroquia Eclesiástica.*

Gaceta Oficial de la República de Venezuela. 1994. *Ley aprobatoria del Convenio Internacional de Maderas Tropicales.*

Gaceta Oficial del Estado Apure. 1993. *Plan de Ordenación del Territorio del Estado Apure.*

IUCN. 1996. The World Conservation Union. *Communities and Forest Management with Recommendations to the Intergovernmental Panel on Forests.* IUCN Working Group on Community Involvement in Forest Management. IUCN: Cambridge, UK.

MARNR. 1986. Comisión de Ordenación del Territorio. *Plan de Ordenación del Territorio. Estado Apure.* Secretaria Técnica Regional, - Zona Nº 9, División de Planificación y Ordenación del Ambiente.

MARNR. 1993. SEFORVEN, *Cartilla Nº 13 Autoecologia de la especie: Jobo.*

MARNR. 1994. SEFORVEN, *Cartilla Nº 15 Autoecologia de la especie: Jabillo.*

MARNR. 1995. Gobernación del Estado Apure, *Monografia de Puerto Páez.*

MARNR. 1996. Servicio Forestal Venezolano SEFORVEN. Dirección General Sectorial Programa Orinoco-Apure (PROA). *Proyecto: Iniciativa ambiental Cinaruco-Meta. Subproyecto: Plantaciones Forestales Comerciales Cinaruco-Meta.*

National Academy of Sciences. 1979. *Tropical legumes: Resources for the Future.* Report of an ad hoc panel of the Advisory Committee on Technology Innovation, Board on Science and Technology for International Development, Commission on International Relations, National Research Council. National Academy of Sciences: Washington, D.C.

Organización para Estudios Tropicales (OTS). 1986. Centro Agronómico Tropical para Investigación y Enseñanza, CATIE. *Sistemas Agroforestales. Principios y Aplicaciones en los Trópicos.* Costa Rica.

Schoonmaker Freudenberger. 1997. *Rapid Rural Appraisal. Participatory Rural Appraisal.* Workshop notes. Yale University: New Haven, Connecticut.

Sullivan, G., S. Huke and J. Fox 1992. *Financial and economic analysis of agroforestry systems.* Proceedings of a workshop held in Honolulu, Hawaii, July 1991. Nitrogen Fixing Association: Paia, Hawaii.

Urban Migration, Urban Restoration: Settlements of the Landless Poor and Urban River Restoration in Kathmandu, Nepal

By Anne Rademacher
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Introduction

Trends in global urbanization and their environmental dimensions have received considerable attention in recent years, particularly among international environmental organizations.[1] Rapid urbanization can complicate and accelerate pre-existing challenges to environmental quality, creating situations requiring careful interdisciplinary analysis. This project addresses a critical social condition that plays a complex role in the definition of environmental restoration priorities in Kathmandu, Nepal. This case represents opportunities for insights into urban environmental management questions common in many rapidly growing cities of the developing world.

Background

Human Settlements and River Restoration

The Bagmati and Bishnumati, principle rivers of the Kathmandu Valley section of the Bagmati Basin, suffer severe degradation inside the urban area of Kathmandu.[2] This degradation includes reduced water quality and altered physical characteristics, and arguably the loss of Hindu cultural and religious values traditionally attributed to these rivers. Both environmental scientists and Kathmandu residents agree that urban river degradation has accelerated dramatically over the past ten years.

Urban river degradation in Kathmandu has been linked to many interconnected factors. Comprehensive studies such as one by IUCN (1994) have documented that the main causes of urban river pollution are direct dumping of untreated sewage discharge and solid waste into the rivers and onto their banks.[3] In addition, sand is quarried from riverbanks and beds to supply a growing urban construction demand for cement. This practice has altered both rivers' morphologies by lowering the beds, channelizing the flow, and undermining the banks.

Beyond these factors of river degradation, recent river restoration policy documents also identify human encroachment on riverbanks, floodplains, and beds exposed by falling water levels, mostly as a result of sand extraction. Illegal settlement on marginal riparian urban lands is a major concern in the city. Urban growth in Kathmandu[4] has caused the rapid spread of urban development over a large area and increased population density throughout the city. Although many new city structures have been erected legally, the housing supply is insufficient to meet the overwhelming demand, and rent prices have become unaffordable to many.[5] Participation in the city's current land and housing markets is impossible for new migrants and poor city residents, often from the lowest castes *(jats)*.

As a result, many new migrants and long-term Kathmandu residents resort to squatting — illegally occupying often marginal land and claiming it by constructing shelters. The resulting settlements, known as *Sukumbassis*, are growing at twice the city's population growth rate.[6] During this research project (fall 1997), there was a total number of 54 Sukumbassis in Kathmandu, half of which were situated on the banks of the Bishnumati, Bagmati, or one of their larger urban tributaries.[7] Of the Kathmandu Sukumbassis' total population in 1996,[8] 69% lived in such riparian settlements and of these, approximately two-thirds were along the Bishnumati or Bagmati Rivers.

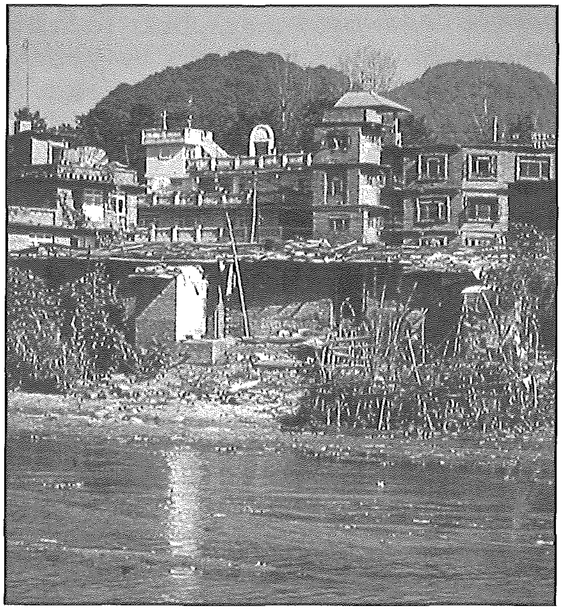

Figure 1: The small, semi-permanent structures along the Bishnumati river bank mark claims to land made by squatters in Kumaristhan. Large legal homes are seen in the background.

The severity and complexity of Kathmandu's river degradation has led to an extensive official dialogue which seeks to restore the Bagmati and Bishnumati Rivers. International and Nepali governmental agencies have produced various reports which explore issues of river restoration and conservation area development. The agencies acknowledge the crowded human settlements along the city's riverbanks and exposed beds. The imperative solution to the "Sukumbassi problem" is most frequently identified as unconditional eviction, justified by claims ranging from undesirable aesthetics to the system's ecological integrity and to issues of property rights and legality. The central focus of this project was to study how Sukumbassi settlements are perceived, understood, and "planned for" in current discussions, river restoration and conservation documents/projects.

Human Settlements and Cultural-Environmental Values

Traditionally, both the Bagmati and Bishnumati Rivers have sacred significance in Hindu representation of the landscape and ritual practice. In parts of Kathmandu, Hindu temples and cremation sites (*ghats*) line the rivers. As the river's condition has worsened, and flow patterns have altered, temples and ghats sometimes have sustained severe damage. The effects are compounded by the long term neglect of many such structures, due to a chronic lack of financial resources or from the breakdown of groups historically responsible for temple maintenance *(guthis)*.

Much of the current river restoration dialogue is committed to restoring the "cultural heritage of the Kathmandu Valley" through the parallel restoration of the rivers and riverbank temple complexes. In a city whose contemporary population is increasingly diverse in ethnic, religious, and "cultural" orientation, it is interesting to view the overlap of the river's cultural value and how its dominant representation affects the policy, planning, and ultimate goals for river and temple restoration projects. In concordance with restoration policy documents, the cultural preservationist-environmentalist view is that Sukumbassi settlements must be evicted unconditionally, if their vision of a restored river system is to be realized.

Methods

Methods were divided into three phases. In Phase I, a survey of existing Bagmati Basin water quality data and ecological studies was conducted in conjunction with key informants in the Nepali government, Lumanti – a Kathmandu-based nongovernmental organization (NGO), and the private sector. A survey was written, pre-tested, and revised for use in the project's next phase.

Preliminary visits in Phase II were made to several riparian Sukumbassi settlements with members of Lumanti, which has developed general social service and microcredit to women's programs in the settlements. The survey on river knowledge, attitudes, and practices was administered to a sample 5% of riparian Sukumbassis. Focus group discussions were also conducted in four settlements covering topics of river condition, history, as well as potential Sukumbassi involvement in river restoration. Phase III involved confirming findings between the phases by revisiting several Phase I informants. The synthesis and analysis of these findings will be completed by fall 1998.

Research Questions

To better understand the complexities of this situation, the project's central research questions were:

1. How are Sukumbassi settlements perceived and represented in urban river restoration planning and projects? What are the justifications, notions of cause-and-effect, and social processes that could influence current policy suggestions at local, national, and international levels?
2. What are the general attitudes, awareness levels, and practices related to the rivers revealed by a survey of riparian Sukumbassis? Are the findings consistent with the representations of Sukumbassi

settlements described in policy documents and dialogue? Do patterns of home "ownership" and migration status affect river attitudes and practices?

3. How might current river restoration planning policy be modified in light of the research findings?

Acknowledgments

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References

HMG Nepal Ministry of Housing and Physical Planning and Asian Development Bank (HMG/ADB). 1992. *Kathmandu Urban Development Project Preparation Report.* HMG: Kathmandu, Nepal.

International Union for the Conservation of Nature (IUCN), Stanley International (Canada), Matt-McDonald Ltd. (UK), and East Consult (Nepal). 1994. *Bagmati Basin Water Management Strategy and Investment Program: Final Report.* International Union for the Conservation of Nature: Kathmandu, Nepal.

Tanaka, Masako. June 1997. *Conditions of low-income settlements in Kathmandu: action research in squatter settlements.* Lumanti: Kathmandu, Nepal.

United Nations Population Fund (UNFPA). 1995. *The State of World Population.* UNFPA: New York, New York.

[1] See World Resources Institute, 1996. *World resources, a guide to the global environment: the urban environment 1996-97.* New York, Oxford UP.

[2] The urban area of Kathmandu is considered conventionally confined within the Ring Road. The previously separate kingdoms (with separate administrative bodies) of Patan and Kathmandu have become one continuous urban entity via growth and sprawl. Both municipalities lie within the Ring Road and are included in this paper's description of "urban Kathmandu".

[3] There are significant gaps in the data base which makes definitive statements about the relative contributions of various degrading practices to the overall river condition difficult. For instance, there is no reliable quantitative data on the pollution caused by the carpet industry, although there is speculation that it, too, contributes to the poor water quality of the rivers in the urban area. The data on water resources and water use are limited, as are time series water quality data.

[4] UNFPA (1995). Nepal experienced a 6.5% urban growth rate in 1995, the most recent year for which data is available. It is second only to Afghanistan in the South Central Asia region, which includes Afghanistan, Bangladesh, Bhutan, India, Iran, Pakistan, and Sri Lanka. The average growth rate for the region is 3.4%.

[5] HMG/ADB (1992) reported that land values in Kathmandu were rising at 20% per year (p.32).

[6] In 1991, the Asian Development Bank/Kathmandu Municipality Concept Plan for the Bishnumati Corridor recorded a 12% growth rate in the 14 settlements inside the Bishnumati Corridor area. At that growth rate, the entire river length of the Bishnumati Corridor would be occupied within ten years.

[7] From Tanaka (1997), in a research project conducted in cooperation with Lumanti, a nongovernmental organization (NGO) concerned with urban housing issues and Sukumbassi settlement in the city.

[8] Recorded as 8,927 by Tanaka (1997).

The Role of Science in Environmental Management: Case Studies from Three Plateau Lakes in Yunnan Province, China

By Jessica Hamburger
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Introduction

The beautiful plateau lakes of Yunnan Province, China have attracted international attention because of their rich biological and cultural diversity. The lakes and their watersheds provide habitat for many species of endemic plants and animals. Several ethnic minorities, as well as Han Chinese, depend on the lakes to provide water for drinking and irrigation, hydropower, transportation, and opportunities for fishing and tourism. The biggest threat to these biological, cultural, and economic resources is lake eutrophication, particularly algal blooms associated with increases in nutrient inputs.

The desire to preserve the cultural and biological diversity and the economic functions of Yunnan's plateau lakes and their watersheds has led to funding for many international environmental protection projects in the region. Because such projects require a sound scientific basis, development organizations have supported international and Chinese experts to work with local scientists and managers in Yunnan. The case studies presented below review the perspectives of both experts and locals on the quality and relevance of scientific activities in the environmental management of three lakes: Dianchi, Erhai, and Lugu.

Study Sites

The three case studies cover a wide range of trophic status, ecological disturbance, and toxic chemical contamination. Lake Dianchi, located downstream from the provincial capital of Kunming, is severely eutrophic and polluted (World Bank 1996). Lake Erhai, in Dali Prefecture in western Yunnan, is moderately polluted; it experienced its first algal bloom in 1996 (Dali EPB 1997a). Lugu Lake, nestled in the mountains of the Yunnan-Sichuan border, has no industrial inputs but its watershed suffers from severe gully erosion and a decline of endemic fish populations. The lakes vary in size, volume, and elevation (Table 1).

Table 1: A comparison of three lakes investigated in Yunnan Province, China.

Lake Name	Drainage Basin Area (km²)	Lake Area (km²)	Average Depth (m)	Total Volume (10^8 m³)	Lake Surface Elevation (m)
Dianchi	2920	298	4.1	12.0	1880
Erhai	2560	250	10.5	28.2	1970
Lugu	248	53	40.0	20.7	2680

Source: Liu et al. *1988.*

Methods

I employed "triangulation," or cross-checking, in my research by collecting information from different sources using a variety of methods (Molnar 1989). Those sources included interviews with Chinese and foreign environmental scientists and managers working at the national, provincial, and local level; scientific, governmental, and development organization documents; and direct observation.

Semi-structured interviews were used to assess opinions regarding the quality and relevance of scientific effort included. Respondents were all provided with identical questions, in Mandarin Chinese, to serve as a basis for discussion. I asked them what scientific methods were used to study their lake and whether they thought the results of scientific studies were useful for decision makers. I chose respondents representing different levels of decision-making at each lake in order to compare local, national, and international perspectives.

Results and Discussion

The results of this investigation can be best understood in the context of the evolution of lake studies in China. Lake water quality monitoring in China initially was limited to determine if the lakes met national monitoring standards applied to all surface water.[1] Maximum allowable contaminant levels were set for five water quality classes corresponding to water body functions (for example, drinking water, irrigation, or industrial use) without regard for ecological differences between lakes and rivers. Concern about lake eutrophication prompted an investigation of China's major lakes and reservoirs, including Dianchi and Erhai, from 1986 to 1990 (Jin *et al.* 1990). Lake monitoring programs expanded during that period to include calculation of Trophic State Indices (Carlson 1977) based on nutrient concentrations, transparency, and other parameters. However, the moni-toring of smaller lakes, such as Lugu, still does not include analysis of trophic state. Biological surveys of the range and type of algae, macrophyte, and benthic species found in the lakes are not conducted on a regular basis.

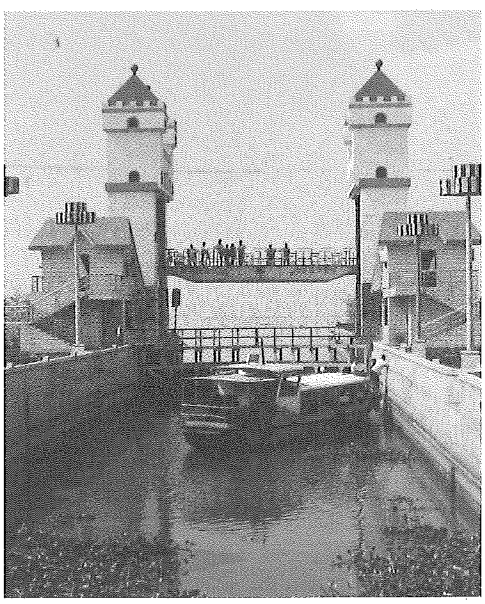

Figure 1: A gateway in the barrage allows boats to pass between Dianchi's inner lake and the outer lake, where pollution is less severe.

Case 1: Lake Dianchi

A water quality report on Lake Dianchi provides an example of how the failure of decision makers to formulate a common definition of the problem can lead scientists to answer the wrong question. This mistake overshadows problems with data quality control, which also plagued the report.

The consulting firm Montgomery Watson, under assignment from the British Overseas Development Administration, led a study predicting the effect of different nutrient input levels on the feasibility of water treatment (Montgomery Watson 1996). The water quality report was prepared to justify the World Bank's $125 million contribution to the Yunnan Environment Project. The World Bank's financial justification of the project was that the local government could pay back the loan with the money saved by avoiding the cost associated with treating water containing high concentrations of algae.[2] However, the government has decided that it will not use Dianchi as a drinking water source in the future.[3] The local government plans to divert water from reservoirs or sources outside the catchment to increase total water quantity and improve drinking water quality. Efforts to restore Dianchi can still be justified on environmental grounds, but not in terms of financial savings.

The quality of the study was compromised by problems with the phosphorus mass balance model, which was intended to predict the amount of phosphorus reduction needed. According to Montgomery Watson's Project Manager, Martin Haddrill, "The phosphorus model is not statistically valid and therefore, neither are its predictions about whether the Yunnan Environment Project will reduce phosphorus enough to control algae in Dianchi."

One reason for the model's failure to achieve statistical significance was the variability of the data. Wang Li, Senior Environmental Engineer with the Yunnan Environment Project Office and the leader of the water quality study, found that although there were many years of data, the monitoring points had been changed several times. In one case, a monitoring point was actually moved from one end of the lake to the other to help city officials in Kunming achieve a higher rating in the attainment of environmental goals. In the lab, lack of standard procedures and failure to ensure quality control exacerbated the variability problem. Large differences in lab analysis results occurred because not all of the samples were filtered before they were measured.[4]

Both local and foreign experts were concerned with problems of data quality. The Kunming Central Station of Environmental Monitoring (KCSEM) proposed the purchase of more advanced equipment, and an increase in the number and frequency of monitoring points (KCSEM 1995). A report by Canadian consultants suggested that these changes should be accompanied by additional training in data quality control (Canrede 1996). It also recommended that central laboratories should be equipped to analyze samples sent in from around the province for heavy metals and toxic organic compounds, and that local monitoring sta-tions should focus on taking routine field measurements and collecting samples for analysis at the central laboratories.

Case 2: Lake Erhai

Scientific research at Lake Erhai appears to have influenced environmental decision making, but only after problems had reached crisis proportions. Three studies (STC and EMB 1989, Jin *et al.* 1990, and YPG and UNCRD 1994) warned the government about the threat of eutrophication and ecological degradation and suggested mitigation measures. A decision to maintain water levels in the lake by temporarily shutting down the hydropower station was made only after the several endemic and economically valuable fish species that breed in shallow areas were threatened with extinction. Aggressive measures to control nutrient and sediment inputs were not taken until after the first algal bloom appeared in 1996 (Dali EPB 1997b). The explanation for the delay given by local scientist Yu Lihua, Director of the Dali Prefecture Environmental Monitoring Station and Environmental Science Institute, was that the government only takes action when food or water supplies are threatened. Yunnan is a poor province, and government funds are only available for clear and present risks to people's welfare.

Yu believes that data quality control at her monitoring station is good, but the monitoring program has been compromised by outdated technology and lack of funds. Her claims are backed up by a study reporting that the Dali Environmental Monitoring Station passed all tests conducted by national and provincial quality control authorities between 1985 and 1995 (Matsui *et al.* 1996). The study proposed improvement of the water quality monitoring systems through the installation of automatic water quality monitoring stations, analytical equipment upgrades, and incorporation of remote sensing and geographic information system (GIS) technology (Matsui *et al.* 1996). Funds for such improvements were not yet available.

Even if the proposal were funded, the institute might have trouble obtaining the data on water flow, soil type, forest cover, and tillage practices needed for GIS analysis because many agencies refuse to share data. "The government needs to do something about this if it is serious about promoting the use of GIS," according to Jia Lusheng, a Senior Programme Officer of the United Nations Development Programme.[5]

Case 3: Lugu Lake

Scientific monitoring and research have played a limited role in Lugu Lake's management. A small amount of monitoring data was collected by the county environmental protection office, but was not shared with village level resource managers.[6] Monitoring data and other scientific support from county agencies could help local resource managers determine the effects of increasing erosion on lake water quality and possible causes of the endemic fish catch decline. Unfortunately, data quality tends to be poor at the county level and in places like Lugu Lake where people have little experience in monitoring water quality.[7]

Conclusion

Effective environmental management requires "getting the science right," i.e., using systematic and reliable methods of data collection and analysis (NRC 1996). It also requires "getting the right science," i.e., designing research and monitoring programs relevant to decisions being made by environmental managers (NRC 1996). The case studies suggest that Chinese scientists and their foreign counterparts generally agree that despite significant progress in lake research in China, more work is needed to "get the science right." They differ only in that Chinese scientists place more emphasis on obtaining better equipment and data processing tools, while the foreign consultants tend to focus on the need for more rational allocation of equipment and better training. Both sides agree that research institutes must be persuaded to share information and to adhere to standard procedures to facilitate the use of GIS and other techniques requiring data integration. As for "getting the right science," the case studies showed that research and monitoring were usually designed to inform decisions. However, scientific studies sometimes answered the wrong questions, and their recommendations were often ignored until a crisis occurred.

This preliminary study has provided some answers about the types of lake research and monitoring conducted in Yunnan and the opinions of scientists about how they can be improved. It has also provided some examples of the ways in which political processes influence what gets studied and whether scientific recommendations are followed. Finally, the study has raised a fundamental question: Are new investments in monitoring equipment justified, given the problems with the use of science in environmental decision making? Equipment upgrades may be necessary, but they are no substitute for more comprehensive efforts to make science a useful tool in preserving Yunnan's plateau lakes.

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Cooperator Notes

My main host was Jin Xiangcan, Director of the Water Research Institute of the Chinese Research Academy of Environmental Sciences (CRAES) in Beijing. CRAES, the research arm of China's National Environmental Protection Agency, conducts research on most aspects of environmental studies: water and air resources, ecology, analysis and measurement, environmental management, environmental standards, and environmental information and computation. Dr. Jin is a leading lake expert in China and often provides advice on lake policy and management to national and local governments, as well as working on international projects. Dr. Jin Xiangcan can be reached via e-mail: abj202@istic.sti.ac.cn

Dr. Jin introduced me to Shang Yumin, Director of the Dali Environmental Protection Bureau (EPB). The Dali EPB was the local leader of the UNDP/UNEP project "Investment Planning and Capacity Building for the Sustainable Development of the Lake Erhai Basin." Luo Zengshou of the international cooperation office of the Dali EPB can be reached via e-mail: erhai@public.km.yn.cn

(Both contacts listed speak English, but students who speak Chinese will have an easier time working with these organizations.)

References

Canrede Inc. 1996. *The Yunnan Environment Project, Environmental Monitoring and Data Management Component, Needs Assessment and Upgrading Plan, Final Report.* Canrede, Inc.: Scarborough, Ontario.

Carlson, R.E. 1977. A trophic state index for lakes. *Limnology and Oceanography*, 22, 361-9.

Dali EPB. 1997a. Dali Prefecture's 1996 Environmental Bulletin. *Dali Environmental Protection Magazine*, No. 21, June 1997. Dali Environmental Protection Bureau: Dali, Yunnan, China.

Dali EPB. 1997b. Dali Bai Autonomous Prefecture People's Government's Decisions Regarding Protection and Control of Erhai's Ecology and Environment. *Dali Environmental Protection Magazine*, No. 21, June 1997. Dali Environmental Protection Bureau: Dali, Yunnan, China.

Jin, X., H. Liu, Q. Tu, Z. Zhang, X. Zhu (eds.). 1990. *Eutrophication of Lakes in China*. Chinese Research Academy of Environmental Sciences: Beijing, China.

KCSEM. 1995. *World Bank Yunnan Environment Project: A Feasibility Study on Environmental Monitoring System in Dianchi Lake Drainage Area of Kunming.* Kunming Central Station of Environmental Monitoring, Environmental Science Institute of Kunming: Kunming, Yunnan, China.

Liu F., X. Zhang and J. Zhang. 1988. Protection of the plateau lakes in Yunnan Province. *World conference on large lakes.* Lewis Publishers: Chelsea, Michigan.

Matsui, S., N. Xu, and L. Yu. 1996. *Pre-Feasibility Study of Water Quality Monitoring System.* United Nations Development Program: Beijing, China. (UNDP Project, "Study of Investment Planning and Capacity Building for the Sustainable Development of Lake Erhai Basin," 1995-1996.)

Molnar, A. 1989. *Community forestry, Rapid appraisal.* Food and Agriculture Organization of the United Nations: Rome, Italy.

Montgomery Watson (under assignment from Overseas Development Administration). 1996. *Project Report, Annex L: Water Quality (Final Draft).* Yunnan Environmental Project Office: Kunming, Yunnan, China.

National Research Council. 1996. *Understanding risk: Informing decisions in a democratic society.* National Academy Press: Washington, DC.

Science and Technology Commission (STC) and Erhai Management Bureau (EMB) of the Dali Bai Autonomous Prefecture (Eds.). 1989. *Collected Scientific Works of Erhai Lake in Yunnan.* Yunnan Nationalities Press: Yunnan, China.

Young, S.S. and Z. J. Wang. 1989. Comparison of secondary and primary forests in the Ailao Shan region of Yunnan, China. *Forest Ecology and Management.* 28(3-4): 281-300.

Yunnan Provincial Government (YPG) and United Nations Centre for Regional Development (UNCRD). 1994. *Regional Development and Environmental Management for the Dali-Lake Erhai Area: A Summary Report of the Planning Study on Integrated Regional Development and Environmental Management for the Dali-Lake Erhai Area, Yunnan Province, PRC.* UNCRD Research Report Series No. 3. UNCRD: Nagoya, Japan.

World Bank. 1996. *Staff Appraisal Report, China, Yunnan Environment Project.* Report No. 15361-CHA. World Bank: Washington, DC.

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[1] Wang Li, Senior Environmental Engineer, Yunnan Environment Project Office. 1997. Personal communication.

[2] Geoffrey Read, Principal Municipal Engineer, Environment and Municipal Development Operations Division, China and Mongolia Department and Task Manager, Yunnan Environment Project, World Bank. 1997. Personal communication.

[3] Martin Haddrill, Environmental Engineer and Project Manager, Montgomery Watson. 1997. Personal communication.

[4] Wang L. 1997. Personal communication.

[5] Jia Lusheng supervised the development of pre-feasibility studies for environmental investments in the Lake Erhai watershed.

[6] Fisheries Office management staff, Lugu Lake Nature Reserve. 1997. Personal communication.

[7] Jin Xiangcan, Director, Water Research Institute, Chinese Research Academy of Environmental Sciences. 1997. Personal communication.

Ethical Considerations of Local Compensation

By Paul Gagnon
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Introduction

Researchers working in developing tropical countries face difficult choices in deciding how best to compensate local people for their assistance with fieldwork efforts. On the one hand, local people deserve compensation for their work and expertise, and for the impositions and expenses outsiders cause the community (Whyte 1955, Wax 1971, and Fine 1988). On the other hand, compensating local helpers can cause serious problems, such as jealousy, unrealistic expectations, dependency on outsiders, and divisiveness within (and between) families and village structures (Rabinow 1977, Appell 1978, Srivastava 1992, and Alexiades 1996). For this reason, the types of compensation for local people merit discussion and evaluation. This article addresses this issue within the context of my Yale Tropical Resources Institute-funded ethnobotanical research (summer 1997), while drawing from my experience as a Peace Corps Volunteer in Togo, West Africa (1991-1993).

Anthropologist V. K. Srivastava (1992) divides local fieldwork assistance into three categories: 1) shelter and meals for the outsider by families or communities, 2) informants who provide widely-known knowledge, including those who answer general surveys, or are interviewed as representatives of broad demographic groups (for example: young mothers, children, or fishermen), and 3) informants who provide "specialist" information not known by wider segments of society (for example: plant healers, midwives, sorcerers). To this list, I would add generalist laborers and fieldwork research assistants.

Researchers concur that local people ought to be somehow compensated for their assistance to outsiders (Alexiades 1996 and Boom 1990). Benefits can take many forms: direct cash payment, such as wages for work as field assistants and flat (or hourly) fees paid for interviews and surveys; direct non-cash payments, such as food for a host family, or gifts for collaborators, their families or village; indirect non-cash payments, such as transportation assistance; or intangible forms, such as technical skills training or institutional contacts for local assistants. It is essential that these various forms of payment be used with discretion, as conflicts and misunderstandings are otherwise created for both the local people and subsequent researchers.

Figure 1: Gloria and her grandson on her backporch with some of the medicinal plants which she cultivates for healing purposes.

Site Description

During my research, I investigated traditional uses of medicinal plants among the Afro-Hispanic communities of the Cayapas-Mataje National Mangrove Reserve on Ecuador's northwest coast. On the margin where the South American continent slides under the Pacific Ocean, a maze of rivers, beaches, and tidal flats give rise to the world's tallest mangroves.[1] This area is home to a vibrant culture descended from former slaves who intermarried with indigenous[2] and Spanish peoples beginning early in the sixteenth century. My goal was to gain further insights into the origins and current state of this complex culture, using ethnobotany as a tool.

I worked in six mangrove towns, ranging in size from two hundred to several thousand residents. Many of these towns are built entirely on stilts, high above tidal mudflats, supporting houses hewn from the red mangroves (*Rhizophora mangle* and *R. harisonii*) which dominate this ecosystem. Most of the men fish for a living, going far out to sea in dugout canoes using a plastic sheet for a sail, while the women search the mangrove roots for crabs and cockle shells.

The Dilemma

Much consideration was given regarding how best to compensate my informants. I inquired locally to determine a typical day's pay for labor, and established a compensation standard that was generous, yet not extravagant. I paid interviewees and guides who helped me locate plants which were pressed and saved as voucher samples for future identification. But I was unsure what to do about plants collected from privately owned gardens and farms. Although it seemed that the owners should be somehow compensated, the local people shared their various herbs and medicinal plants freely among themselves. Paying for such plants was unusual, but not unwelcome. The risk was that doing so might erode the system of communal sharing upon which this society relied.

During a three-week stay in the town of Palma Real, I felt increasing pressure to pay for various sorts of informal assistance beyond those previously mentioned, such as providing meals, drinks, and medical expenses for people unrelated to my work. My dilemma stemmed from a conflict between my belief that local people must benefit from research, while my Peace Corps experience reminded me of how the "*cadeau* (gift) mentality" was pernicious to both local people and outsiders, and how quickly it could take root. Therefore, it was necessary to exercise caution in "sharing the wealth." Without such discretion, a dangerous precedent could be set that might raise unrealistic expectations among the town's residents, while also contributing to the dehumanization of outsiders as sources of money. Simultaneously there was a risk that, at the neglect of traditional practices, a local dependency would develop on outside revenue sources.

Case Study

In Palma Real, I worked most closely with a fisherman-farmer named Jenaro. He was very active politically, and had many ideas on how the town could develop, including plans for attracting tourists. I paid Jenaro and the other interviewees, guides, and assistants a wage for their labor. While I made no promises of cash to the owners of the plants I cut for my research, I gave some money as compensation in proportion to the quantity of the plants that I collected. Upon my departure, various villagers who had not contributed to the project requested money; these requests were refused.

I later worked with an elderly plant healer, Gloria, in the village of San Lorenzo. Still unsure of the best way to help my informants, I consulted a friend in my collaborating nongovernmental organization (NGO), CIDESA, to discuss how best to compensate Gloria for her work. My friend discouraged me from paying cash, but recommended that I help via other means.

Through our work I met Gloria's daughter, a single mother working on her college degree and struggling to collect information for her senior thesis on local tourism possibilities. Gloria's family was very poor, and her daughter needed contacts around the area to collect the requisite information. It seemed that the best way to compensate Gloria for her time and knowledge was to help her daughter make the appropriate contacts. I accompanied Gloria's daughter and paid for her transport to Palma Real to introduce her to several contacts I knew there, including Jenaro.

This seemed a win-win situation for Gloria, her daughter, and myself. Because Gloria's daughter was a local, and even a distant relative of Jenaro, I had assumed that the information would be freely provided, according to local custom. Thus I was disappointed when Jenaro offered to sell her the information on his town's history for a large sum of money. It seemed that Jenaro had done so based on the precedents set by previous researchers and myself. Fortunately she was able to collect the necessary information from other contacts in the village, without being charged.

During this visit, I received numerous pleas for handouts from people in Palma Real, including several who had been informants during my previous work. If I had acquiesced, it could have led to greater difficulties for researchers working in the area, including my collaborating local NGO. Such difficulties could eventually doom Jenaro's own dream of tourism.

Conclusion

My research experience highlighted several problems related to the impacts of outsiders on local communities, and the responsibilities researchers must accept in order to minimize the potentially detrimental effects their presence might have. It is only right that local people benefit from research done in their milieu. However, the researcher must carefully consider the various forms of compensation and their consequences on local people. Research projects requiring local labor may need to offer a set wage to ensure that the workers benefit sufficiently and that the study runs smoothly. Although in some cases, paying cash for knowledge or time is an easy way out, such cash payments can often have harmful effects and other forms of compensation may be more appropriate. Non-cash compensation is occasionally less expensive, but often requires more of the researcher's time, a commodity frequently in shorter supply than money. Non-cash compensation entails greater personal involvement for the researcher, but has the potential for greater long-term benefits to the individuals and communities involved.

The issue of how local people should best benefit from research projects is extremely complex. I encourage scientists to give it serious consideration prior to beginning their fieldwork.

References

Alexiades, M. N. (ed.) 1996. *Selected Guidelines for Ethnobotanical Research: a Field Manual.* New York Botanical Gardens: Bronx, New York.

Appell, G.N. 1978. *Ethical Dilemmas in Anthropological Inquiry: a Case Book.* Crossroads Press: Waltham, Massachusetts.

Boom, B. 1990. Ethics in ethnopharmacology. In: *Ethno-biology: Implications and applications.* D.A. Posey and W.L. Overals (eds.) Proceedings of the First International Congress of Ethnobiology, Belem, Para, Brazil, July 1988. Pp. 147-153. Belem, Brazil.

Fine, G.A. and Sandstrom, K.L. 1988. Knowing children: participant observation with minors. *Qualitative Research Methods Series #15.* Sage Publications: Newbury Park, California.

Rabinow, P. 1977. *Reflections on Fieldwork in Morocco.* University of California Press: Berkeley, California.

Srivastava, V.K. 1992. Should anthropologists pay their respondents? *Anthropology Today* 8(6):16-20.

Wax, R.H. 1971. *Doing Fieldwork.* University of Chicago Press: Chicago, Illinois.

Whyte, W.F. 1955. *Street Corner Society.* University of Chicago Press: Chicago, Illinois.

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[1] In 1995, a team of Japanese scientists from Action for Mangrove Reforestation (ACTMANG), a Japanese NGO involved in local mangrove restoration efforts, estimated a group of *Rhizophora harisonii* to be well over 60 meters tall. For more information regarding these activities, contact Kogo Motohiko, Chairman, ACTMANG, 3-29-15-1104 Honcho, Nakano, Tokyo 164 JAPAN. Phone/fax 03-3373-9772.

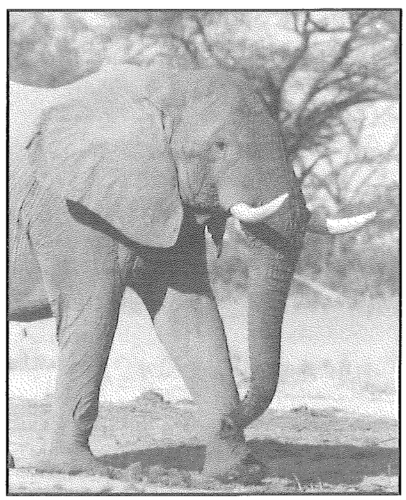
[2] In this article, the term "indigenous" is not used to describe African-Americans, despite their presence in the region for centuries. In Ecuador, "indigenous" refers exclusively to Amerindian .

Yale School of Forestry and Environmental Studies in Africa

By Heather E. Eves
Candidate for Doctor of Forestry and Environmental Studies

Students and faculty from the Yale School of Forestry and Environmental Studies (FES) formed the African Natural Resources Group (ANRG) in September 1996, with Professor Gordon Geballe as its acting faculty advisor. Its aims are to facilitate, coordinate, and promote future research and study programs in Africa. During the 1997-1998 academic year, ANRG has continued to actively pursue its goal of incorporating African environmental issues into the FES program, and to offer professional training and research opportunities for students. ANRG aims to establish a permanent source of funds to enable students to conduct summer research projects in Africa, and to develop a resource center with a comprehensive database of natural resource conservation issues and African environmental organizations. Additional objectives include a speaker program featuring Ph.D. and Master's presentations, as well as outside experts and a professional training workshop series.

Photo credit: Richard Ruggiero



Sangha River Conference[1]

The academic year began with an international conference at Yale which brought together representatives from central Africa (Cameroon, Central African Republic, and Congo [Brazzaville]), Europe, and the US. Over 100 participants were involved in discussions and presentations concerning natural resource use relations in this ecologically important Congo Basin tropical forest region. ANRG played a critical role in ensuring the conference's success.

This gathering of experts resulted in the formation of the Sangha River Network, a professional and academic research network dedicated to facilitating information exchange concerning the region and providing teaching, research, and communication opportunities. Proceedings of the conference will be published as a volume (in both French and English) in the spring 1998 *FES Bulletin Series*.[2]

African Wildlife Update[3]

The African Wildlife News Service established its new office in New Haven, CT (fall 1997), providing a tremendous resource base and professional opportunity for FES students to contribute articles on African wildlife issues. This has been a unique and positive opportunity for FES students. This past spring, second year FES student Mila Plavsic began working as an assistant to Steve Mishkin, President of African Wildlife News Service and Editor of the *African Wildlife Update*. Many FES students continue to communicate with *African Wildlife Update* regarding information they have from the field, a trend we hope will continue. Steve has been a wonderful resource and recently helped ANRG arrange its first guest speaker. Allen Bechky, currently on a book tour in the eastern US, spoke at Yale in March concerning his work as an adventure travel writer on southern and eastern Africa.

FES Student Research in Africa

The opportunity to gain professional experience during the summer is invaluable in helping many FES students find employment after graduation. However, research costs are extremely high and difficult to secure, and logistics difficult to arrange. Nevertheless, several students will be conducting research in Africa this summer:

· *Tori Derr*, FES doctoral candidate, has been contracted to write a 70+ page illustrated reference guide for 6th graders about the history, geography, government, people, and art of **Kenya**. The book will be part of a series called *Countries of the World* published by Time Books International.

· *Heather E. Eves*, FES doctoral candidate, will be going to **Zimbabwe** to conduct a review of a duiker (*Cephalophus* spp.) antelope research program. A Yale alumnus generously provided funds for her visit and associated research.

· *Drew DeBerry*, FES master's student, will be studying the distribution and relative abundance of carnivores in logged and unlogged areas of **Uganda's** Kibale Forest. The project is associated with the Wildlife Conservation Society and other organizations. Funding has been requested from TRI to partially support this endeavor.

· *Elise Granek*, FES master's student, will be in **Comoros** for community-based conservation planning regarding fruit bats and mangrove forests. In-country collaborators are The Regional Federation of Environmental Associations and Action Comoros. Funding has been requested from TRI, Bat Conservation International, and the Coca-Cola Foundation.

· *Laly Lichtenfeld*, FES master's student, will be in **Tanzania** with the African Wildlife Foundation's internship program where she will assist in the development of participatory monitoring techniques among communities involved with conservation and management. Her work will be partially supported by AWF, with additional funding requested from TRI.

· *Mila Plavsic*, FES master's student, will visit **Madagascar** to present the results of her TRI-funded 1997 research to the Conservation and Development Symposium of the International Primatological Society. In addition, she may continue the research she began last year.

FES Alums in Africa

David Moffat (FES '94), Senior Advisor for the Eastern African Coastal Area Management Secretariat (SEACAM), contacted ANRG from **Mozambique** regarding student internship possibilities. Research areas included capacity building, database management, aquaculture, tourism, and sustainable financing. Chris Page (FES '97) is in Naro Moru, **Kenya** with the National Outdoor Leadership School (NOLS) program; Gus Le Briton is back working with SAFIRE in Zimbabwe; and Karen Westley is working with CARE in Togo.

ANRG Professional Workshop Series

ANRG members have worked diligently to locate funding for the proposed Professional Workshop Series. Numerous consultants had agreed to participate this spring, and a tentative workshop agenda had been created to address: conflict resolution, project evaluation, fund-raising, development projects and the private sector, proposal writing, and the Rapid Rural Appraisal approach. However, despite months of effort, ANRG was unable to secure the necessary funding to support this series.

This past February, ANRG contacted the consultants who had agreed to participate to see if they were still interested in conducting a workshop at FES. Positive responses were received, and ANRG is renewing its efforts to provide this potentially unique and important opportunity for students to hone their professional skills. We look forward to working with FES and ANRG's faculty advisor to launch this worthwhile project.

[1] Full conference title: Natural Resource Use Relations in the Trinational Sangha River Region, Northwestern Congo River Basin Conference. September 26-28, 1997.

[2] Additional results, summaries, and contact information from the conference can be found at: www.concentric.net/~evesclan/sangha

[3] 210 Prospect St., New Haven, CT 06511. Phone: (203) 776 - 9215. E-mail: awnews@aol.com. Website: www.africanwildlife.org

Organic Agriculture and Pesticide Reduction Conferences in Cuba

By Carlos A. González
Doctoral Student in Forestry and Environmental Studies

In May 1997 two conferences were held in Santa Clara, Cuba which addressed organic agriculture and pesticide use reduction. Thanks to funding from the Yale School of Forestry and Environmental Studies and the Pesticide Action Network (PAN), I was able to attend both conferences.

The Third National Organic Agriculture Conference was sponsored by the Cuban Organic Agriculture Association (Asociación Cubana de Agricultura Orgánica - ACAO). Panel discussions featured subjects such as: adverse effects of pesticides, sustainable agriculture, urban agriculture in Cuba, the global agricultural crisis and agro-ecological alternatives, organic products in the European market, and the transformation of Cuban agriculture in the 1990s. Representatives from around the world presented research, including members of Food First, Sustainable Agriculture Networking and Extension, World Resources Institute, and Genetic Resources Action International.

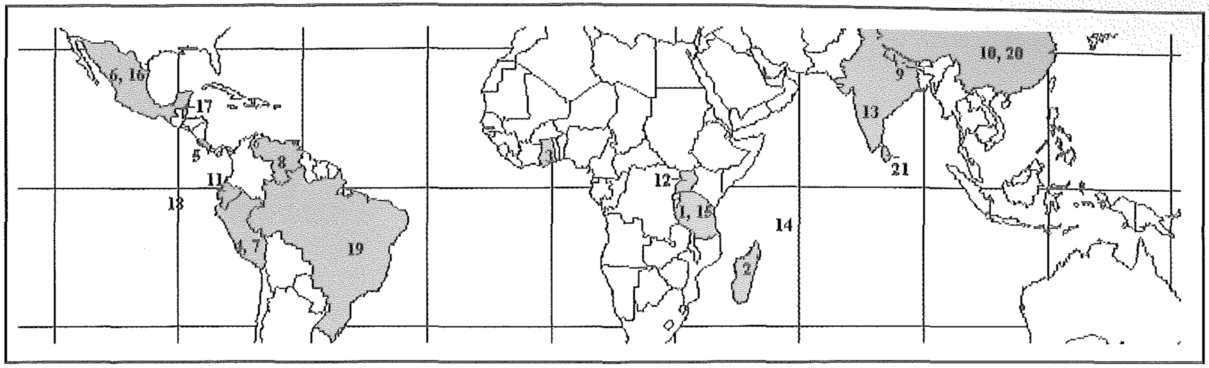
The other conference, "The Fourth Pesticide Action Network International Meeting: Feeding People Without Poisons" had a similar format to ACAO's, with panel discussions and workshops interspersed with reports from PAN's regional offices. In addition to those organizations mentioned from the ACAO meeting, other renowned attendees and participants were from The Pesticides Trust, Research Foundation for Science and Natural Resource Policy, World Wildlife Fund International, and International Federation of Organic Agriculture Movements. Panel discussions addressed issues such as global food security, economic globalization, organic agriculture, agricultural sustainability, women in agriculture, and also assessed the success of PAN's activities. Workshops focused on three main areas: *Problems with Pesticides:* obsolete pesticides, methyl bromide, biodiversity and genetic resources, agrochemical industry strategies, and health issues; *Politics:* biotechnology, international pesticide conventions, information sharing, women and pesticides, and food security; and *Alternatives:* Integrated Pest Management and organic conversion, pesticide use reduction programs, food safety, and traditional knowledge and sustainability.

Of particular interest were discussions about food safety and the new "global supermarket." Vandana Shiva of the Research Foundation for Science and Natural Resource Policy discussed the effects of free trade, which has flooded produce markets and food supplies with chemical residue-laden products. She argued that while people worldwide are denied the right to know what they are eating, some farmers are denied the right to grow the products they want.

Plant patenting was another topic associated with many problems. One particular problem concerns the contracts for Monsanto Company's "Round-up Ready" seeds for crops, such as soybeans, which require the farmers to purchase seeds for more than one growing season, sometimes for up to five years. Furthermore,the contracts prohibit the farmers both from trading seeds with fellow farmers and from saving any of the seeds. Failure to meet these stipulations is punishable by large fines. Effectively, such patented seed contracts can often remove the control that farmers once had over their own crops.

For ACAO conference information, contact: Fernando Funes, Asociación Cubana de Agricultura Orgánica, Tulipan 1011 e/Loma y 47, Apdo. Postal 6236, Código Postal 10600, Nuevo Vedado, La Habana, Cuba. E-mail: ica@ceniai.cu For PAN conference information, contact: the Pesticide Action Network North America (PANNA), 116 New Montgomery, #810, San Francisco, CA 94105. Phone: (415)541-9140; e-mail: panna@panna.org Contact the author at: carlos.gonzalez@yale.edu

Current and Potential TRI Research Sites



Current author sites:

1 - Ben Gardner, Tanzania
2 - Mila Plavsic, Madagascar
3 - David Bowes-Lyon, Ghana
4 - Robert D. Hauff, Peru
5 - Daniel Shepherd, Costa Rica
6 - Luisa Camara, Mexico
7 - César Flores Negrón, Peru
8 - Antonio del Mónaco, Venezuela
9 - Anne Rademacher, Nepal
10 - Jessica Hamburger, China
11 - Paul Gagnon, Ecuador

Summer 1998 TRI internship sites:

12 - Drue DeBerry, Uganda
13 - Kavita Gandhi, India
14 - Elise Granek, Comoros Islands
15 - Laly Lichtenfeld, Tanzania
16 - Andrew S. Mathews, Mexico
17 - Benjamin Piper, Belize
18 - Benjamin Ruttenberg, Galapagos Islands
19 - Bhavna Shamasunder, Brazil
20 - Xiaoping Wang, China
21 - Radhika Wijetunge, Sri Lanka

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