TROPICAL RESOURCES

The Bulletin of the Yale Tropical Resources Institute

2006 Volume 25

In This Issue

In order to view maps, graphs, photographs, and figures in color, please access the 2006 Bulletin at www.yale.edu/tri/bulletin.html

Yale Tropical Resources Institute: Envisioning Synthesis and Synergy

Mission

The Mission of the Tropical Resources Institute is the application of interdisciplinary, problem-oriented, applied research to the creation of practical solutions to the most complex challenges confronting the management of tropical resources worldwide. Lasting solutions will be achieved though the integration of social and economic needs with ecological realities, the strengthening of local institutions in collaborative relationships with international networks, the transfer of knowledge and skills between local, national, and international actors, and the training and education of a cadre of future environmental leaders.

Vision

The problems surrounding the management of tropical resources are rapidly increasing in complexity, while demands on those resources are expanding exponentially. Emerging structures of global environmental governance and local conflicts over land use and environmental conservation require new strategies and leaders who are able to function across a diversity of disciplines and sectors and at local and global scales. The Tropical Resources Institute aims to build linkages across the natural and social sciences and among government agencies, academia and practitioners, enabling the formation of successful partnerships and collaborations among researchers, activists and governments. The Tropical Resources Institute seeks to train students to be leaders in this new era, leveraging resources, knowledge, and expertise among governments, scientists, NGOs, and communities to provide the information and tools this new generation will require to equitably address the challenges ahead.

Dear Readers,

It is with great pleasure that we present the 2005-2006 TRI Bulletin. The themes in this volume reflect various emergent topics within the environmental field: planning, subsistence livelihoods, agriculture, public infrastructure, mining, and industry. Addressing issues through differing perspectives, these works aim to understand and mitigate the interactions between people and their natural environment, producing results designed to better our efforts as conservation practitioners.

Several writers focus specifically on environmental planning efforts and their influence on the human and natural landscapes in the hopes of creating better management plans. Radhika Dave's paper informs current conservation initiatives on the impact that anthropogenic change has on mangrove forest ecosystems, while urging planners to consider human needs in large-scale mangrove conservation. Similarly, Krupa Patel explores the establishment of transboundary conservation areas and its potential to disrupt social, economic, and livelihood networks across country borders unless it considers current needs of border populations. Alvaro Renondo-Brenes and Kristen Welsh conduct a case study, addressing the advantages and disadvantages of a working conservation program that provides payments for environmental services.

Other articles explore specific human-environment interactions. Catherine Schloegel and Tendro Ramaharitra offer different perspectives on the environmental impact of subsistence livelihoods on the landscape. Catherine creates an introspective account of the economic and ecological tradeoff that occurs when a village association harvests trees against their public doctrine. Tendro presents an analysis on the effect of tree removal by villagers on adjacent forest areas.

An additional human-environment thread focuses on the impacts of agricultural practices. Wendy Fransesconi and Gonzalo Griebenow provide a dichotomous account of the impact of agricultural practices on animals. Wendy explores the influence of live fences on bird diversity and abundance in areas near forests, creating conclusions which serve to better agricultural practices. Gonzalo studies the effect farm establishment on the edge of a forest reserve has on the movement of elephants in the region. Richard Chavez's piece provides an alternative approach to studying agriculture, offering a model to identify soil erosion levels, which can help with establishing farms and lessening their impact on the environment.

A prevalent theme in this issue is infrastructural development and its impact on social and environmental systems. Caroline Simmonds, Kristen Welsh, and Ikuko Matsumoto offer insight on the societal response to the creation of public infrastructure. Caroline analyzes the effect of road creation on rural villages and illustrates the significant positive and negative changes that can transpire. Kristen Welsh assesses the absence of infrastructure, analyzing what can be done to improve village access to potable drinking water. Ikuko Matsumoto takes a critical look at infrastructural mitigation projects through the analysis of large dam development.

We end this year's bulletin with a call to action through the exploration of societal responses to industrial development. Linda Kramme reviews how NGO activities can affect sustainable forest management projects and possibly improve industry accountability. Oscar Franco takes a more local approach, illustrating the potential impact community uprising may have on mining development and future land stewardship.

The quality of this volume serves as a reminder of the long hours, both in tropical field sites and Yale computer labs, that many people have invested—not only student researchers, but also, and especially, Amity Doolittle, TRI coordinator and guide; Lisa Curran, indomitable Institute director, and our spirited acting director (during Lisa's leave), Mark Ashton. As editors, we would appreciate hearing from you and appreciate any suggestions, potential collaborations, or additional opportunities for students and expanding our programmatic reach.

Monisha Gangopadhyay, MEM 2007; Laura Kiernan, MEM 2006;
and Colleen Morgan, MEM 2007

Yale Environmental Leadership and Training Initiative

We are pleased to announce a new joint initiative with Tropical Resources Institute at the Yale School of Forestry & Environmental Studies and the Center for Tropical Forest Science at the Smithsonian Tropical Research Institute.

An environmental leadership and training program to promote biodiversity conservation in tropical forests in Asia and Central and South America has been established at Yale University with a $4.8 million gift from the Lisbet Rausing Charitable Fund.

"The worldwide environmental crisis reflects deep disparities in the capacities of nations, institutions, communities and individuals to develop and implement solutions that sustain both human societies and the biosphere," said Mark Ashton, the program's principal investigator and professor of silviculture and forest ecology at the Yale School of Forestry & Environmental Studies (F&ES). "The future success of conservation efforts requires a major enhancement of social capital in the developing world."

The Tropical Resources Institute at F&ES, in partnership with the Center for Tropical Forest Science of the Smithsonian Tropical Research Institute, will coordinate the program in building the environmental conservation and management capacity of individuals, communities and institutions in regions of high biological diversity in tropical forests.

The program will focus on the training of field workers in conservation, park managers, officials concerned with energy, infrastructure services and natural resources, and environmental policy makers and community leaders.

Short courses, workshops and field trips will take place at the program's principal sites in Panama City and Singapore, where Yale and the Smithsonian already work together, as well as at field sites in South and Southeast Asian and Central and South American regions.

"With the support of the Rausing Charitable Gift Fund, we will be able, for the first time, to develop and offer a systematic, integrated program of training and education in the tropics, building on our existing relations with the Smithsonian Institution and forging new relationships within each region," said Gus Speth, Dean of Yale School of Forestry and Environmental Studies.

The Yale Environmental Leadership and Training Initative (YELTI) expands TRI's existing research programs and offers tremendous opportunities for students at F&ES. For over two decades TRI has provided students with the chance to experience the rewards and challenges of conducting independent research in the tropics. Now we can broader their learning experiences by offerering students the possibility to join YELTI as teaching interns.

News from the IUCN Internship Program

Thanks to the generous support from Jim Leitner, YC 1975, Madeline Meek MEM 2006, and Saima Baig, MEM 2006 were able to work as IUCN interns in Sri Lanka and Pakistan.

"*Keeahla vahdaknay*" is my favorite Sinhalese expression, and it perfectly captures my experience in Sri Lanka this summer for I have "no words to express" the intensity, the beauty, the pain, and the hardship that I saw and felt throughout the ten weeks I spent there. While working with the IUCN on tsunami rehabilitation, I saw the struggles and heard the stories from hundreds of devastation and havoc, I struggled with Sri Lankan issues of political turmoil and ongoing ethnic conflict...I had so many adventures, made so many acquaintances, and questioned myself, my career, and my life innumerable times in those ten weeks.

-Madeline Meek, MEM 2006

Remembrance
Margaret (Peggy) Rasmussen King
1957-2005

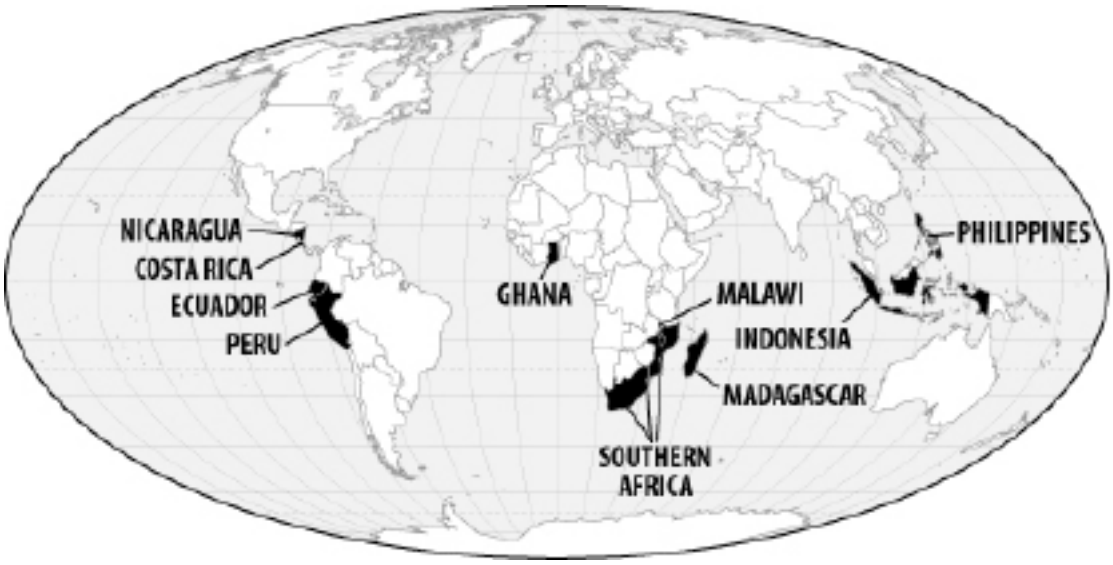
It is with sadness that we mention that one of our dedicated supporters to the Tropical Resources Institute, Peggy King (MFS 1985), died on December 16th 2005 with Larry (MES 1985), her husband, by her side. I remember Peggy well as a classmate, a close friend, and a colleague. She was a quiet and unassuming person, with a drive and determination to conserve and protect the environment. Peggy was one of the first students in the TRI internship program that went to Puerto Rico in the summer of 1984. After graduation she continued to work directly for TRI as a program assistant for Bill Burch. Then when Peggy and Larry left for Minneapolis she served as an advisor to TRI as it developed from an idea into reality, from small to large, and from an island-based program to a global network. Peggy and Larry have been generous and thougtful supporters to TRI and its internship program. We will miss her dearly and her contribution to TRI will be lasting.

-Mark Ashton, MF 1985. PhD 1990

An internship fund in support of TRI's research activities is being established in honor of Peggy

Contributions may be sent to:
Amity Doolittle, Program Director
Tropical Resources Institute
Yale School of Forestry and Environmental Studies
205 Prospect Street
New Haven, CT 06511

2005 TRI Fellows



Costa Rica:	Alvaro Redondo-Brenes
	Wendy Francesconi
	Kristen Welsh
Ecuador:	Catherine Schloegel
Ghana:	Gonzalo Griebenow
Indonesia:	Linda Kramme
Madagascar:	Radhika Dave
	Tendro Ramaharitra
Malawi:	Caroline Simmonds
Nicaragua:	Richard Chávez
Peru:	Oscar Franco
Philippines:	Ikuko Matsumoto
Southern Africa:	Krupa Patel

Mangrove Ecosystems of Southwest Madagascar:

An Ecological, Human Impact, and Subsistence Value Assessment

by Radhika Dave, MESc 2006

Introduction

The importance of mangrove forests in maintaining crucial ecosystem functions such as nutrient filtering, supporting coral reef fisheries, and providing storm buffers has become increasingly evident after the tsunami that ravaged parts of Asia in December 2004 (Alongi 2002; Mumby et al. 2003; UNEP-WCMC 2006). However, these vital tropical ecosystems in the coastal inter-tidal zones, covering about 181,000 km^2 (Spalding et al. 1997), continue to be under immense threat from a variety of human actions. Over the last twenty years, approximately 35% of the world's mangrove forest area has been lost (Valiela et al. 2001). Nevertheless, activities that contribute to this depletion continue. These activities include timber and fuel wood extraction, urban development, and the expansion of shrimp aquaculture, which is by far the greatest cause of mangrove loss (Valiela et al. 2001).

Mangrove ecosystems in many countries face a combination of these pressures. This is true for the island nation of Madagascar as well. Along with some of the most remote and biodiverse coral reefs, 3,270 km^2 of mangrove forest lie within Madagascar supporting numerous coastal communities and the nation's economy (Cooke et al. 2003). There is limited documentation of these forests in Madagascar, particularly in southwest Madagascar, which is home to the nomadic Vezo fishing communities.

My summer research focused on the mangrove ecosystems of Baie des Assassins, a small bay harboring about 25 km^2 of mangrove forest, approximately 185 km north of the port city of Toliara. I aimed to explore the dynamics of the forest structure, to obtain a measure of the human impact on the forest, and to understand the subsistence value of mangroves to the local community. The indigenous Vezo populations that reside in fishing villages around and north of the Baie des Assassins use these mangroves for timber, fuel wood, and fishing. However, the intensity and periodicity of use and level of dependence on the mangrove forest is undocumented. The region around the Baie des Assassins may potentially form part of a multiple-use conservation site, thus necessitating a clear understanding of the forest structure and its significance to local communities.

Background

Nearly 98% of Madagascar's mangroves lie along the west coast of the island facing the Mozambique Channel (Roger and Andrianasolo 2003). The mangroves here are part of the Indo-Pacific domain. But like other African mangroves, Madagascar's mangroves exhibit less floral and faunal diversity than those of South East Asia (Roger and Andrianasolo 2003; Gaudian et. al. 1995). A total of eleven species of mangrove trees are known in Africa, out of which eight species have been recorded in Madagascar.

Baie des Assassins lies at 22°11'S and 43°15'E within a region that is important for its coral reefs and mangroves. About half of the 50km^2 of mangroves in the region lie within the

Radhika Dave is originially from India, but has spent the better part of the last decade studying and working in the US. She obtained her BS in Biology and Environmental Sciences at the College of William & Mary and worked with Conservation International in DC before coming to F&ES. In the future, she hopes to continue with ecological research and working to integrate conservation within economic development.

Baie des Assassins (Cooke et al. 2003; Gaudian et al. 1995). Mangroves on the west coast are important breeding grounds for several commercial fish species such as mullet (*Mugilidae*), sickle fish (*Drepanidae*), and pony fish (*Leiognathidae*) (Cooke et al. 2003). These mangroves also provide local communities with timber for construction and fuel.

Madagascar is currently in the third phase of its National Environmental Action Plan, a government program that prioritizes marine and coastal ecosystem management. The government aims to expand the nation's terrestrial protected area coverage from 15,000 km^2 to 50,000 km^2 and its coastal and marine protected area coverage from 2,000 km^2 to 10,000 km^2 within a period of five years (Conservation International 2003). It has taken a series of steps in consultation with various organizations to meet its aim of tripling Madagascar's protected area network and several new *Sites des Conservation*, or conservation sites, are in the planning stages. Baie des Assassins and its surrounding region may be included in one such site; hence, it is important at this stage to inform the official management and planning process with the relevant ecological and socio-economic data on mangrove use values and threats. While shrimp aquaculture increasingly is threatening mangrove habitats in the northwest part of the country and tourism has negatively impacted the mangroves of Toliara, the Baie des Assassins mangroves are yet to witness large-scale destruction brought on by these external factors.

Methods and Data Analysis

My study focuses on the peninsular region of the Lamboara village and its surrounding mangrove forests within the Baie des Assassins. This land mass, though accessible by foot from the mainland at low tide, is essentially an island at high tide. The village is comprised of the Vezo fishing community and has a population of approximately 600 people, of which 60% are children.

To evaluate the direct use value of this mangrove forest in the daily lives of Lamboara residents, I conducted semi-structured interviews with 30 households in the village, accounting for about one-third of the population, with the aid of a translator who was also my research assistant. I asked questions to assess the level of dependence and the variety of human services provided by the mangroves. When available, information on the source site of mangrove wood and other products was also recorded. I collected data from the end of June through mid-July, which coincided with the seasonal northern migration of many fishermen in search of better fishing. Hence, most of the respondents for my social survey were women and older men, essentially, those who remained in the villages.

To assess species composition and level of human impact in the mangrove forests, I selected four sites to be sampled ranging in distance from the village of Lamboara (Figure 1). The first site (Site A), is located adjacent to the village on the same land mass. Site B is a small island across the water channel from the village. Sites C and D are on the fringes of the mainland of Madagascar, also across the water channel from the village, but not connected to Site B. Site A is the closest to the village followed by Site B, Site D, and finally, Site C. Within each site, three 10m x 10m plots were laid out to record the mangrove species composition, to collect diameter (according to CARICOMP 2001) and height measures for mature trees, and to record the number of cut tree stumps as a measure of human impact. Randomly placed subplots were set within each plot to record the species type and number of seedlings and saplings as a measure of regeneration (CARICOMP 2001).

The relative density of the five species recorded was calculated using the formula worked out by Cintrón and Schaeffer-Novelli (1984). Multivariate analysis of variance was conducted on square root transformed data for height and diameter for mature trees – those with diameter greater than 2.5 cm at breast

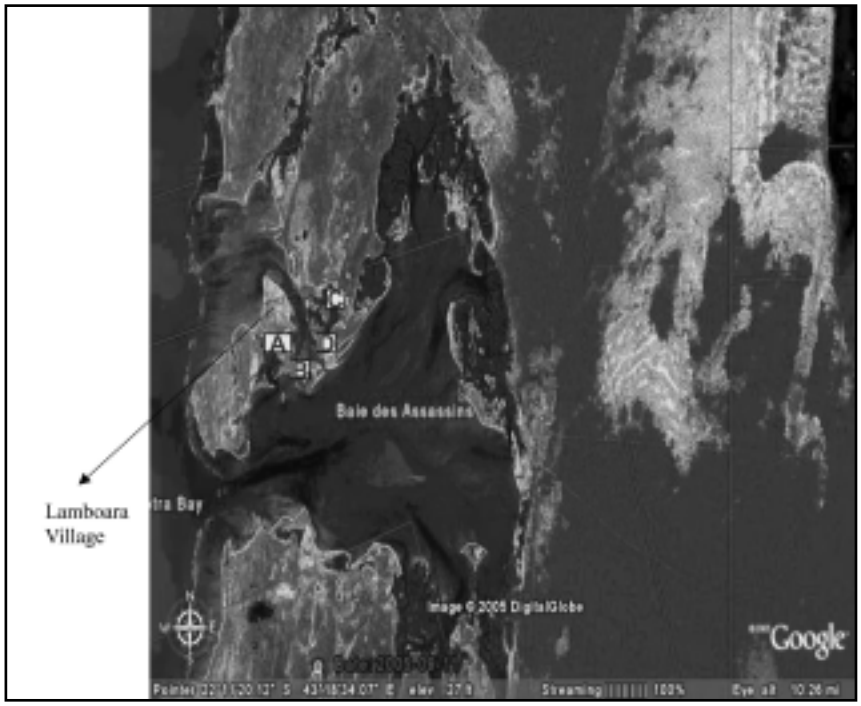
height – to test for differences in these variables as a function of differing site locations. These sites are presumably differentially impacted because of distance from village and stated use by respondents. I analyzed the human impact index in the form of ratio of stumps to mature trees for variation between the four sites. I used diameter size class distribution of trees to detect differences between sites in species rejuvenation. Finally, I performed paired t-tests to detect significance in the difference between the mean abundances of mature trees and juveniles.

Results and Discussion

Five species of mangrove trees were found in the mangrove stands surrounding Lamboara. These are (Malagasy common names in parenthesis): *Avicennia marina* (*hafihafy*), *Rhizophora mucronata* (*tangandahvy*), *Sonneratia alba* (*songery*), *Bruguiera gymnorrhiza* (*tangampoly*) and *Ceriops tagal* (*tangambavy*). However, only *Rhizophora*, *Ceriops*, and *Bruguiera* were found in plots across all four sites and only two individuals of *Sonneratia* were found, one each in Sites B and D. Site A, which is closest to the village, is used mainly for collecting fuel wood and occasionally pole wood,[1] with *Ceriops* exhibiting the highest relative density of 51% for mature trees,[2] *Ceriops* showed a similar high relative density when compared to the other four species in Sites B (51%) and C (72%), but was relatively less abundant in Site D (21%). Among sites, *Ceriops* had the highest relative dominance of 31% followed by *Rhizophora* at 28.2%.[3] *Ceriops* also showed the highest relative density across sites of 49.6%, while *Rhizophora* and *Bruguiera* had similar overall relative density of 21.6% and 21.9% respectively. Based on the analyses performed on the data for mature trees, the diameter and height of mature trees does not vary significantly at sites with differing distances from the village. Diameter size class distribution for all the vegetation at each of the four sites showed the reverse-J shape characteristic of species with good rejuvenation (Lykke 1998).

Regeneration, measured as the total num-

Figure 1. Location of Lamboara village in Madagascar



ber of seedlings and saplings found at each site, and the number of mature individuals showed similar variance in abundance across the four sites. This was true for all the sites except B, where the total number of total seedlings and saplings is markedly less for *Ceriops tagal* than its adult abundance (Figure 2). A paired t-test conducted on the total number of mature individuals and total regeneration indicated that there was no significant difference (at p value of 0.05) in means of mature and juvenile tree numbers (p of 0.094). The next step would be to perform another analysis of variance to determine any significant difference between species and groups (juveniles and adult trees) for each of the sites.

It is worth noticing also that consistently high stump abundance equal to the abundance of mature trees was found in Site B (Figure 3). Site B is a small island and experiences a mixed use pattern of fuel wood and pole wood collection. Site C, which is farthest from the village and is used for its relatively taller wood, had a highly variable human impact index in its plots. One of its plots exhibited a 2:1 ratio of stumps to mature trees (Figure 3).

Houses in Lamboara are made from pole wood that originates from the surrounding mangrove forests. In addition to using pole wood and collecting dead wood for use as fuel, Lamboara residents also collect crabs in the mangroves during neap tides and shrimp when in season. Occasional use of *Avicennia marina* to treat stomach ailments and fevers was also observed. Shellfish (*Murex sp.*) are harvested from the mangroves for consumption. Their shells are burned to produce lime. When mixed with sand it is called *sookay* and is used as cement in constructing the walls and floors of some houses or sold to other villages upon order. A considerable amount of pole wood

Figure 2. Variation in abundances of mature trees and regeneration (total number of seedlings and saplings) across sites

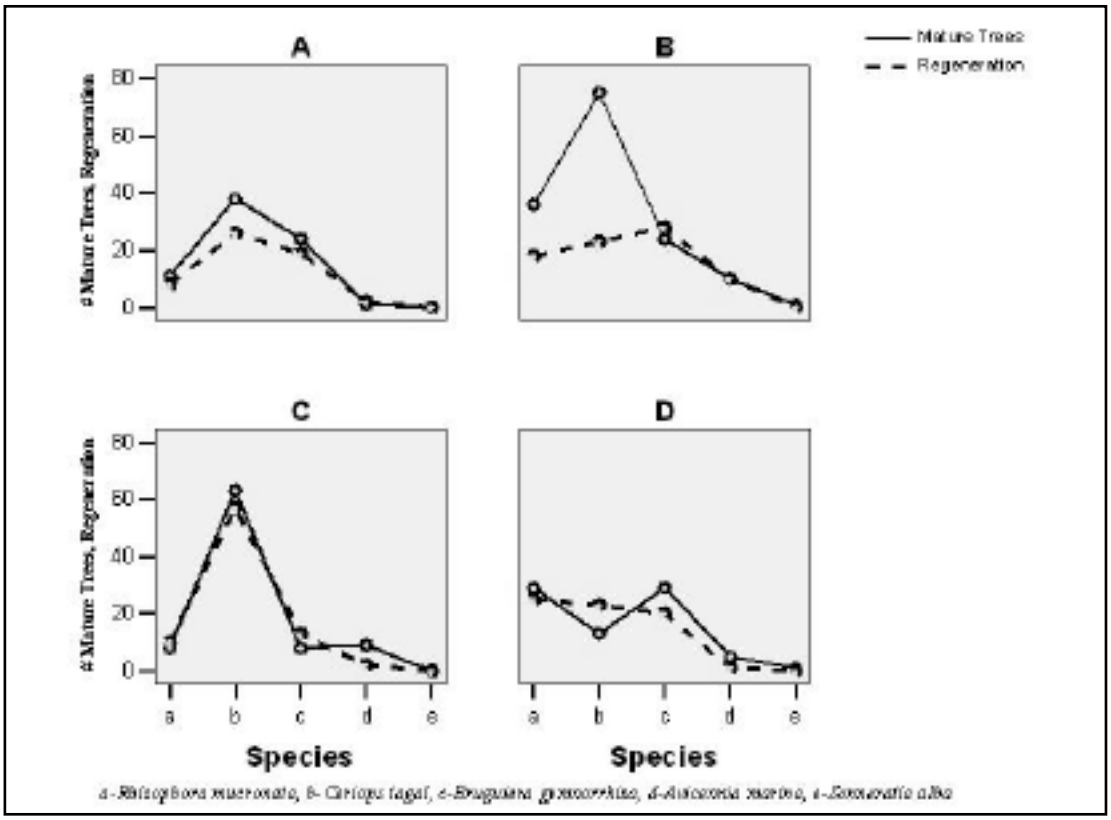
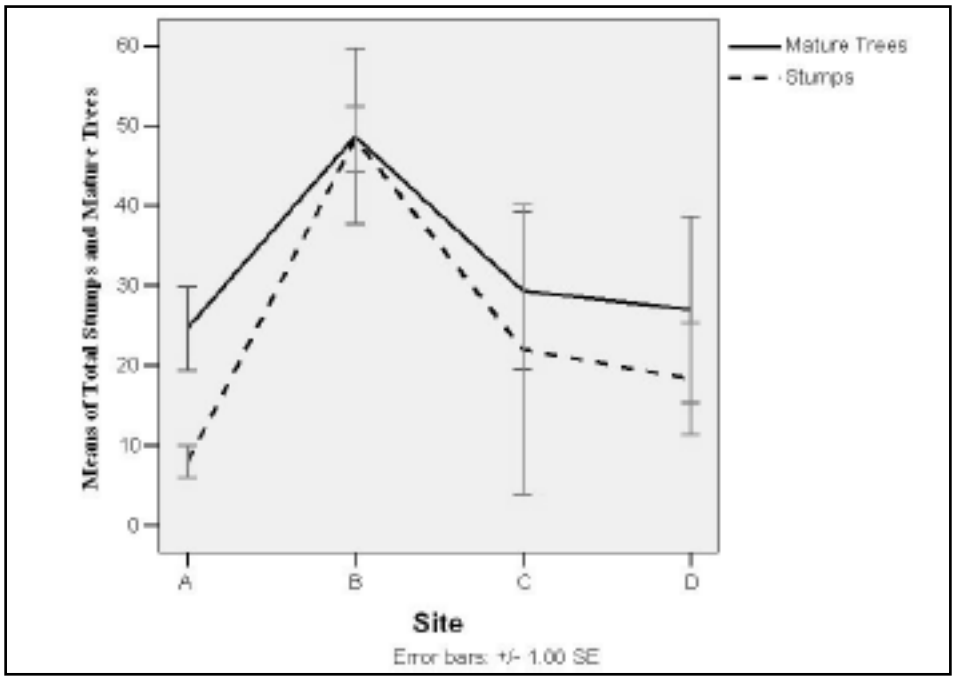


Figure 3. Variation in abundances for mature trees and stumps across sites



collected from the mangroves is used to burn the shells, make drying lattices, walls, fences, and torch lights for night fishing of sea cucumbers. No charcoal production takes place in the Baie des Assassins region, and most people collect dead branches for fuel wood. Women are generally the ones to collect fire wood and crabs, while pole wood collection and finishing is a predominantly male activity. Occasionally, some women collect crabs for sale within the village to augment their income from fishing, selling each palm size crab for about 200 ariary (equivalent to $0.11 at the time of research). Cutting pole wood and producing *sookay* is also a means of earning additional income for some people in the village, who sell them to people from other coastal villages north of the Baie des Assassins. Pole wood fetches varying prices depending upon the quality and size – pole wood for constructing houses is sold for anywhere from 600 to1,200 ariary for poles 8 cm in diameter and 3 to 4 m long. Similarly, a sack of *sookay* (the size of a 50 kg rice bag) will be sold for 1,000 ariary ($0.53) to others within the village and to outsiders if it is in demand.

The mangrove species preferentially harvested for pole wood in the Lamboara region are *Rhizophora*, *Ceriops*, and *Bruiguiera*. This is also a preference seen in other parts of Africa, such as in Kenya's Mida Creek region (Dahdouh-Guebas et al. 2000). *Rhizophora*, *Ceriops*, and *Bruiguiera* grow long and tall and have different properties that make them valuable for constructing different parts of houses or fences. While *Bruguiera gymnorrhiza* is well-suited to constructing roofs due to its strength, *Rhizophora mucronata* is considered ideal for building walls and especially for use as thicker corner poles because it can withstand saline conditions better (Dahdouh-Guebas et al. 2000). *Ceriops tagal* yields thinner poles and is used for the interweaving structures of the walls or towards the construction of fences or small sheds for poultry.[4]

According to Kairo et al. (2002), field observations show that in a mixed stand of *Rhizophora* and *Ceriops*, there is a tendency for natural regeneration to favor *Ceriops*, irrespective of the harvested crops. This has implications for the long term species composition of the

Lamboara forests as well. If the forest structure shifts to a predominantly *Ceriops* forest, then a more socially desirable forest of *Rhizophora* may give way to an inferior one from a local economic viewpoint (Kairo et al. 2002).

Conclusions

The local communities surrounding Baie des Assassins are highly dependent upon the mangroves for a variety of services and subsistence needs. Small-scale, selective extraction of individual mangrove trees may have little effect on the entire mangrove ecosystem, but it removes individual trees. *Rhizophora* species do not sprout again following cutting, while *Avicennia* do (Ellison and Farnsworth 1996). Since the forest is composed of, at most, five species of trees supporting a variety of faunal assemblages, drastic reduction in a single species can potentially reverberate throughout the ecosystem. However, ecosystem functions of each mangrove species is not yet quantified in ways that can inform management decisions (Ellison and Farnsworth 1996). In the case of the Lamboara mangroves, human use of the forests is not leading to outright loss of forested area; however, a shift in species composition and forest structure may be changing the forest qualitatively. While the ecological impact of shifts in dominant species is difficult to estimate from the data gathered and from other studies (Kairo et al. 2002), the subsistence function of the forests may be changed or weakened more perceptibly. All four study sites exhibit higher regeneration by *Ceriops tagal* in comparison to *Rhizophora* and the other species (See Figure 2). *Ceriops* also has the highest relative density. Further multi-year data collection on forest structure and human use can yield conclusive information to determine if the forests surrounding the village are undergoing a species shift. Ecological data should be augmented with information collected during household surveys to determine which species are under the most harvesting pressure. The next steps will be to disseminate these results to the Lamboara residents in order to produce a community initiated management plan to govern the use of mangroves in this region of Baie des Assassins.

Endnotes

1 Based on interviews with village residents.

2 Relative Density = (Number of Individuals of a species/Total number of inividuals) x 100.

3 Relative Dominance = (Total basal area of a species/basal area of all species) x 100.

4 Based on interviews with village residents.

Acknowledgements

I would like to thank the community of Lamboara and Andavadoaka in Madagascar for their support and hospitality, the staff and students at the Institut Halieutique et des Sciences Marines (IHSM) at the University of Toliara, the Wildlife Conservation Society (WCS) staff at Toliara and Antananarivo and the Blue Ventures staff in London and Andavadoaka. Special thanks to Hajaniaina Rantsoavina and Joelson Rakotoson for their invaluable assistance and friendship during my field work at Lamboara and Ampasilava. WCS staff, Francisco in Andavadoaka, Mr. Rijasoa in Toliara, Mr. Bemahafaly Randriamanantsoa, Dr. Simon Harding, and Dr. Helen Crowley deserve special thanks for their technical guidance and logistic support. I would also like to thank my former colleagues at Conservation International in Washington D.C. and Antananarivo for their insights and support. I am grateful for the advice I received from Dr. Oswald Schmitz throughout this project, to Dr. Jonathan Reuning-Scherer and Dr. Amity Doolittle for their guidance, and to Monisha Gangopadhayay for her edits to this paper. Thanks also to Tendro Ramaharitra (F&ES '05) for his guidance. This research was made possible in part by funding from the Tropical Resources Institute and the Yale School of Forestry and Environmental Studies Summer Research Fund.

References

Alongi, D.M. 2002. Present State and Future of World's Mangrove Forests. *Environmental Conservation* 29 (3): 331-349.

CARICOMP Methods Manual Level I & II: Manual of Methods for Mapping and Monitoring of Physical and Biological Parameters in the Coastal Zone of the Caribbean. 2001. Jamaica: CARICOMP Data Management Centre, University of West Indies.

Cintrón, G. and Y. Schaeffer-Novelli. 1983. Methods for Studying Mangrove Structure. Pp. 91-113 in *The Mangrove Ecosystem: Research Methods*, edited by C.S. Samuel and G.S. Jane. Paris: UNESCO.

Conservation International. Madagascar To Triple Areas Under Protection: Plan Calls for the Creation of a 6-million-hectare Network of Terrestrial and Marine Reserves. Press Release. 16 Sept 2003. http://www.conservation.org/xp/news/press_releases/2003/091603_mad.xml (accessed December 15, 2005).

Cooke, A., J. R. E. Lutjeharms, and P. Vasseur. 2003. Marine and Coastal Ecosystems. Pp. 179-209 in *Natural History of Madagascar*, edited by S. Goodman and J. Benstead. Chicago: Chicago University Press.

Dahdouh-Guebas, F., C. Mathange, J.G. Kairo, and N. Koedam. 2000. Utilization of Mangrove Wood Products Around Mida Creek (Kenya) Among Subsistence and Commercial Users. *Economic Botany* 54 (4): 513-527.

Ellison, A. M. and E. J. Farnsworth. 1996. Anthropogenic Disturbance of Caribbean Mangrove Ecosystems: Past Impacts, Present Trends and Future Predictions. *Biotropica* 28(4): 549-565.

Gaudian, G., K. Anderson and S. Wells. 1995. Marine Region 12: East Africa. in *A Global Representative System of Marine Protected Areas: Central Indian Ocean, Arabian Seas, East Africa and East Asian Seas, Volume III*, edited by G. Kelleher., C. Bleakley, and S. Wells. Washington D.C.: The World Bank Environment Department.

Kairo, J. G., D.G. Farid, P.O. Gwada, C. Ochieng and N. Koedam. 2002. Regeneration Status of Mangrove Forests in Mida Creek, Kenya: A Compromised or Secured Future? *Ambio* 31 (7-8): 562-56.

Lykke, A.M. 1998. Assessment of Species Composition Change in Savanna Vegetation by Means of Woody Plants' Size Class Distributions and Local Information. *Biodiversity and Conservation* 7:1,261-1,275.

Mumby, P., A. J. Edwards, J. E. Ernesto Arias-Gonzalez, K. Lindeman, P. G. Blackwell, A. Gall, M. I. Gorczynska, A. R. Harborne, C. L Pescod, H. Renken, C. C. C. Wabnitz, and G. Llewellyn. 2004. Mangroves Enhance the Biomass of Coral Reef Fish Communities in the Caribbean. *Nature* 427: 533-536.

Roger, E. and M. Andrianasaolo. Mangroves and Salt Marshes. 2003. Pp. 209-210 in *Natural History of Madagascar.* edited by S. Goodman and J. Benstead. Chicago: Chicago University Press.

Spalding, M., F. Blasco, and C. Field. 1997. World Mangrove Atlas: Okinawa, Japan: The International Society for Mangrove Ecosystems: 178 pp.

Valiela, I., J. L. Bowen, and J. K. York. 2001. Mangrove forests: One of the World's Threatened Major Tropical Environments. *BioScience* 51 (10): 807-815.

UNEP-WCMC. 2006. In the Front Line: Shoreline Protection and Other Ecosystem Services from Mangroves and Coral Reefs. Cambridge, UK: UNEP-WCMC, p. 33.

Reconstructing the Political Boundary in the Lubombo Transfrontier Conservation Area

by Krupa Patel, MESc 2006

Introduction

Imagine a landscape where elephants migrate freely along ancient migratory routes, crossing back and forth across international boundaries; a place where tourists can drive through multiple African countries in one day to view wildlife and enjoy ecotourism opportunities that promote biodiversity conservation while also providing income to local communities. This is the central vision for Transfrontier Conservation Areas (TFCAs). TFCAs, or Peace Parks, attempt to reconcile human land use with conservation objectives. They are comprised of conservation corridors linking major protected areas across international borders. The result is a large, unified ecological area that can be managed jointly by different countries through international cooperation.

Transboundary conservation has been hailed as a new frontier in conservation and development due to its goal of simultaneously pursuing biodiversity conservation, rural economic growth, and regional peace through international cooperation. The Southern African Development Community (SADC), an economic and political alliance of nine southern African states, has embraced the TFCA as a way to provide poverty relief to local communities by bolstering local economies while keeping biodiversity conservation at the center of the TFCA initiative. Three governments in southern Africa – Swaziland, Mozambique, and South Africa – have embarked on an initiative, currently in construction, to implement a TFCA within their boundaries. The TFCA would remove international border fences, thereby allowing a free flow of ecosystem *and* local economic functions. In the process, the *political* boundaries within the TFCA are intended to become less discernible, or less "visible."

However, despite positive intentions for the plan, on the ground the TFCA may strengthen political lines within its jurisdiction, intensifying the presence of the state in border regions and increasing the regulation of civilian movement across these borders. Consequently, the TFCA may adversely impact those whose lives depend on cross-border movement and the overall local economy in the region.

Krupa Patel attended Smith College before working for the Federal government and embarking on an array of international environmental experiences. Krupa intends to use her graduate degree to further her interest in the environmental aspects of development as a Presidential Management Fellow next year.

Background

In June of 2000, the governments of Swaziland, Mozambique, and South Africa entered into the Lubombo Transfrontier Trilateral Protocol to formally establish the Lubombo Transfrontier Conservation and Resource Area (Figure 1). The Trilateral Ministerial Committee, comprised of a ministerial representative from each of the participating nations, appointed high-ranking government officials from the three country to a Trilateral Commission. Under the direction of the Trilateral Commission, five stakeholder Task Teams were deemed responsible for planning and organizing the implementation of the five corresponding sub-TFCAs that, together, comprise the Lubombo TFCA. Each country's conservation agency is then responsible for managing the TFCA land under their jurisdiction.

The anticipated Lubombo TFCA is 4,195

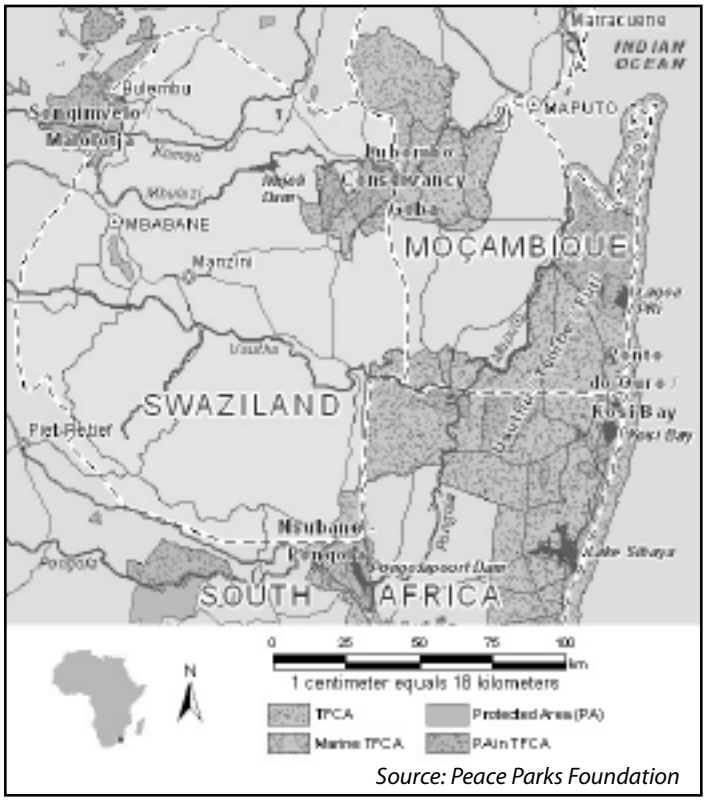


Figure 1. Map of the Lubombo Transfrontier Conservation Area.

Source: Peace Parks Foundation

km^2 and lies on a coastal plain running from Tembe Elephant Park and Ndumu Game Reserve in northern KwaZulu-Natal, South Africa, to the Maputo Elephant Reserve in Mozambique (Peace Parks Foundation 2005). Tembe Elephant Park will be connected to the Maputo Elephant Reserve through the creation of the Futi Conservation Corridor, which will reunite elephant populations in the two parks.

Several communities live in and are adjacent to the Lubombo TFCA. Most homesteads in the border regions are constructed using traditional materials and methods, and many people rely on a combination of livelihoods, which generally include subsistence farming, local *ilala* palm wine production, bush meat markets, and reed harvesting, as well as illicit transboundary activities. These communities frequently depend on natural resources that lie on opposite sides of the international boundary fence.

Although government officials are attempting to hasten the process of making the Lubombo TFCA operational, within the TFCA, international border fences have yet to be dismantled. TFCA officials are still in the process of settling land claims, building infrastructure, and developing management plans.

Changing Regulation and its Impact on Policing and Creating Linkages

On an abstract level, the international boundary creates distinctions between systems of governance, history, and society. However, physical boundaries that separate the laws and policies that govern South Africa, Mozambique, and Swaziland can be walked across with little difficulty on the ground. On a local level, the international boundary that falls within the proposed TFCA is a single-track sand road that runs between two four-foot-high wire fences formally separating the three countries. These fences are broken in some places and non-existent in others.

The border regions where South Africa, Mozambique, and Swaziland meet are sparsely

Th e boundary road between South Africa and Mozambique
Photograph by K. Patel

populated and state presence is all but absent in many of these areas. According to political scientist and anthropologist, James Scott, "Border zones have traditionally been non-state spaces, characterized by perceived chaos and illegibility" (1998: 187). Most local movement along the border regions is fairly unimpeded. According to an inspector in KwaZulu-Natal, South Africa, "border control is a major problem in the South Africa-Mozambique border regions and there is very little regulation of movement" (South African security forces, pers. comm., 2005). As such, security in the borderlands is a heavily discussed issue among TFCA administrators.

Since conservation requires government action to regulate people's activities and manage land (Ellis 1994), the Lubombo TFCA will intensify state presence in the borderlands through increased security and border forces. Border regulation will increase through the creation of corridor areas that are patrolled by both national forces and conservation authorities, leading to more effective policing of the borderlands (South African conservation authorities, pers. comm., 2005).

In addition, the TFCA will also strengthen core-periphery institutional linkages through the construction of infrastructure for the TFCA. Roads and tourist facilities have been planned in all three countries to better connect the border regions to urban areas. Road-building is an inherently political activity. The extensive road-building planned for the TFCA will increase market access into and out of the communities affected by the TFCA, restructuring local economies. It will also strengthen state access, bringing more visibility to the borderlands.

The Effect of TFCA Regulation on Local Economies: Cross-Border Trade, Market Access, and Interaction

Although international cooperation is a main goal of the TFCA, cooperation across the political boundary is already taking place through systems of trade that contribute to the local economy. In a sense, these border zones are already transfrontier areas since local livelihoods and identities depend on cross-border trade and interaction. Most movement across the international border is from the local population who crosses back and forth to visit family, purchase bush meat, sell fish, and buy supplies at the local markets (community member, pers. comm., 2005). According to Jennifer Jones in her article, *Transboundary Conservation: Development Implications for Communities in KwaZulu-Natal, South Africa*,

many members of the Mbangweni community on the South African side of the border have primary household garden plots that lie one to two kilometers over the border in Mozambique on the floodplains where the soil is more fertile (2005). Greater regulation of local movement across the international border may affect local access to productive farming land and informal markets that are currently used by people on both sides of the international border.

In addition, small dirt paths can be seen winding their way through the dense bush on both sides of the international border road. The small dirt paths are the routes people take to avoid paying "crossing tolls" in the form of crops and money at stop-points along the main border road (South African Conservation Authorities, pers. comm., 2005). Increasing border forces may highten the visibility of these informal border crossings. When security forces flow into the borderlands through the TFCA, it may place a further economic burden on people by imposing stronger regulation of local crossing paths and border zones, and perhaps expanding the crossing tolls network into previously informal routes.

Bush meat is an integral part of local diets since it is a traditional form of sustenance and also tends to be cheaper and more nutritious than store-bought meat. Bush meat also has profound implications for the local use of domestic livestock as capital investments for the economic security of the household. "People, regardless of ethnicity [in Eastern and Southern Africa], generally refrain from utilizing their livestock for domestic use, especially when a viable meat protein alternative exists so that livestock can be preserved as household capital and cultural assets, and be used only in dire circumstances during drought and famine" (Pillinger 2004: 22).

There are three informal markets that are currently operating along the international border on land that will become part of the TFCA. These markets support the trade of bush meat, household goods, *ilala* palm wine, and locally grown produce from household plots in the area. Most of the daily movement across the border is foot movement for these markets. Although border communities access the markets differentially, Jones found that 18% of Mbangweni residents on the border sell household goods at the local markets, and 77% buy household goods at these markets (2005).

These informal markets are forums for social interaction as well as cross-boundary trade between border communities. At the KwaMshudu border market, women grill fish and sell stews in giant cauldrons. Giant plastic gas cans of locally made *ilala* palm wine are stacked in piles for local sale, and men smoke and socialize under trees from which red duikers and other bush meats hang. Women hang their fresh-plucked fowl and dried meat from the border fence, and people cross through the fence as if it was merely there to display their goods. Border guards with AK-47s lounge along the fence-lines smoking and watching the local movement through the fences.

The KwaMshudu market will most likely be consumed by the proposed Futi Conservation Corridor that will link Tembe Elephant Park in South Africa to the Maputo Elephant Reserve in Mozambique. The proposed Futi Corridor will encompass two of the three existing informal bush meat markets, as well as several crossing points used by South Africans to access their household garden plots in Mozambique. Walking access in the borderlands within the TFCA may also be restricted by the expanded range of elephants and other dangerous fauna in the conservation areas (Jones 2005).

The Potential for Increasing Visibility of Socio-Economic Disparities

Mobilization of border forces along the political border within the TFCA has many implications. Will increased security forces contribute to more regional stability, more governance of the border regions, or perhaps more

conflict? At current international border posts within the TFCA, South African and Mozambican border forces are camped roughly 60 m from each other across the international border road. The Mozambican security forces live in make-shift tents on one side of the political border, while the South African forces live in solid, weather-proof barracks on the other side. Unequal ground-level funding often leads to jealousy and intimidation among international border forces (South African Security Forces, pers comm). A further implication is that salary and infrastructural disparities along the international border may make the political border visible socio-economically even after the border fences has been removed physically.

Conclusion

In his article, *Transfrontier Conservation Areas: A New Dawn for Eco-tourism or a New Form of Conservation Expansionism*, Saliem Fakir astutely wrote, "There is a real danger that if TFCAs are not carefully thought through in terms of their economic and social impacts, a purely conservation mind-set may drag regional governments to support what may turn out to be large tracts of unproductive land...the cost of which will have to be borne by already impoverished citizens in the region" (Fakir 2000: 4). In southern Africa, security forces that patrol the international boundaries within the TFCA may increase the regulation of movement across the political border.

Although people will always find ways to cross boundaries, the TFCA may present an additional hurdle, hindering local systems of trade, household production, and social interaction that depend on unregulated cross-border movement. Thus, despite its purpose to transcend international boundaries, the TFCA may, in fact, reinforce boundary lines and undermine the efforts of the southern African political community to improve local economies and combat rural poverty.

Acknowledgements

This research was conducted through the funding support of the Yale Tropical Resources Institute, the Coca-Cola World Fund at Yale, and the F&ES Summer Internship Fund. Thanks to various members of the local communities impacted by the TFCA for sharing their insight and knowledge. In addition, thanks to my advisor, Michael R. Dove, as well as the following individuals for their unique insights and contributions: W. Foltz, R. Kloppers, W. Dlamini, L. Gunter, R. Bartlett, M. Tembe, C. Mokuku, J. Jones, J. Ntsele, members of the South African Security Forces and Conservation Authorities, the Carpenter/Doolittle/Dove Masters Lab, and the TRI staff.

References

Ellis, Stephen. 1994. Of Elephants and Men: Politics and Nature Conservation in South Africa. *Journal of Southern African Studies* 20(1): 53-69.

Fakir, Saliem. 2000. Transfrontier Conservation Areas: A New Dawn for Eco-tourism, or a New Form of Conservation Expansionism. *Policy Think Tank Series* (3). South Africa: Pretoria, IUCN South Africa.

Jones, Jennifer L. 2005. Transboundary Conservation: Development Implications for Communities in KwaZulu-Natal, South Africa. *The International Journal of Sustainable Development & World Ecology* 12(3): 266-278.

Peace Parks Foundation. 27 October 2005. http://www.peaceparks.org/ (accessed October 27, 2005).

Pillinger, S.D. 2004. The Illicit Bush Meat Trade (Northern KwaZulu-Natal). Unpublished Report. Pietermaritzburg: Ezemvelo KwaZulu-Natal Wildlife.

Scott, James, C. 1998. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. New Haven: Yale University Press.

Payment for Hydrological Environmental Services in Costa Rica:

The Procuencas Case Study

by Alvaro Redondo-Brenes, MFS 2005 and Kristen Welsh, MESc 2006

Introduction

Implementation of Payment for Environmental Services (PES) programs, especially for watershed services, is a recent activity. PES is a mechanism where landowners receive compensation for the environmental services their land provides to society in general (Pagliola 2002). This program is often used to improve water quality through watershed protection. Watersheds accomplish this by improving flow regulation, filtering water, controlling erosion and sedimentation, and maintaining the hydrological functions provided by forests (Johnson et al. 2002; Echavarria et al. 2004). The watershed-based PES programs have been deemed a success for both conservation and development (Echevarria 2002; Redondo-Brenes 2005), which has led to the establishment of programs in Latin America, such as in Costa Rica (Miranda et al. 2003; Rojas and Aylward 2002; Cruz and Navarrete 2000; Mejias and Segura 2001), Ecuador (Echavarria 2002; Echavarria et al. 2004; Redondo-Brenes 2005), Colombia, and Brazil, and in the US, such as in New York City (Tam 2002).

The assessment of these programs is important because prototypes have been established in different countries and it can be useful in creating a framework for further implementation in other regions. This paper assesses a PES program participating in watershed conservation, the Public Services Enterprise of Heredia (ESPH) Procuencas program in Costa Rica, for strengths, weaknesses, and feasibility of implementation in other countries. ESPH was selected since it is seen as one of the most successful projects for watershed protection within the country. This effort is one component of a larger research project addressing water management in Costa Rica (see "Assessing Accesss to Potable Water in Rural Communities in Costa Rica" by Welsh, this volume). We interviewed technicians in charge of Procuencas, as well as other governmental institutions related to water issues and PES in Costa Rica. Additionally, we reviewed available literature related to Procuencas, ESPH, and PES programs for watershed conservation.

Background of Payment for Environmental Services in Costa Rica

In Costa Rica, a PES program was implemented throughout the country with the creation of the Forestry Law in 1996. The Forestry Law identifies a range of environmental services derived from natural forests, tree plantations, and agroforestry systems, such as carbon fixation, hydrological services (i.e. reduction of silt

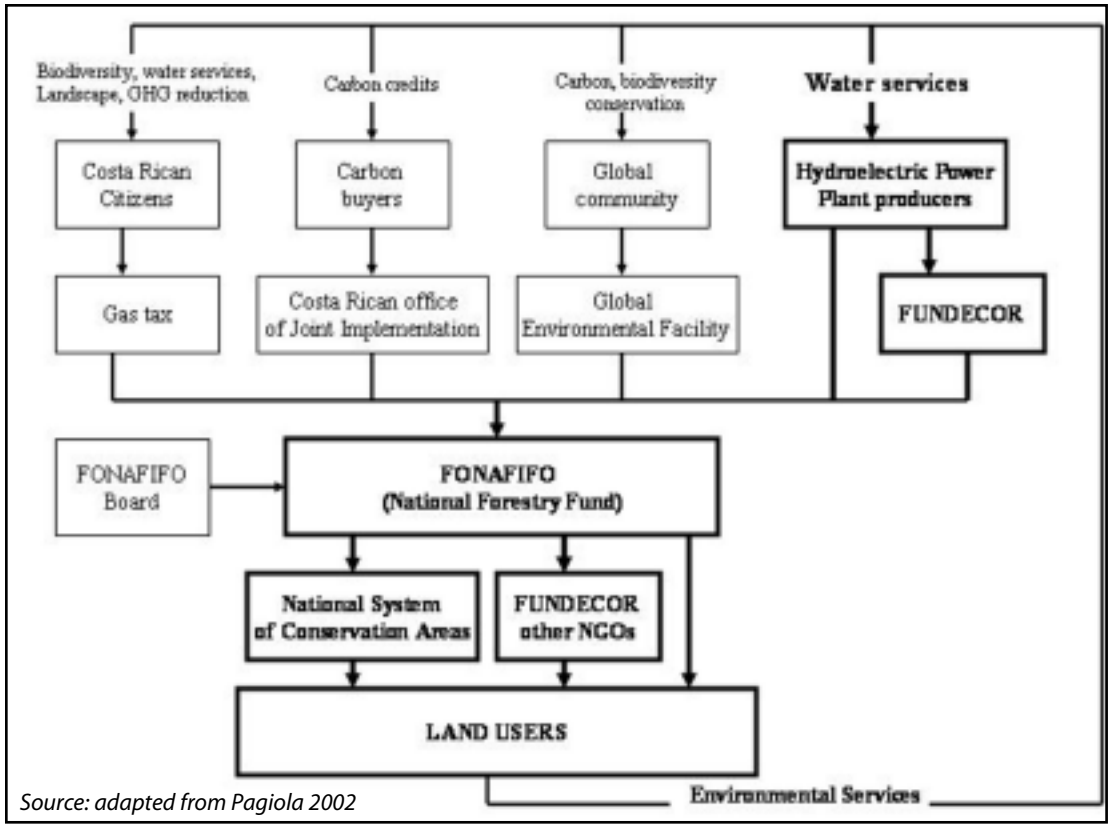
Alvaro Redondo-Brenes is from Costa Rica and he has a BSc. in Forestry Engineering from the Technological Institute of Costa Rica and a MFS from the Yale School of Forestry & Environmental Studies. He worked from 1998 to 2002 at La Selva Biological Station (Organization for Tropical Studies) in Costa Rica and now he is a doctoral student in Tropical Forestry and Conservation at F&ES.

Kristen Welsh, a native of Massachusetts, attended Tufts University, where she obtained her bachelors degree in Spanish and Environmental Studies. Before coming to the Yale School of Forestry and Environmental Studies, she worked with an environmental consulting firm.

in the water supplied to hydropower and aquifers), biodiversity protection, and provision of scenic beauty (Subak 2000). On average, landowners receive $540 per hectare for establishing new tree plantations, $210 per hectare for established plantations, $210 per hectare for forest conservation and regeneration, and $0.8 per tree for supporting the establishment of agroforestry systems over a period of five years (FONAFIFO 2004). The PES program receives revenues from a five percent tax on gasoline consumption, private-sector contributions, and the sale of certifiable tradable offsets (CTOs) to foreign investors. For example, in 1997, Norway purchased $2.0 million in CTOs in exchange for carbon offsets (Subak 2000), and the government of Germany, through the Kreditanstalt für Wiederaufbau Bank, is investing $10 million (FONAFIFO 2004). The PES program is administrated through the National Forestry Fund (FONAFIFO) and implemented by the Ministry of Environment and Energy (MINAE), private consultants, and NGOs, such as FUNDECOR (Foundation for the Development of the Central Volcanic Range), working at the community level with landowners (Figure 1).

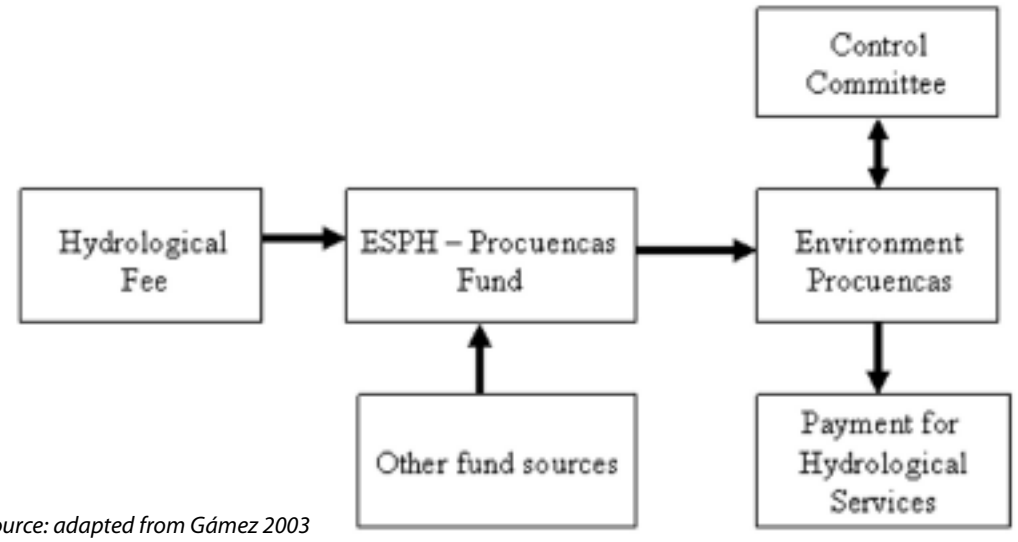
As a component of the PES program, private companies support the program through signed agreements with FONAFIFO that promote watershed conservation in Costa Rica. The hydroelectric power company Energía Global is paying $10/ha/yr for the protection of 1,818 ha in near the San Fernando River watershed and 2,493 ha around the Volcán River. Platanar, another hydroelectric power company, is paying between $15/ha/year and $30/ha/year to protect 3,654 ha in the Platanar watershed. The State Power Producer (CNFL) is paying $40/ha/year to protect 10,900 ha around the Balsa Superior River, the Aranjuez

Figure 1. The Costa Rican payment program for environmental services. The water services program is in bold



Source: adapted from Pagiola 2002

Figure 2. Administration of the ESPH-Procuencas project funds acquired from the hydrological fee and payment for hydrological services



Source: adapted from Gámez 2003

River, and the Cote Lake. The final example is of the Florida Ice and Farm Co. (Costa Rica Brewery), which signed an agreement in 2000 to pay $45/ha/year to protect 1,000 ha in the Segundo River watershed, where they obtain water for their activities (FONAFIFO 2004).

The Procuencas Project

ESPH (Public Services Enterprise of Heredia) was created in 1976 as a public institution and was transformed into a private institution in 1998. As the main water authority in the region, the company also provides electricity, sewage services, and public illumination to a total of 188,000 residents located in three municipalities – Heredia, San Rafael, and San Isidro – within the province of Heredia (Gámez, pers. comm., May 30, 2005). ESPH obtains its water from five micro-watersheds: Ciruelas, Segundo, Bermúdez, Tibás, and Pará, located in northern areas of the Heredia province (Solano, pers. comm., May 30, 2005). According to Gámez (pers. comm., May 30, 2005), the main problems affecting watershed conservation in the region are deforestation, urban growth, and livestock. However, these problems have been decreasing in recent years.

The Procuencas project started in 2000 as an initiative of ESPH (Gámez 2003). Procuencas is a private PES program for watershed conservation independent of FONAFIFO, and it provides more payment to the beneficiaries in its region than FONAFIFO does in the rest of the country (Gámez, pers. comm., May 30, 2005). ESPH pays landowners approximately $100/ha/yr for conservation distributed over 10 years and $946/ha for reforestation distributed over 5 years (Gámez, pers. comm., May 30, 2005).

The main objectives of Procuencas are (1) to conserve and restore the watersheds of the water that ESPH administers and (2) to improve river water quality by providing economic compensation to landowners who voluntarily protect their forested lands or to those who want to reforest their land (Solano, pers. comm., May 30, 2005). Procuencas receives revenues from a Hydrological Fee included on each user's water bill, private contributions, and through partnerships between ESPH and other private companies (Figure 2).

To date, the ESPH fee is the first in the country that internalizes environmental benefits (e.g. forest services such as capture and infiltration of water and restoration of degraded lands) and opportunity costs for traditional uses of protected land (e.g. cattle ranching for dairy, which is the most common land use in this region) in a public service tariff (Gámez 2003). The Hydrological Fee was approved by the government's Public Services Authority (ARESEP) in 2000 (Solano, pers. comm., May 30, 2005). This fee is located in a separate column on the water bill, which draws users' attention to the additional amount they are charged. In 2004, the fee amounted to $\$0.01/m^3$ of water (Gámez, pers. comm., May 30, 2005). This fee is used to finance the ESPH-Procuencas fund administered by the Procuencas environmental division within ESPH (Figure 2). The final decision of how to prioritize the use of the fund is delegated to a control committee, consisting of one member from each of the three municipalities represented in ESPH, two representatives of ESPH, the director the Central Volcanic Range Conservation Area of MINAE as the fiscal advisor, and the director of FONAFIFO as an observer. The fund has been invested in payments for forest conservation, reforestation programs with native tree species, environmental education programs, and land purchase in priority areas delineated by ESPH (Solano and Gámez, pers. comm., May 30, 2005).

According to Gámez (pers. comm., May 30, 2005), the program's success can be attributed to (1) separating Procuencas from FONAFIFO, which has enabled better investment in ESPH priority areas instead of FONAFIFO areas, as well as the avoidance of bureaucratic requirements; (2) establishing their own institutional framework (Figure 2) that simplifies and focuses efforts and allows them to have control at the community level instead of the national level; (3) focusing on local and direct benefits as a means to activate the interest and responsibility of the local people; and (4) providing communities with large benefits from the project at a low cost because the administration of the fund represents only 0.5% of the ESPH budget.

Critique of Procuencas

The Procuencas project is considered a successful case study in Costa Rica and has been used as a model in other regions of the world, such as in Ecuador (Echevarria 2002; Redondo-Brenes 2005). There are four main achievements of the program that can be highlighted. First, the Hydrological Fee was created as a means to compensate landowners for the hydrological services their lands provide. Second, while 97.5% of Costa Rican residents have access to water in their households, 40% of them drink public water that is not potable (Segura Bonilla et al. 2004). However, 100% of the local residents receive potable water from ESPH. Third, over 1,000 ha of land are protected within the program to date. Finally, other local water companies and municipalities are approaching ESPH to acquire knowledge about the program and implement similar approaches in their territories (Gámez, pers. comm., May 30, 2005).

There are, however, some weaknesses within the project that should be addressed to avoid failures in the future. First, ESPH personnel have not succeeded in communicating the objectives and benefits of the program to the users. Though local people see the fee on their water bills, according to Gámez and Solano (pers. comm., May 30, 2005), people are not educated about this new fee or the importance of preserving upstream watersheds. For instance, even though ESPH has invested in environmental education, most of the rivers within their territories are still highly polluted. More time and money must be spent to educate people about the importance of watershed protection. Second, the program would benefit from a revised delineation of areas designated for well protection. Based on current delin-

eations, areas are not large enough to protect wells from the complexities of hydrological flow, such as shifts in groundwater movement. If ESPH expands the area currently under protection, more land could be forested. Finally, according to Gámez (pers. comm., May 30, 2005), urban development in the region is significantly affecting the conservation of watersheds. Heredia is one of the provinces with the highest rate of urban growth. Although it is illegal, municipalities are allowing the construction of new development projects close to water sources, which may lead to future problems. Thus, there needs to be more coordination and control across different Costa Rican institutions.

Final Remarks: Feasibility of Project Implementation in other Regions

The implementation of a watershed conservation model that targets household water consumption is attractive because it is cheaper to pay for environmental services than restoration activities. For instance, by investing approximately $1 billion in land protection and conservation practices, New York City hopes to avoid spending $4 to 6 billion on filtration and treatment plants (Johnson et al. 2002). In addition, in Portland, Oregon; Portland, Maine; and Seattle, Washington; authorities have found that every $1 invested in watershed protection can save anywhere from $7.50 to nearly $200 in costs for new filtration and water treatment facilities (Johnson et al. 2002). People worldwide have expressed their willingness to pay for better water quality (Gámez, pers. comm., May 30, 2005; Coronel-Castro and Jaramillo-Ordonez 2005; Echavarria et al. 2004; Rodriguez and Southgate 2003). In Costa Rica, for instance, a bottle of water costs approximately $1.50, and one cubic meter of water supplied to households is only $0.20. Thus, it is more economical for local users to pay for watershed protection and to have access to potable water than to spend a large amount of money buying bottled water.

Before implementing a payment mechanism for hydrological services, we have to consider the following questions: (a) Who are the beneficiaries? (b) Who are the suppliers? (c) How much should we charge the beneficiaries? (d) How will the project compensate service providers? (Johnson et al. 2002). ESPH-Procuencas addressed these questions before implementing the project, and the outcomes are highlighted above. Moreover, Procuencas created an adequate endowment from the Hydrological Fee, which allows them to implement and invest in conservation and environmental education in the region. On the contrary, in Ecuador, the water authority of Quito encountered several problems when trying to implement their watershed conservation program due to the lack of an endowment (Pugh 2002). Thus, building a strong endowment is a key step in starting a watershed conservation program.

Procuencas, as mentioned above, is independent from FONAFIFO and has a more simple structure in comparison to the latter (Figures 1 and 2). While in FONAFIFO intermediaries such as MINAE, local consultants, and NGOs are needed to invest money into conservation issues, Procuencas works directly with the local suppliers and beneficiaries of their watershed conservation approach. This is another key point that should be considered before implementing a watershed conservation program in a particular region of the world. As mentioned by Gámez (pers. comm., May 30, 2005), if ESPH could implement Procuencas with just 0.05% of their total budget and with only one technician working full time on the project, other water authorities in Costa Rica or worldwide should be able to implement a similar project. If only 40% of Costa Ricans have access to potable water and Procuencas has dramatically improved this situation, water authorities in the country should think about establishing similar approaches to ensure better water quality for their residents.

Utilizing water as a means for watershed conservation not only ensures better quality water for users but also is a good strategy for preserving forests, restoring or rehabilitating degraded lands through reforestation, protecting biodiversity, and achieving other forest services, such as carbon sequestration and scenic beauty. Despite considerations of certain weaknesses in the Procuencas program, ESPH provides a useful model for implementation in other regions of the world. This implementation may be feasible in regions where water authorities work with local residents to improve water quality and watershed conservation and where every participant can potentially benefit from the program.

Acknowledgements

The authors want to thank Luis Gámez and Viviana Solano for the information provided regarding the ESPH Procuencas project. We also want to thank personnel from MINAE, FONAFIFO, AyA, and other institutions that helped us to gather information regarding PES and water management in Costa Rica. Laura Kiernan provided important feedback in previous drafts of this paper. This project was supported by the Tropical Resources Institute (TRI) at the Yale School of Forestry and Environmental Studies.

References

Coronel-Castro, R.M. and A.B. Jaramillo-Ordonez. 2005. *Valoración Económica del Servicio Ambiental Hídrico de la Microcuenca Hidrográfica El Limón. Tesis Ing. en Manejo y Conservación del Medio Ambiente*. Ecuador: Universidad Nacional de Loja.

Cruz, G. and G. Navarrete. 2000. *Los Bosques y el Servicio Ambiental de Protección del Recurso Hídrico en Costa Rica*. Costa Rica: FONAFIFO.

Echevarria, M., J. Vogel., M. Alban, and F. Meneses. 2004. *The Impacts of Payments for Watershed Services in Ecuador: Emerging Lessons from Pimampiro and Cuenca*. London: International Institute for Environment and Development.

Echavarria, M. 2002. Financing Watershed Conservation: the FONAG Water Fund in Quito, Ecuador. Pp. 91-101 in *Selling Forest Environmental Services: Market-Based Mechanism for Conservation.*, edited by S. Pagliola, J. Bishop, and N. Landell-Mills. London, UK: Earthscan

FONAFIFO (Fondo Nacional de Financiamiento Forestal, Costa Rica). 2004. Pago de Servicios Ambientales. Data available at http://www.fonafifo.com. Accessed on December 7, 2004.

Gámez, L. 2003. Remunerar la Protección de las Fuentes de Agua. *Ambientales* 25: 58-66.

Johnson, N., A. White, and D. Perrot-Maitre. 2002. *Developing Markets for Water Services from Forests: Issues and Lessons for Innovators.* Washington, D.C.: Forest Trends, WRI, and the Katoomba Group.

Mejias, R. and O. Segura. 2001. S*ituación Actual del Pago de Servicios Ambientales en Centroamérica: Documento Borrador*. Heredia, Costa Rica: World Resource Institute and Centro Internacional de Política Económica para el Desarrollo Sostenible (CINPE).

Miranda, M., I.T. Porras, and M.L. Moreno. 2003. *The Social Impacts of Payments for Environmental Services in Costa Rica: A Quantitative Field Survey and Analysis of the Virilla Watershed*. London: International Institute for Environment and Development.

Pagiola, S. 2002. Paying for Water Services in Central America: Learning from Costa Rica. Pp. 37-61 in *Selling Forest Environmental Services: Market-Based Mechanism for Conservation*, edited by S. Pagliola, J. Bishop, and N. Landell-Mills. London, UK: Earthscan.

Pugh, J. 2002. *The Public Perception of "FONAG": A Case Study of an Ecuadorian Watershed Sustainability Program*. Paper presented at The

National Conference on Undergraduate Research (NCUR). Whitewater, Wisconsin: University of Wisconsin.

Redondo-Brenes, A. 2005. An Assessment of a Fund for Watershed Conservation in the Southern Ecuadorian Andes. *Journal of Sustainable Forestry.* Submitted November 2005.

Rodriguez, F. and D. Southgate. 2003. Water Resources Management and Willingness to Pay: the Case of Cotacachi, Ecuador. Sanrem CRSP Research Brief #15. Sustainable Agriculture & Natural Resource Management. Collaborative Research Support Program, University of Georgia.

Rojas, M. and B. Aylward. 2002. The Case Study of La Esperanza: a Small, Private, Hydropower Producer and a Conservation NGO in Costa Rica. *FAO´s Land Water Linkages in Rural Watersheds Case Study Series*. Available online at www.fao.org-landandwater-watershed.

Segura Bonilla, O., M. Miranda Quirós, Y. Astorga Espeleta, J.E. Solano Mora, F. Salas Pinel, M. Gutiérrez Miranda, M. Dierckxsens, and M.M. Cespedes Mora. 2004. *Agenda Ambiental del Agua en Costa Rica*. Costa Rica: Fundación CR-USA.

Subak, S. 2000. Forest Protection and Reforestation in Costa Rica: Evaluation of a Clean Development Mechanism Prototype. *Environmental Management* 26(3):283-297.

Tam, L. 2002. *Economic Incentives to Protect Watersheds: A Review of Literature and Case Studies of Payments for Environmental Services*. Washington, D.C.: Conservation International.

Ziegelmayer, K., T.W. Clark, and C. Nyce. 2004. Biodiversity and Watershed Management in the Condor Bioreserve, Ecuador: An Analysis and Recommendations. *Journal of Sustainable Forestry* 18(2/3):139-169.

Source: Rhind, William. 2004. **The Vegetable Kingdom.** ***Fine Rare Prints. Available at: www.finerareprints.com***

From Research to Reality:

Exploring the Tensions between Environmentalism's Moral Religion and Rural Agricultural Poverty in the Ecuadorian Amazon

by Catherine Schloegel, MESc 2006

Introduction

The hum of a chainsaw punctuated the otherwise melodic cacophony of sounds deep within the Ecuadorian rain forest. Ducking underneath pendulant cacao branches, I walked through the forest seeking the source of the chainsaw's drone. At the back of a cacao orchard I saw three stumps. Sawdust littered the pathway and I watched as a sinewy man with a chainsaw carved the trunks into thin 2 inch by 10 inch boards.

I had arrived in Ecuador's rain forest nearly two months before to investigate locally-devised sustainable alternatives to deforestation and mineral exploitation. For a total of three months, I worked alongside members of the Kallari Association, a group comprised of indigenous Kichwa and *colono*, or smallholder farmer, communities in Ecuador's Napo Province (Figure 1). Kallari's goal is to identify direct international markets for the sale of products – chocolate beans and handcrafts – produced locally by its members. Direct access to international markets allows Kallari to pay higher prices to its members than the prevailing regional prices offered by middlemen. By some estimates, members of Kallari are likely to earn nearly $250 more per year than their non-participating neighbors.[1]

Catherine Schloegel, originally from Boulder, Colorado, has worked as an environmental educator in state, national, and international parks. She completed a bachelor's in Geography at Vassar College in 2000. Upon graduation she hopes to pursue further work in the field of community-based conservation in Latin America.

In one community I discovered that, despite the presence of alternatives, some Kichwa families, nevertheless, continue to harvest timber. Timber sales provide pocket cash throughout all seasons of the year, not only during seasons of peak harvest; however, timber removal can cause changes in forest microhabitat affecting subsistence food production and decreasing forest biological diversity. Moreover, harvesting a mature tree removes it from the base resource pool for several decades. Those who choose to harvest timber, therefore, are choosing short-term benefits at the cost of long-term sustainability.

As a student of environmental anthropology, I sought to investigate decision-making processes within Kichwa households. After two months of work alongside members of the association, I struggled to comprehend why members of one community continued to harvest timber trees, instead of focusing production on cocoa and handicrafts, which are more sustainable livelihood options. As an outsider, I used a familiar cultural ideology of trade-offs and alternatives to understand Ecuador's complex social and environmental landscape. I found that unlike North American conservationist paradigms, Kichwa choices are not mutually exclusive. Instead, subsistence and market-based livelihood strategies vacillate upon a continuum of decisions determined by ecological limits and shaped by social necessity. Upon first impression, the Kichwa willingly engage in "conflicting" activities. While a household might choose to harvest organic cocoa, maintaining a complex agroforestry system within its farm, it might also choose to over-extract valuable timber species, in essence, trading long-

Figure 1. Map of Ecuador by Stephen Holland

Source: Whitten, N.E. Jr. 2003.

term necessity for short-term necessity. To them, these activities are not contradictory; rather, they are complementary and requisite for survival.

Within this article, I seek to examine the logic underlying Kichwa economic and ecological decision-making. I will examine how Kallari's sustainable development choices affect Kichwa market-based choices. Using this discussion as a foundation, I will explore how my own perspectives on conservation and development paradigms were limited in terms of visualizing types of activities that might be understood as sustainable. I will end by posing a critical question to environmental researchers to support the employment of a new paradigm to present complex realities.

The Kichwa: Amazonian Farmers and Forest Stewards

For most outsiders it is difficult to differentiate a traditional Kichwa farm in Ecuador's rain forest from the surrounding verdant tropical landscape. In Ecuador's Napo Province, subtle variations of green bathe the profusion of vines, trees, bushes, and shrubs that form patches of primary and secondary rain forest. In comparison with the tidy rows of Iowa corn on a North American farm, a typical Kichwa farm appears chaotic – a mixture of staple food crops including cassava, peanuts, beans, corn, and plantains, as well as a variety of fruit, hardwood timber, and firewood species are planted underneath the overhanging forest canopy. For the Kichwa, a farm produces subsistence crops for family consumption in addition to serving as a savings account stocked with mature hardwood trees.

The Kichwa's ancestors have lived in the rain forest for hundreds of years, farming and hunting. Most Kichwa today are bilingual, speaking Kichwa as well as Spanish. Within Ecuador, the Kichwa number over 3,070,000 individuals (Wibbelsman 2003). The majority of Ecuador's Kichwa live in the sierra, along the steep Andean backbone that runs down the length of South America. Approximately 70,000 Kichwa live in the rain forest (Wibbelsman 2003).

Making Trade Fair: The Kallari Association

The indigenous-run Kallari Association consists of 22 communities that include the Kichwa and *colonos* and represents 1,700 individuals who reside in the Napo Province of Ecuador. The members of the association are smallholders who typically own less than 30 hectares of land. Generally, their landholdings consist of a mixture of primary forest and active farms.[2] The Association's primary objective is to provide members with fair prices for locally produced chocolate beans and handmade crafts. Kallari's overarching goal is to provide its members with sustainable livelihood choices.

During the 2005 cacao season spanning from late May through early August,[3] Kallari purchased 126,300 lbs of fresh cacao beans from participating members. Each member harvests ripe cacao pods from his or her trees every two to three weeks during the season (see photos below). Numerous factors affect the amount of cacao harvested including land quality,[4] extent of total land holdings, age of cacao trees, and degree of tree, and field maintenance. Reported bi-monthly harvests of dry beans from individual farms varied from one pound up to 600 pounds. In addition to buying fresh cacao beans, the Kallari Association also purchases handmade jewelry and crafts from participating communities one or two times per year.[5]

While cacao and jewelry production have long been a feature of the Kichwa market-based production, unscrupulous middlemen have taken advantage of the small profit margin, leaving local Kichwa with little more than pennies for their labor. In contrast to these arrangements, Kallari directly markets cacao and handmade jewelry to both domestic and international outlets, passing on the profits to local association members. Middlemen pay one dollar per strand for jewelry, be it a bracelet or a necklace, and typically sell them in regional markets in Tena, Ecuador. Kallari, in contrast, pays members anywhere from three to twelve dollars per strand, based on quality, and sells most of the jewelry directly to markets in the United States or Europe. The same direct marketing of chocolate allows Kallari to pay locals a much higher price than middlemen. Prior to Kallari's entrance into the market, middlemen bought dry cacao beans for 15 to 20 cents per pound. During the summer of 2005, Kallari paid members 78 cents per pound of dried beans. In response to Kallari's cacao prices, middlemen purchased cacao at 40

The photograph on the left is a ripe cacao pod, ready for harvest. On the right is a picture of the fleshy interior of a cacao pod
Photograph on left by C. Schloegel, 2005; photograph on right by N. Cooper, 2005

to 50 cents per pound during the months of May through August 2005.

Trade-offs? Timber Production and Cacao Production

In three communities located in the Upper Arajuno watershed, I interviewed a total of 43 households. Within a formal interview, 100 % of respondents said they sell cacao and handmade jewelry. Of the 43 households, one respondent maintained a small-scale balsa tree plantation of approximately 40 trees. The other 42 respondents did not identify timber production as part of their livelihood strategies, although when questioned further, their answers reflected a different reality or a different understanding of "livelihood strategy."

Unlike other Kallari communities, those in the Upper Arajuno are located at a greater distance from regional markets. I asked residents what market activities or wage labor they sought when they were unable to participate in regular and planned market activities (including the selling of cacao, jewelry, corn, or coffee). Nearly everyone said that in times of emergency, they sell timber.

The case of Jorge,[6] one area resident, is instructive for it describes the reasons that one household chose to harvest and sell timber. In three days, Jorge harvested three small trees (from the rain forest), which yielded 46 boards. Each board had to be carried approximately a quarter of a mile to the riverbank, and floated downstream to the regional market. Most likely, Jorge earned between $30 and $40 dollars for his efforts, approximately five percent of his annual income.[7] In an informal conversation, Jorge revealed that this money would be used to pay for his 16-year-old son's school matriculation fee and to buy medicines for his elderly father. In addition to timber, Jorge grows cacao and several members of his family make handicrafts and jewelry for sale to Kallari. For people like Jorge, selling organic cocoa and handmade jewelry provides a greater number of livelihood choices; nevertheless, timber extraction continues to provide an important income source.

A Question of Scale

Denuded hillsides in Ecuador's rain forest are distinct for several reasons. They are almost always accessible by the roads that large forestry companies have built through previously standing rain forest. Secondly, although the market will only accept certain tree species, it is rare to see a hillside with any trees left standing. In large clear cuts, original landscapes are cleared; non-native grasses and cattle replace the once-rich biologically diverse forest ecosystem. Nevertheless, to most visitors these hillsides in the rain forest create a strange optical illusion - they are beautiful, green, and seemingly natural breaks in the thick forest canopy. Upon closer investigation, tree stumps between two and three feet tall litter these green pastures, serving as subtle reminders of the forest that was once there.

The picture of timber production on Kichwa farms varies greatly. As I watched the work of a single chainsaw cutting boards, a different picture emerged. The surrounding forest contines to be intact. No skid trails or log landings remain as legacies of timber harvesting. machines or roads carry out the boards. The missing three trees left a perceptible light gap filtering through the canopy and the surrounding vegetation readied to take advantage of it.

Rhetoric versus Reality

On the Kallari website maintained by a young Kichwa man, Kallari states that the association, "has proven to be a sustainable and consistent means for the Kichwa people to fulfill our basic family needs without logging our rain forests or selling...lands to farming, mining, or petroleum interests" (2005). Although Kallari members echo this rhetoric, it is not always reflected in their daily realities.

In this gray area between timber production and rural agricultural poverty, I puzzled over Kallari's statement. Anthropologist Anna Tsing, in her description of Dayak villagers of the Meratus mountain range in Indonesia, claims that, "we can make sense, too, of Meratus respect for these authoritative conservation and development demarcations, but as the rhetoric of leaders assuaging powerful outsiders, rather than as the practice of daily life" (2005: 175). She acknowledges that conservation and development vocabularies project crisp environmental lines onto non-linear rain forest landscapes. Kallari's webpage might best be understood as part of a strategy to assuage powerful outsiders who, like myself, have constructed a clear environmental line with logging on one side and conservation on the other. Among such audiences for this webpage are international funding agencies, including the United States Agency for International Development, the Canadian International Development Agency, and the German development agency, GTZ. Kallari's rhetoric makes Kichwa life readable to outsiders and places their actions into a comfortable and familiar paradigm of trade-offs and choices.

The practice of daily life and rural agricultural poverty defy such crisp boundaries and definitions. Poverty is too sterile a word to express the myriad of emotions, strategies, choices, trade-offs, and decisions that are necessary for survival. For the Kichwa who I came to know, poverty meant going to bed hungry; for Kichwa mothers it meant high infant mortality; for Kichwa families it meant that diarrhea could become a killer; for Kichwa villages it meant no formal education past sixth grade. Poverty meant simple things too. No shoes. No electricity. No cash. No bed. Poverty problematizes conservation rhetoric, making it nearly impossible for Kichwa people to comply with the trade-offs that conservationists all-too-frequently demand.

Conclusion: A Search for New Paradigms

Utilizing a limited frame by which to understand an association like Kallari delegitimizes the Kichwa's complex and seemingly contradictory market strategies. It fails to acknowledge small steps. Kallari might be best understood as one of those small steps. To the Kichwa, Kallari is more than chocolate or crafts; it represents a fundamental break from existing systems of exploitation. Middlemen are no longer the only ones who speak Ecuador's *lingua franca*, Spanish, and understand how to enter national and international markets. Today, 100% of the Kichwa under the age of thirty are bilingual. Of Kallari's 1,700 members, one of its first university-trained agronomists will graduate in May 2006; several more are set to follow.[8]

The Association's accomplishments are finely enmeshed in an uncomfortably gray area bridging conservation and development, as well as cacao production and timber extraction. These accomplishments challenge existing conservation and development paradigms. My initial conservation vocabulary simplified Ecuador's complex landscape, erasing scale and obfuscating hope. After three months, I found that small-scale timber production differs from the march of industry-led deforestation in scale, scope, and intensity. Should conservation equate with the promise to stop logging? Although pleasing to conservationists, such a defined line ignores rural agricultural realities.

Conservation in the tropics has become an enumeration of rights and wrongs – tapirs, monkeys, and buffer zones are right while logging, petroleum extraction, and human land use are wrong (Redford and Sanderson 2000; Schwartzman et al. 2000a; Schwartzman et al. 2000b; Terborgh 2000). However, a critical part of this equation is left out: that of people and poverty. Those who criticize local small-scale timber extraction in the tropics, a group I

was once part of, quite often come from places where the norm of daily trade-offs is made possible by the existence of choices and purchasing power. Why is it that we have asked those who are the most vulnerable and the least able to imagine a trade-off, to be the first ones to do so?

Acknowledgements

Thank you to Amity Doolittle, Judy Logback, and Monisha Gangopadhyay for your insights and advice on previous drafts. To all the members of the Kallari Association, *ashka pagarachu*.

Endnotes

1 In this region, the average incomes before Kallari was established ranged from $500 to $900 per year. Today incomes are $750 to $1,100 per year (Logback, pers. comm., December 2005).

2 Although most of the Kichwa have lived and farmed the same plot of land for generations, very few farmers have legal land title. Most Kichwa have usufruct rights to the land. A land title for an average 20 ha farm can cost between $500 and $600. Kichwa land is not communally used or managed. Clear landscape boundaries, informal fences, or impassible natural features demarcate individual "property".

3 The season for peak cacao production varies from year to year, as well as by location.

4 In general, people who lived on islands located in rivers reported a higher yield per pod and per tree than farmers with production on less fertile land.

5 In the past, the Kallari Association has bought jewelry one to two times per year, but this year due to an inventory overstock, they have not yet purchased any jewelry from members.

6 Pseudonyms are used to maintain anonymity.

7 See endnote 1 for a discussion of annual household income. Prices paid per board ranged from $0.50 to $8.00 depending on the width of the board and the type of wood. For those who do not own a chainsaw, their final earnings are much less.

8 Although several Kallari members have completed two-year university teaching degrees, fewer than five Kallari members have completed a full five-year university degree.

References

Terborgh, John. 2000. The Fate of Tropical Forests: A Matter of Stewardship. *Conservation Biology*. 14(5): 1,358-1,361.

Schwartzman, Stephan, Adriana Moreira, and Daniel Nepstad. 2000a. Rethinking Tropical Forest Conservation: Perils in Parks. *Conservation Biology*. 14(5): 1,351-1,357.

Schwartzman, Stephan, Daniel Nepstad, and Adriana Moreira. 2000b. Arguing Tropical Forest Conservation: People versus Parks. *Conservation Biology*. 14(5): 1,370-1,374.

Redford, Kent H. and Steven E. Sanderson. 2000. Extracting Humans from Nature. *Conservation Biology*. 14(5): 1,362-1,364.

Kallari Association website. http://www.kallari.com (accessed October 28, 2005).

Tsing, A.L. 2005. *Friction: An Ethnography of Global Connection*. Princeton, NJ: Princeton University Press.

Wibbelsman, M. 2003. General Information on Ecuador. Pp 375-387 in *Millennial Ecuador: Critical Essays on Cultural Transformations and Social Dynamics*, edited by N. E. Whitten Jr. Iowa City, Iowa: University of Iowa Press.

Whitten, N.E. Jr. 2003. *Millennial Ecuador: Critical Essays on Cultural Transformations and Social Dynamics.* University of Iowa Press, Iowa City, Iowa.

The Effects of Anthropogenic Disturbances on the Structure and Composition of Rain Forest Vegetation

by Tendro Ramaharitra, MESc 2005

Introduction

The tropical forests of Madagascar, which shelter thousands of plant and wildlife species, have a well-known reputation for their unique biodiversity. Approximately 80% of the plant species are not found elsewhere in the world (Lowry et al. 1997; Schatz 2001; Gautier and Goodman 2003). A recent study by Schatz (2001) revealed that up to 96% of the large shrubs and trees in Madagascar are endemic, which is estimated to consist of over 12,000 species. Capuron stated that "any given hectare of forest cannot be compared to its neighboring one's, and at anytime, community composition changes dramatically" (Gautier and Goodman 2003). This statement illustrates the complexity of the ecosystem and, at the same time, confirms its vulnerability. A specific example is the rain forest of Ranomafana, which represents one of the last remaining strips of primary vegetation in the eastern escarpment of Madagascar. Though unique, a large part of the forest has been destroyed due to deforestation; the loss was estimated by Green and Sussman (1990) to be around 80% of the original cover. The forest of Ranomafana was classified as a protected area in 1995, which required all human populations to move out of the designated boundaries. At present, about 110 villages are located in the peripheral zone of the park, subsisting mainly on agriculture and hunting and gathering practices. About 10 years after the park's designation, much of the forest in the peripheral zone has been transformed into agricultural land; there is little to no forest acting as a buffer zone separating human settlement from the park. Resources in the park are protected, but locals continue to claim their right to use the forest by illegally exploiting the timber and non-timber forest products for commercial and domestic uses (Peters 1999).

This research assesses the impact of human settlement around the park on rain forest vegetation. I aimed to uncover and understand the dynamism of the forest over time and space and how this change relates to human uses through the analysis of patterns between middle altitude evergreen rainforest vegetation structure and composition and the presence of anthropogenic disturbances, such as wood extraction, selective logging, and trails for non-timber forest product harvesting. The main hypothesis is that increased human accessibility to the forest leads to increased disturbance. This implies that: (a) the forest edge has a more open canopy due to increased cutting for fuel wood and other uses, (b) the number of vines diminishes as we move to the forest edge, and (c) the trail system density is higher at the forest edge. It is important to assume that the natural gap formation in the forest is not significantly affecting the forest community structure and composition.

Tendro Ramaharitra attended the Agronomy School at the University of Antananarivo, Madagascar, where he began working on various projects in Ranomafana National Park. He continued working with Ranomafana at the Yale School of Forestry and Environmental Studies and obtained a Masters of Forestry in 2005. He is currently working as a consultant for the Wildlife Conservation Society in Madagascar and will pusue a doctoral degree at Berekley's School of Natural Resources in the fall.

Figure 1. Shannon diversity index (*H'*) and the evenness index (*J'*), where H_{max} = ln(*S*), *S* as the total number of species, *p* the proportion of all individuals in a sample belonging to the *i* th species

$$H' = \sum_{i=1}^{s} (pi)(\ln pi) \qquad J' = \frac{H'}{H \max}$$

Methods

This study is based on a biological inventory of the forest in Ranomafana National Park. Field measurements were entered and statistically analyzed using Minitab 14 and SAS v8. ESRI ArcMap 9 mapping software was utilized for spatial analyses.

I quantified the vegetation structure and composition from the forest edge to the interior by looking at the different forest layers and by estimating the Shannon diversity index (*H'*) and the evenness index (*J'*) (Krebs 1989; Magurran 1988; Pielou 1975) (Figure 1). I then measured the following parameters to quantify human disturbances: percent of canopy cover, quantity of vines and trees cut in each botanical plot, and trail density inside each plot. I performed both linear and quadratic regression analyses relating all human and vegetation values with the distance of the plots from the forest edge to illustrate the spatial pattern in each stratum; I then used the disturbance parameter values to predict the diversity and evenness of the study plots through regression analysis as well.

The study site encompasses 3.36 ha of forest, which was subdivided into 21 botanical plots of 40 meters by 40 meters and distributed along three transect lines. Trees in each botanical plot were clustered into four categories: (1) seedlings less than 25 cm in height or less than 1 cm in diameter, (2) small shrubs between 1 cm and 5 cm in diameter, (3) mid-canopy trees less than 10 cm in diameter, and (4) canopy trees greater than 10 cm in diameter. The botanical materials were identified using the identification keys of Turk (1997) and Schatz (2001). Updates on certain species names were verified through many authors, using mostly Goodman and Benstead (2003).[1]

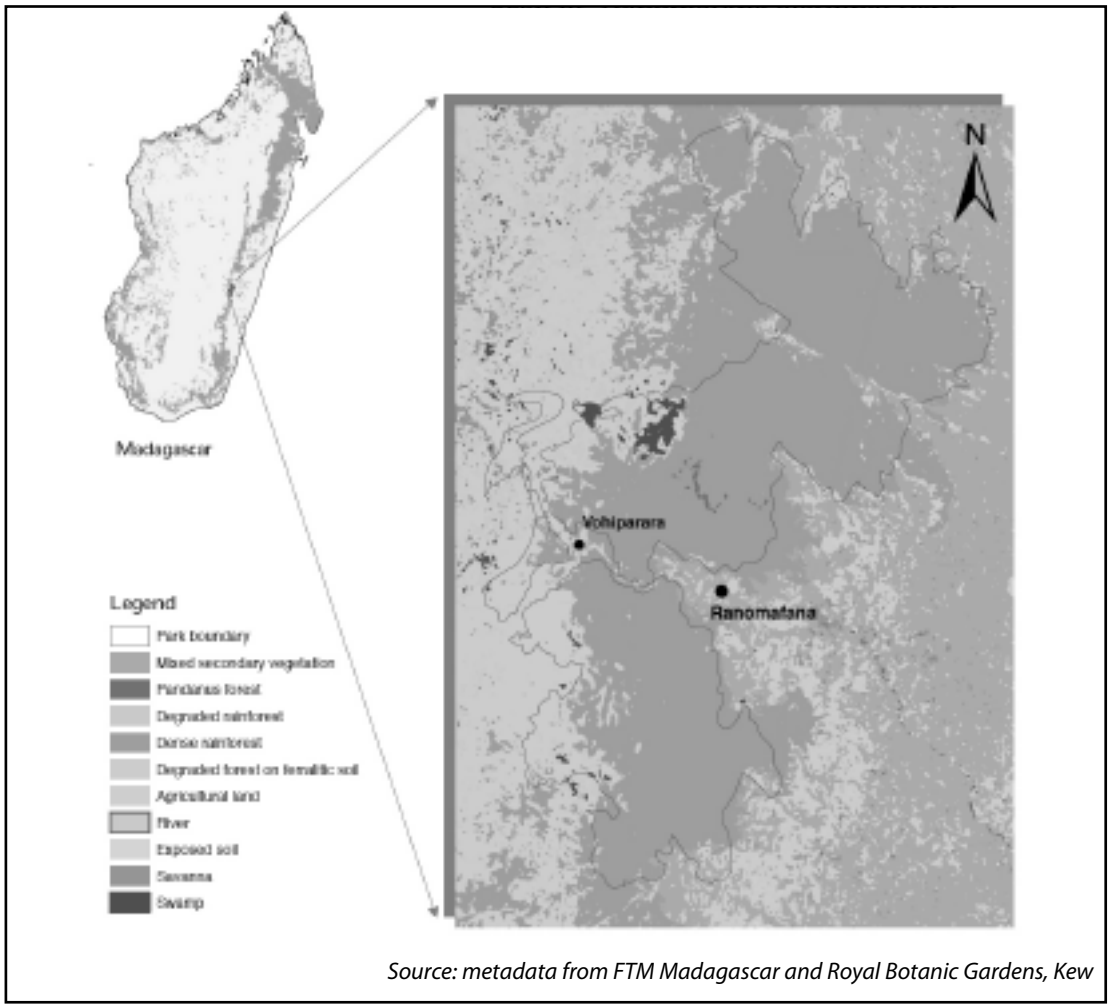
Background

Ranomafana National Park (RNP) is located in the eastern escarpment of Madagascar at latitude 21°15'S and longitude 47°27'E (Figure 2). The elevation ranges from 600 m to 1,375 m above sea level. The temperature is moderately tropical, with an average annual temperature of 19°C and a low of 6°C during the winter. Precipitation typically falls more than 280 days a year, leading to an annual accumulation of 4,000 mm.[2] The forest in Ranomafana National Park was classified as evergreen, humid mid-elevation by Du Puy and Moat in 1996. The forest is subdivided into three strata: (1) the forest canopy, reaching 25 m on average, (2) the high shrub and mid canopy trees, and (3) the understory vegetation and forest floor, covered with moss and lichen. The canopy trees are characterized by a series of *Weinmannia sp.* (Cunoniaceae) and *Tambourissa sp.* (Monimiaceae) (Lowry et al. 1997; Du Puy and Moat 1996). The vegetation cover changes over the landscape from tree savanna to savanna pseudosteppe with increased human activity (Humbert and Cours-Darne 1965).

Results

A total of 194 locally known species were found in the three sites, including 23 scientifically unknown species. These species belong to 46 families and 103 genera; I could only identify 80 trees to the species level and the others to their respective genera. The number of stems

Figure 2. Map of Ranomafana National Park



Source: metadata from FTM Madagascar and Royal Botanic Gardens, Kew

per hectare of canopy trees varied from 688 to 881, while understory trees reached a maximum of 30,000 stems/ha. The canopy trees were dominated by the Cunoniaceae family and the understory vegetation was dominated by the Rubiaceae family.

Plant diversity significantly increased (p<0.05) from the edge of the forest to the interior (Figure 3). Following this trend, the evenness index value was higher in the forest core than in the edge. It is necessary to note that the evenness index ranged from 0.60 to 0.96, where the maximum at which a forest community is designated as totally even is set at 0.99 (Pielou 1975).

I performed linear and quadratic regression analyses between the distance from the forest edge and the four disturbance indicators. There was a significant decrease (f=13.6, p=0.002) in the number of trees cut from the edge to the interior of the forest. This shows the use of the forest edge by local villagers (Figure 4). There was no visible pattern in the number of lianas or trails from the edge of the forest to the interior. Percent canopy cover was found to decrease towards the exterior of the forest, but this trend is not statistically significant. There is high variability in percent canopy cover due to the presence of forest gaps in the study plots.

Correlation analyses show that the diversity and evenness index values are positively correlated with the number of lianas for canopy trees and low shrubs (f=15.89, p<0.001; f=15.32, p<0.001, respectively). Thus, the number of lianas can explain forest structure at

some level of significance, while none of the three disturbance indicators left can significantly predict the diversity and evenness of the forest (Table 1). In addition, percent canopy cover predicts the diversity of both low shrub vegetation and canopy trees.

Discussion

Two major types of human disturbance were identified in the forest. First, there is evidence of direct physical disturbance, such as the formation of forest gaps and the removal of valuable species. In this study, a link was not established between the designated disturbance parameters and the structure and composition of the forest community. However, results do confirm that the forest structure and composition are altered at the forest edge and that there is more extraction at the forest edge than in the interior. Yet there is no evidence suggesting that the number of trees cut per hectare, which increases when moving from the interior to the edge of the forest, is affecting the diversity and evenness of the vegetation. Similarly, the results show that the number of lianas per hectare affects the diversity and evenness of the forest community, but there is no significant pattern from this parameter across space that would suggest human use.

Second, there are the edge effects created by human deforestation outside of the park. The change in structure and composition of the forest might be a consequence of changes in the biotic and abiotic conditions created by edge effects (Ozanne et al. 2000; Laurance and Yetsen 1991; Murcia 1995) and not from the cutting of trees. Consequently, we cannot confirm that selective logging and other forest extraction practices alone altered the diversity and structure of the forest by diminishing the canopy cover near the edge. In addition, a low evenness index value was found in the forest edge, which reveals the dominance of opportunistic species or a species that can adapt better to the ecology condition. This may create a favorable environment for heliophilous vegetation and decrease the chance of regeneration for shade tolerant species. This may be considered harmless to the forest, as these pioneer species disappear as soon as the forest reaches its climax (Lowry et al. 1997 in

Figure 3. Correlation between distance from the forest edge and the diversity Index values

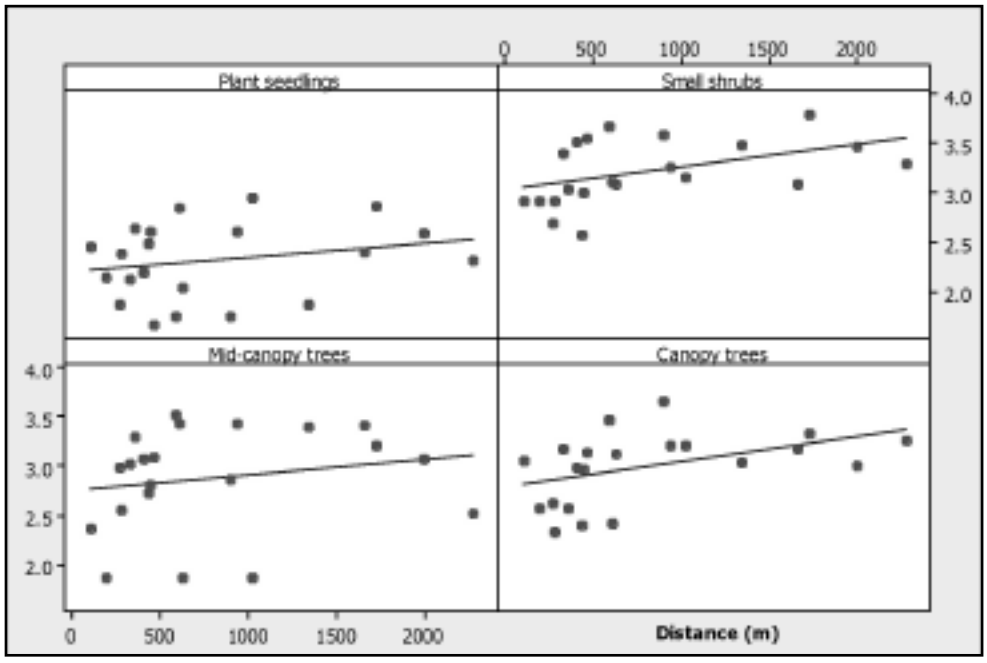
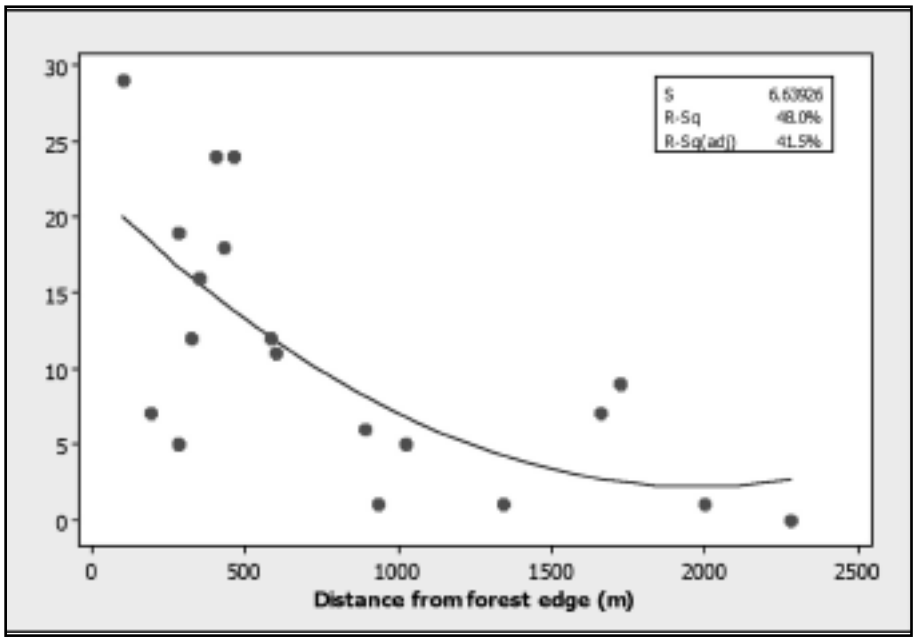


Figure 4. Fitted line plot of number of trees cut per hectare versus distance from forest edge



Goodman and Benstead 2003). On the contrary, the establishment of some invasive species, such as the Chinese guava, *Psidium cattleianum* (Myrtaceae), is considered to be a threat to the forest. This species has already colonized most of forest gaps in Ranomafana (Binggeli et al. 2003 in Goodman and Benstead 2003).

Conclusion

Despite the low significance of some studied parameters, the forest pattern suggests that human disturbances have significantly altered the vegetation composition around the edge of the forest. These impacts, direct human manipulation or indirect edge effects, are translated largely into a change in the proliferation of some shrub species and the loss of canopy trees on the forest edge. These changes may not be as menacing as slash and burn agriculture or timber forest harvesting, but they are indicators of ecosystem health and the ability of the forest to assume its functions (Rapport 1995). Moreover, it is certain that if villagers continue to travel deeper into the protected rain forest of Ranomafana for food and supplies, the core of the park, a primary forest, will change radically into an ecosystem that reflects the peripheral zone of the park. This situation will eventually leave nothing for the people living around the park to use, and will impact also the conservation of the primary forest. This problem needs to be addressed by both the local community and park management so it does not jeopardize the future of Ranomafana National Park.

Table 1. Significance of the regression analysis indicators vs. diversity index

	Seedlings		Low shrub		Mid canopy trees		Canopy trees	
	F stat	P values	F stat	P values	F stat	P values	F stat	P values
Trees Cut/Ha	0.100	0.757	0.800	0.383	0.040	0.853	0.660	0.428
Trails	0.040	0.851	1.670	0.211	0.510	0.483	0.000	0.966
Lianas/Ha	4.390	0.050	15.320	0.001	0.450	0.511	15.880	0.001
% Canopy Cover	0.840	0.370	7.430	0.013	0.280	0.601	14.450	0.001

Endnotes

1 Plant identifications and descriptions are distributed from the following authors in Goodman and Benstead 2003: Leguminosae (Fabaceae): Labat and Moat p.346; Sapotaceae: Gautierp.342; Moraceae: Dalecky et al. p.322; Annonaceae: Thomas and G Aymonin p.316; Melastomataceae: Almeda p.375; Euphorbiaceae: Hoffmann and McPherson p.379; Anacardiaceae: Randrianasolo p.398; Rubiaceae: David and Bridson p.431.

2 Data from the research station at Ranomafana.

References

Binggeli, P., 2003. Introduced and Invasive Plants. Pp. 257-268 in *The Natural History of Madagascar*, edited by S.M. Goodman, and J.P. Benstead. 2003. Chicago: University of Chicago Press.

DuPuy, D., and J. Moat. 1996. A Refined Classification of the Primary Vegetation of Madagascar Based on the Underlying Geology: Using GIS to Map its Distribution and to Assess its Conservation Status. *Proceedings of the International Symposium on Biogeography of Madagascar*. Editions de l'Orstrom, Paris.

Gautier, L. and S.M. Goodman. 2003. Introduction to the Flora of Madagascar. Pp 229 - 250 in *The Natural History of Madagascar*, edited by S.M. Goodman and J.P. Benstead. 2003. Chicago: University of Chicago Press.

Goodman. S.M. and J.P. Benstead (eds.). 2003. *The Natural History of Madagascar*. Chicago: University of Chicago Press.

Green, G. and R. Sussman. 1990. Deforestation History of the Eastern Rain Forests of Madagascar from Satellite Images. *Science* 248:212–215.

Humbert, H. and G. Cours-Darne. 1965. C*arte Internationale du Tapis Végétal et des Conditions Écologiques*. 3 coupures au 1/1,000,000 de Madagascar. Trav. Sect. Sci. Tech. Inst. Franç. Pondichéry, hors sér., 3 maps.

Krebs, C.J. 1989. *Ecological Methodology*. New York, Harper & Row.

Laurance, W.F. and E. Yensen. 1991. Predicting the Impacts of Edge Effects in Fragmented Habitats. *Biological Conservation* 55(1): 77-92.

Lowry, P.P., G. E. Schatz, and P.B. Phillipson. 1997. The Classification of Natural Anthropogenic Vegetation in Madagascar. Pp. 93-123 in *Natural Change and Human Impact in Madagascar*, edited by S.M. Goodman and B.D. Patterson. 2003. Washington, D.C.: Smithsonian Institution Press.

Magurran, A.E. 1988. *Ecological Diversity and its Measurement*. Princeton, N.J.: Princeton University Press.

Murcia, C. 1995. Edge Effects in Fragmented Forests: Implications for Conservation. *TREE* 10: 58-62.

Ozanne, C.M.P., M.R. Speight, C. Hambler, and H.F. Evans. 2000. Isolated Trees and Forest Patches: Patterns in Canopy Arthropod Abundance and Diversity in *Pinus sylvestris* (Scots Pine). *Forest Ecology and Management* 137(1-3): 53-63.

Peters, J. 1999. Understanding Conflicts between People and Parks at Ranomafana, Madagascar. *Agriculture and Human Values* 16(1): 65-74.

Pielou, E.C. 1975. *Ecological Diversity.* New York: Wiley.

Rapport, D.J. 1995. Ecosystem Services and Management Options as Blanket Indicators of Ecosystem Health, J*ournal of Aquatic Ecosystem Stress and Recovery* (Formerly *Journal of Aquatic Ecosystem Health*) (Historical Archive) 4(2): 97

Schatz, G. E. 2001. *Generic Tree Flora of Madagascar.* St. Louis, MO: Kew, Royal Botanic Gardens & Missouri Botanical Garden.

Turk, D. 1997. A *Guide to Trees of Eastern Madagascar and Ranomafana National Park*. St. Louis, MO: Missouri Botanical Garden.

Bird Composition in Living Fences:

Potential of Living Fences to Connect the Fragmented Landscape in Esparza, Costa Rica.

by Wendy Francesconi, MESc 2006

Introduction

Many traditional agricultural practices replace natural vegetation with crop or pasture production systems, which directly reduce diversity (Swift et al. 2004). Among the agricultural practices, monocultures are more damaging to the environment than polycultures, which make agricultural ecosystems more complex and, therefore, more similar to the natural environment. Agroforestry systems are polyculture systems that have trees as one of the managed crops in the agricultural system (Nair et al. 1995). Incorporating agroforestry into monocultures could ameliorate the disturbing characteristics of conventional agriculture (Nair et al. 1995).

Agroforestry practices vary depending on the objectives and characteristics of the region (Nair et al. 1995). Agroforestry, a science that has been studied for a few decades (ICRAF 2004), employs systems that are able to generate a wide range of environmental services. The services include secondary benefits lauded by conservation biologists, such as integration of natural resources management and biodiversity conservation (Perfecto et al. 1996).

Wendy Francesconi began her undergraduate studies in Bogotá, Colombia at Pontificia Universidad Javeriana. She studied Ecology and participated in a student exchange program at Colorado State University, after which she moved to New York City - the town where she was born. Afte receiving a Biology degree from Hunter College, she began her masters program at Yale School of Forestry and Environmental Studies, where she is in her second year. She plans to pursue a Ph.D. at the School of Forest Resources and Conservation at the University of Florida.

As the fragmentation of natural landscapes continues, greater biodiversity losses are expected. Since the trend for tropical forest areas is conversion into agricultural fields, the agricultural matrix determines the decline or preservation of the remaining natural areas and the associated wildlife. Replacing conventional agriculture with agroforestry is a suggested approach that could conserve biodiversity in the landscape (Schroth et al. 2004).

The ecological value of silvopastoral systems and the role of live fences for biodiversity conservation are still under examination. Live fences consist of live vegetation, their primary purpose is to divide, separate, and protect agricultural plots or livestock. However, they are also attractive to farmers because they offer fuel wood, fruits, shade, soil enrichment, and fodder for livestock, in addition to promoting biodiversity (Zahawi 2005; Alonso et al. 2000; Bennett 1999; Budowski 1987).

Live fences are thought to contribute to ecosystem function by increasing landscape connectivity through vegetative coverage and enhancing biodiversity by supplying habitat to wildlife and plants in the landscape. Because live fences create tree networks and divide open agricultural fields into smaller units, they allow for more interactions on the landscape, including interactions between forest fragments. Depending on the species composition and the intrinsic physical characteristics of the trees, these fences have the potential to provide refuge and habitat for wildlife while they move across the landscape (Harvey et al. 2003).

Eumomota superciliosa (turquiose-browed motmot)
Source: Stiles, G.F. and Skutch A. 2003

Site Description

The study took place in Esparza, a cattle grazing region in Costa Rica located at 9°58'60N and 84°40'0W and at altitudes of between 400 and 1,000 meters above sea level. The hilly topography of the area creates riparian forests at lower elevations. Precipitation is 1,500 to 2,500 mm per year and the mean annual temperature is 27°C, conditions that place Esparza's climate as tropical sub-humid (Camargo 2003).

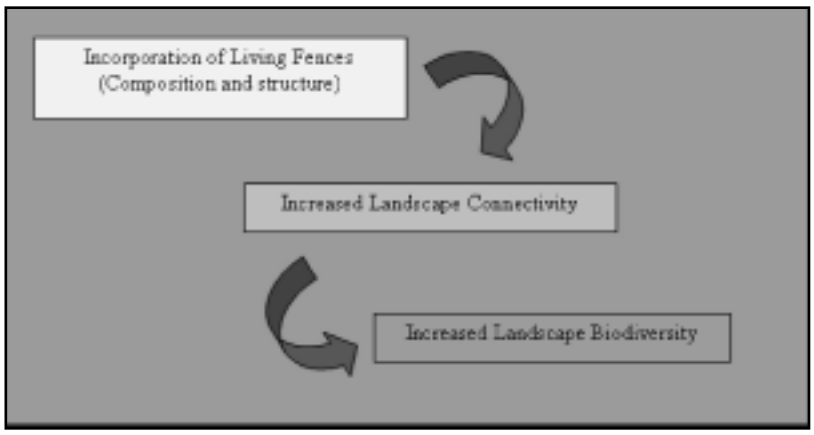
As a developing country, Costa Rica depends on agriculture, including the export of products such as coffee, pineapples, bananas, and beef. In recent decades, population growth and the need for economic expansion has expanded this industry, resulting in an increased conversion of unprotected forest habitats into agricultural lands. In fact, the export-oriented cattle industry of the 1960s and 1970s is responsible for most of the country's deforestation (Sequeira 1984). Beef production is more sustainable today because silvopastoral systems have spread throughout the country, especially among smallholder farms.

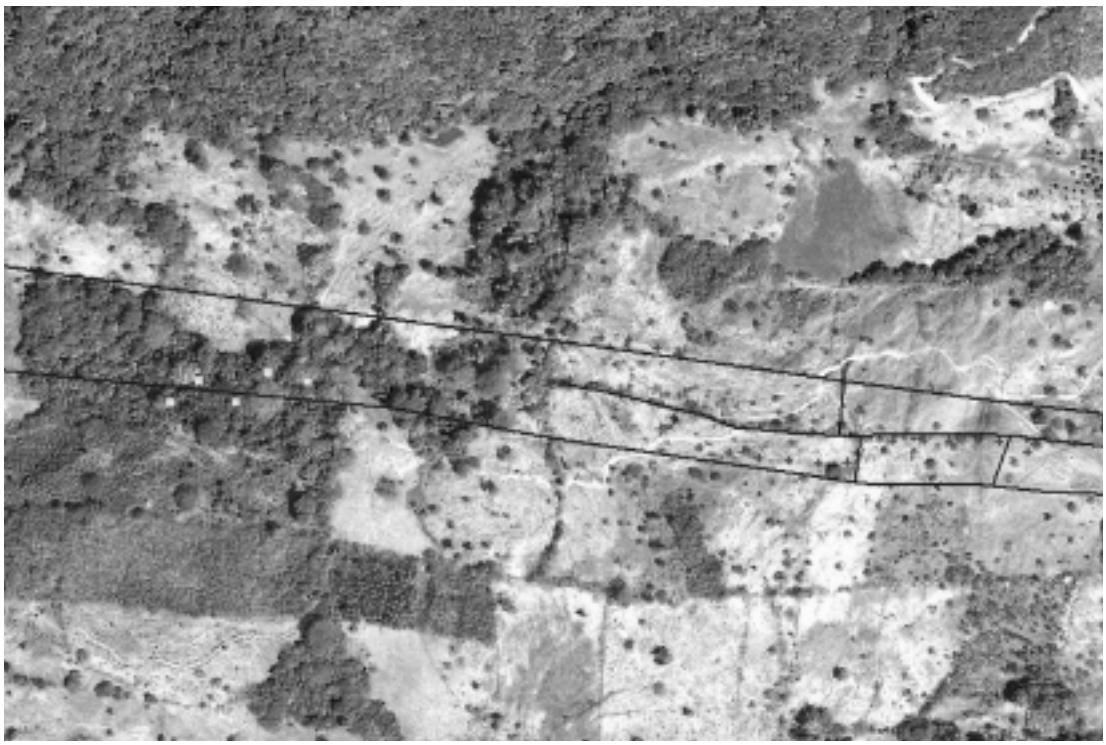
Five farms in the San Carlos and San Jeronimo districts were selected based on their live fence network designs and surrounding habitats. The natural vegetation can be defined as dry tropical forest, and the region is characterized by an abundance of flora and fauna. In general, the landscape is rich and colorful, and the hilltops of these districts provide a view of the Pacific Ocean.

Methods

Living fence networks of five silvopastoral farms were analyzed in this study. Three live fences at each farm were classified into three different treatments: living fences connected,

Figure 1. Function of Live Fences for the Conservation of Biodiversity in the Landscape





Satellite image of one of the silvopastoral farms used for the study. The farm, owned by Napoleon Gonzales, is located in the district of Peñas Blancas in Esparza, Costa Rica.

intermediate, and distant from secondary forest patches. Distance from the fences to the forest patch was 0 m to 125 m, 125 m to 250 m, and 250 m to 375 m, respectively.

Bird presence was observed in fences and at a control site in the nearest riparian forest. Point counts were used to perform the observations, using modifications based on Santivanez for live fences (2005). Five consecutive point counts were performed at each live fence, and these were located along the transect 25 meters from each other (Santivanez 2005). A total of 667 individuals of 75 species were observed at the live fence sites.

The selected live fences and control site were visited four times in four weeks during July and August. This is the rainy season and migrating birds are absent in the region. Bird presence was registered at each point count during 10-minute intervals from 6:00 am to 11:00 am, which are the hours of highest bird activity (Santivanez 2005). The order of observations at the sites was altered during the study to avoid any bias, as bird activity decreases with increasing temperature.

Live fence vegetative cover was characterized based on the methodology used by Lang et al. (2003). Number of trees within the point count area was recorded. Live fence and remnant pasture trees were identified and measured for vegetative structure and species composition. Measurements of total tree height, trunk height, diameter at breast height (dbh), and crown diameter (taken using instruments such as clinometer, tape measurer, and diameter measuring tape) were used later to compare the vegetative characteristics of each fence. The dominant tree species in most fences was Indio Desnudo (*Bursera simaruba*), and secondary species include Pochote (*Pachira quinata*) and Roble Sabana (*Tabebuia rosea*). Other less frequent species were also found, indicating fence tree diversity.

Distance of each point count to the riparian forest was measured using a Geographic Positioning System (GPS) unit and satellite images of the farms. The Tropical Agricultural

Research and Higher Education Center (CATIE), a collaborator in this project, had previously manipulatedthe satellite images using Arc View 3.2 Geographic Information Systems (GIS) software, to depict living fence networks on each farm. This made the selection of the farms and fences easier, as well as the visualization of the study's design.

Conclusions

Based on our finding we can conclude that living fences promote biodiversity. Living fences are used by forest, generalist and savanna specialist bird species. The presence of birds in living fences could also be improved. After comparing the fence characterization variables

Figure 2. Species composition in living fences

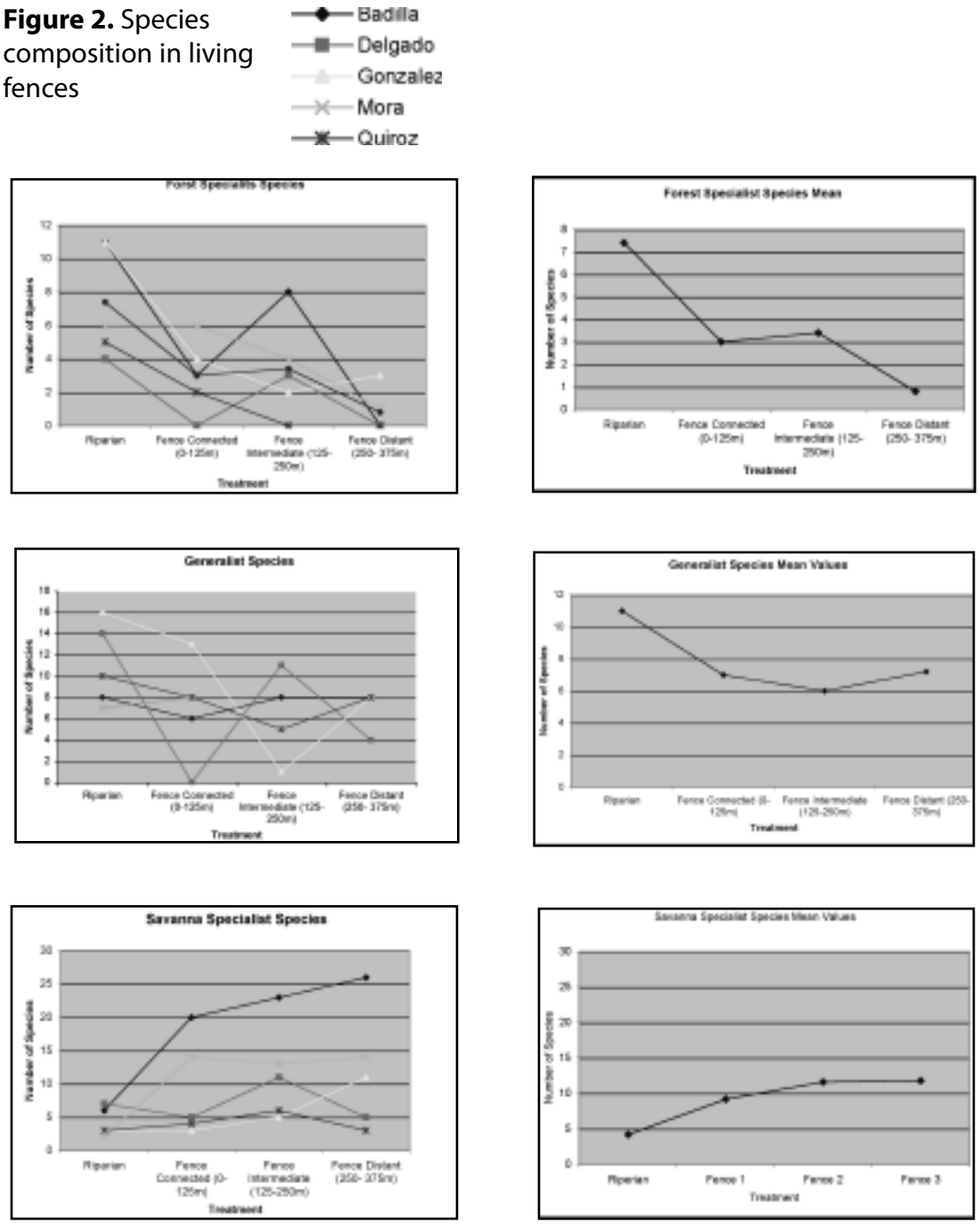


Table 1. SPSS MANOVA analysis. Multivariate test between tree characteristics and bird observations. (df= degrees of freedom, F=test statistic)

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	NBirds	313.589[a]	20	15.679	4.136	.000
	SpeBirds	1274.532[b]	20	63.727	5.027	.000
Intercept	NBirds	12.394	1	12.394	3.269	.076
	SpeBirds	47.194	1	47.194	3.722	.059
NTrees	NBirds	3.949	1	3.949	1.042	.312
	SpeBirds	.074	1	.074	.006	.940
MeanDBH	NBirds	91.511	1	91.511	24.137	.000
	SpeBirds	295.313	1	295.313	23.293	.000
MeanTotalH	NBirds	.214	1	.214	.056	.813
	SpeBirds	2.975	1	2.975	.235	.630
MeanTrunkH	NBirds	8.585	1	8.585	2.264	.138
	SpeBirds	22.072	1	22.072	1.741	.193
MeanCrown	NBirds	15.395	1	15.395	4.061	.049
	SpeBirds	78.726	1	78.726	6.210	.016
SpTrees	NBirds	68.551	1	68.551	18.081	.000
	SpeBirds	192.464	1	192.464	15.181	.000
Fence	NBirds	76.347	14	5.453	1.438	.168
	SpeBirds	380.339	14	27.167	2.143	.023
Error	NBirds	204.732	54	3.791		
	SpeBirds	684.615	54	12.678		
Total	NBirds	1534.000	75			
	SpeBirds	5400.000	75			
Corrected Total	NBirds	518.320	74			
	SpeBirds	1959.147	74			

a. R Squared = .605 (Adjusted R Squared = .459)

b. R Squared = .651 (Adjusted R Squared = .521)

against the number of bird individuals and species, we found that crown diameter, tree diversity, and dbh values are significant variables that can be manipulated to affect bird species diversity and abundance. High values for these variables should result in fences that are more attractive to birds.

Living fences effectiveness to connect the fragmented landscape is a dependent factor. Living fences have the capability to attract forest species and facilitate the movement of wildlife across the fragmented landscape, but all living fences are not equally effective. There is much variability in the design, structure, and composition of fences, which makes their evaluation very difficult. According to our results, for a live fence to be successful at connecting the fragmented landscape, the fence needs to contain trees with broad crowns, large dbh values, and of various species.

Distance to the forest patch affects the number of species present in living fences. Only few forest specialist species venture out of the forest areas and into the agricultural scenery. The number of forest species present in living fences decreases as we move away from the forest habitat. According to our results, living fences could potentially counteract the effect of distance to patches if the fences contain high values of the significant variables identified.

Differences in bird observation between the farms (Figure 2, left column) can be explained by the variability between silvopastoral systems. Besides the differences in structure and composition of the fences, some other factors that could lead to variability are the live fence network design and the number of fences in a farm. For the purposes of this study, we only compared the structure and composition of the selected fence segments, but future studies should consider the spatial design of the fences in the pasture.

Discussion

An important characteristic of living fences is tree management by farm owners. Since the main priority in silvopastoral systems is pasture availability for grazing purposes, trees in living fences are subjected to pruning. Large crowns are not a desirable feature in silvopastoral systems because they limit pasture growth, so pruning is done once or twice per year to improve pasture growth as well as for fodder, fuel wood, and stem production for new live fences (for species with vegetative growth capability). Due to these reasons farm owners have little incentive to allow full crowns to develop. In turn this practice lowers the potential for living fences to be attractive to generalist or forest specialist species.

It is recognized that a farmer's choice to use living trees instead of dead post for fences increases landscape connectivity. Better yet, when the trees in those fences are large and diverse they provide greater benefits to the ecosystem and to the farmer. In the same line of thought, fences that provide greater landscape connectivity are better at providing refuge to a higher number of bird species and individuals. Based on the results, crown area, tree diversity, and dbh are significant variables associated to the bird species composition in living fences. In addition, living fences could be effective at connecting the fragmented landscape for some forest species to be able to move across the pasturelands to distant forest patches, but only if those fences contain the tree characteristics identified as significant.

Among the environmental services provided by living fences, landscape connectivity, and biodiversity conservation are proposed as secondary services of these agroforestry systems. This is a true assumption but the contributions from living fences vary depending on the characteristics of their tree composition. Living fences are effective at providing habitat to savanna specialist and generalist species, though they do no seem very effective providing refuge to forest species unless the fence is manage to allow a few trees to develop naturally.

The application of these findings could be use to modify management techniques of living fences. Either by altering pruning cycles or by performing selective pruning, modifications to the pruning techniques could be done to allow the best bird hosting trees to continue providing landscape connectivity which promotes wildlife conservation. Farmers usually appreciate greater biodiversity in their farms and are aware of the benefits of birds to disperse seeds and prey on parasites, so we believe they would be interested on improving their living fence managing practices, in order to enhance the conservation of wildlife.

Acknowledgements

The completion of this study would not have been possible without the support of the Tropical Research Institute and Amity Doolittle's enthusiasm. Nor it would have been possible without the patience and guidance of my adviser Florencia Montagnini, and the professional advice of Jonathan Reuning-Scherer and Dr. Dave Skelly. Also, I would like to express my enormous gratitude to the Tropical Agricultural Research and Higher Education Center (CATIE), for their essential collaboration in the execution of this project. Very specially, I would like to thank Dr. Muhammad Ibrahim and his team for being the project backbone and for all the cooperation provided. Last but not least, I would like to thank Diego Tobar and Giovanni Cardenas for their hard work and their intellectual insight.

References

Alonso, J., G. Febles, and J.C. Gutierrez. 2000.. Methods for Introducing Species of Trees as Living Fences in grazing Areas. *Cuban Journal of Agricultural Science* 34 (2): 153-157.

Bennett, A.F. 1999. Linkages in the Landscape. T*he Role of Corridors and Connectivity in the Wildlife Conservation*. Gland, Switzerland and Cambridge, UK: IUCN. 240-244.

Budowski, G. 1987. *Living Fences in Tropical America, a Widespread Agroforestry Practice. Agroforestry, Realities, Possibilities and Potentials*. Doordrecht, Netherlands: Martinus Nijhoff.

Camargo, J.J. 2003. *Sistemas Silvopastoriles con Laurel (Cordia alliodora) en el Tropico Humedo y Subhumedo de Costa Rica. Agroforesteria para la Produccion Animal en America Latina – II*. Estudios FAO Produccion y Sanidad Animal.

Harvey, C., C. Villanueva, J. Villacis, M. Chacon, D. Munoz M. Lopez, M. Ibrahim, R. Gomez, R. Taylor, J. Martinez, A. Navas, J. Saenz, D. Sanches, A. Medina, S. Vilches, B. Hernandes, A. Peres, F. Ruiz, F. Lopez, I. Lang, S. Kunth, and F. Sinclair. 2003. Contribucion de las Cercas Vivas a la Productividad e Integridad Ecologica de los Paisajes Agricolas en America Central. *Agroforesteria de las Americas* 10 (39- 40): 30 – 40.

ICRAF (World Agroforestry Center). 2004. *International Council for Research in Agroforestry* . Nairobi, Kenya. Consulted on June 6, 2005. Available http://www.worldagroforestry.org

Lang, I., L.H.L Gormley, C.A. Harvey, and F.L. Sinclair. 2003. Composicion de la Communidad de Aves en Cercas Vivas de Rio Frio, Costa Rica. *Agroforesteria en las Americas* 10 (39-40): 86-92

Nair, P.K., B. Kang, and D. Kaas. 1995. Nutrient Cycling and Soil Erosion Control in Agroforestry Systems. Pp. 117-138 in *Agriculture and Environment: Bridging Food Production and Environmental Protection in Developing Countries*, edited by A. Juo. Madison, WI: American Society of Adronomy (ASA). (ASA Special Publication n°60).

Perfecto, I., R.A. Rice, R. Greenberg, and M.E. van der Voort. 1996. Shadecoffee: a Disappearing Refuge for Biodiversity. *Bioscience* 46: 598-608.

Santivanez, J.L., 2005. *Contibucion de las Cercas Vivas en la Connectividad para Mantener y Conservar Aves en un Paisaje Fragmentado en Rio Frio, Costa Rica*. Tesis Mg. Sc. Turriabla, CR CATIE. 108

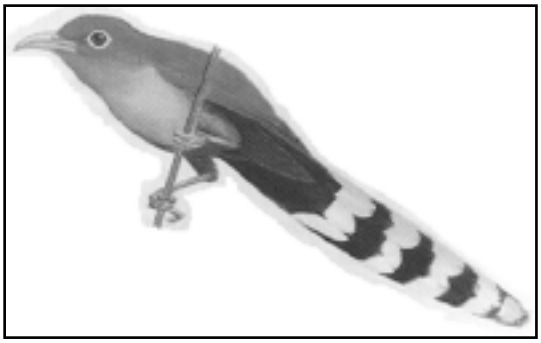
Schroth, G., G.A.B. da Fonseca, C.A. Harvey, C. Gascon,, Vasconcelos, H.L., and A.M.N. Izac. 2004. *Agroforestry and Biodiversity Conservation in Tropical Lanscapes*. Washington, DC: Island Press.

Sequeira, W. 1984. *Agroforestry Systems and Rural Development in Costa Rica.* Tesis Mg. Sc. Turrialba, CR, CATIE.

Stiles, G.F. & Skutch A. 2003. Guía de aves de Costa Rica. 3ra. edición Trad. L. Roselli, illus. D. Garner. Instituto Nacional de Biodiversidad, Heredia, Costa Rica. 572 pp.

Swift, M.J., A.M.N. Izac, and M. van Noordwijk. 2004. Biodiversity and Ecosyustem Services in Agricultural Landscapes – Are We Asking the Right Question? *Agriculture Ecosystems and Environment* 104: 113 – 134.

Zahawi, R. A. 2005. Establishment and Growth of Living Fence Species: An Overlooked Tool for the Restoration of Degraded Areas in the Tropics. *Restoration Ecology* 13 (1): 92-102.



Piaya Cayana (Squirrel Cuckoo)
Source: Stiles, G.F. and Skutch A. 2003

Conflicts in the Human-Elephant Border:

Studying the Possible Causes in the Bia Conservation Area in Ghana

Gonzalo Griebenow, MEM 2006

Working in the field one day, my assistant asked me whether I had tried the raw cocoa fruit, and I answered no. With surprising dexterity he grabbed a cocoa fruit and split it open with his machete. When he realized how much I liked it, a wide smile came to his lips and he said, "They like it too." He was referring to the elephants of the forest, and the fact that they had become like kids in a candy store. However, their newfound treat is indirectly causing them harm.

Introduction

The forest elephant (*Loxodonta cyclotis*), a smaller and less studied species compared to its savannah counterpart, is an endangered species in Ghana. They are threatened by the continuous changes in the land use, the illegal ivory trade and, more recently, the conflicts with farmers.

Therefore, gaining insight into this organism's behavior and studying the actual state of its conservation has been an increasing challenge in recent years. Blanc et al. (2003) reported that 63% of West African populations include fewer than 100 elephants. Populations are plummeting because of the animal's fragile status and the increasing number of threats it faces. My research focuses on the possible causes of the human-elephant conflicts and establishes connections among probable factors that may affect elephant movement patterns in the forest. The results could serve as a basis for policy-oriented alternatives that would mitigate the current human-elephant conflicts in the area.

Gonzalo Griebenow is a native of Lima, Peru, where he obtained a Bachelor of Science in Biology at the Universidad Ricardo Palma and a Masters of Science in Environmental Science at the Universidad Nacional Agraria La Molina. Once he obtains his Masters in Environmental Management from Yale, he plans to pursue a career in the development of policy solutions for conservation problems in developing countries.

Study Site

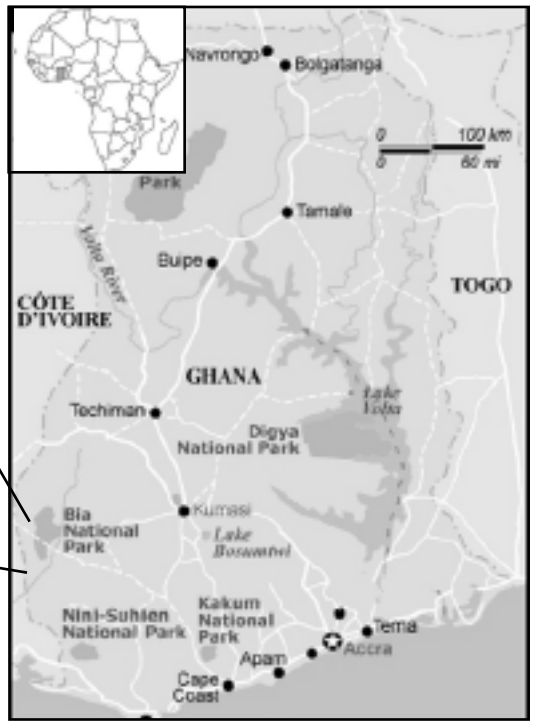
The Bia Conservation Area (BCA) in western Ghana (Figure 1) is composed of The Bia National Park and The Bia Resource Reserve, which are twin conservation areas with the same protection status. The park was initially created in 1935 and recognized as a Biosphere Reserve by the United Nations Educational Scientific and Cultural Organization (UNESCO) in 1984 - it is the only one of its kind in Ghana. The BCA has one of the highest oncentrations of forest elephants in Ghana, and also serves as a refuge for other endangered species such as chimpanzees, antelopes, leopards, and a variety of plant genus (Conservation International-Ghana 2002).

The BCA is 305.62 square kilometers of forest containing the last portions of Guinean Rainforest in West Africa (The Forest Commission of Ghana 2006). Rainfall is bimodal, occurring from March to July and from September to November, with a long dry season lasting from December to March. The average relative humidity is 85% and temperatures fluctuate between 10.2°C and 31.6°C (Forest Commission of Ghana 2006).

Methodology

To get data about the elephants distribution along the Bia Conservation Area, an adaptation

Figure 1. Map of Ghana



The area studied was the protected Bia Conservation Area (BCA), which includes The Bia National Park and the adjacent Bia Resource Reserve.

Source: http://www.siliconhotel.com/images/ghana_map.gif

of the standard line transect method (Buckland et al. 2001) was employed for counting dung piles in the BCA (Barnes and Jensen 1987). A grid consisting of squares, each one-minute of latitude and longitude, was superimposed on the map of the study area (Sam and Danquah 2004). During July and August of 2005, fifty transects were distributed along the BCA using a stratification method – distributing more transects where elephants are known to be concentrated and less in the areas where they are sparse – to reduce the variance of the results.

Each kilometer-long transect was located in the middle of a selected grid; thus, 30, 15 and 5 transects were distributed in the high, medium and low-density strata, respectively (Figure 2).

Positions of dung piles – easily identifiable because they resembled stacks of balls 9-12 cm in diameter – were marked on a field data sheet using a Global Positioning System (GPS), and the data was later plotted as fixed points on a map. Findings of dung piles were then associated with ecological factors that are known to influence elephant movement patterns, i.e., vegetation type, swamps, presence of rivers, fruiting trees, and canopy gaps. In addition, proximity of farms to the reserve was included as a possible factor influencing the forest elephant.

The study involved three groups of four people: two groups were in charge of collecting data from transects within the BCA and the third group was responsible for collect data elsewhere. The group working outside the reserve interviewed people about primary land uses in the surrounding area, such as logging, farming, and cattle ranching.

Problem Description

In the past, the forest elephants' range has shrunk to a quarter of its original size, partly because the Sukusuku and the Bia Tawya Forest Reserves, which are near the Bia Conservation Area, have been illegally and completely transformed to farmlands (Martin 1982). These forest reserves were once around the BCA acting as a buffer zone, but even though they are still on the official maps, they no longer exist.

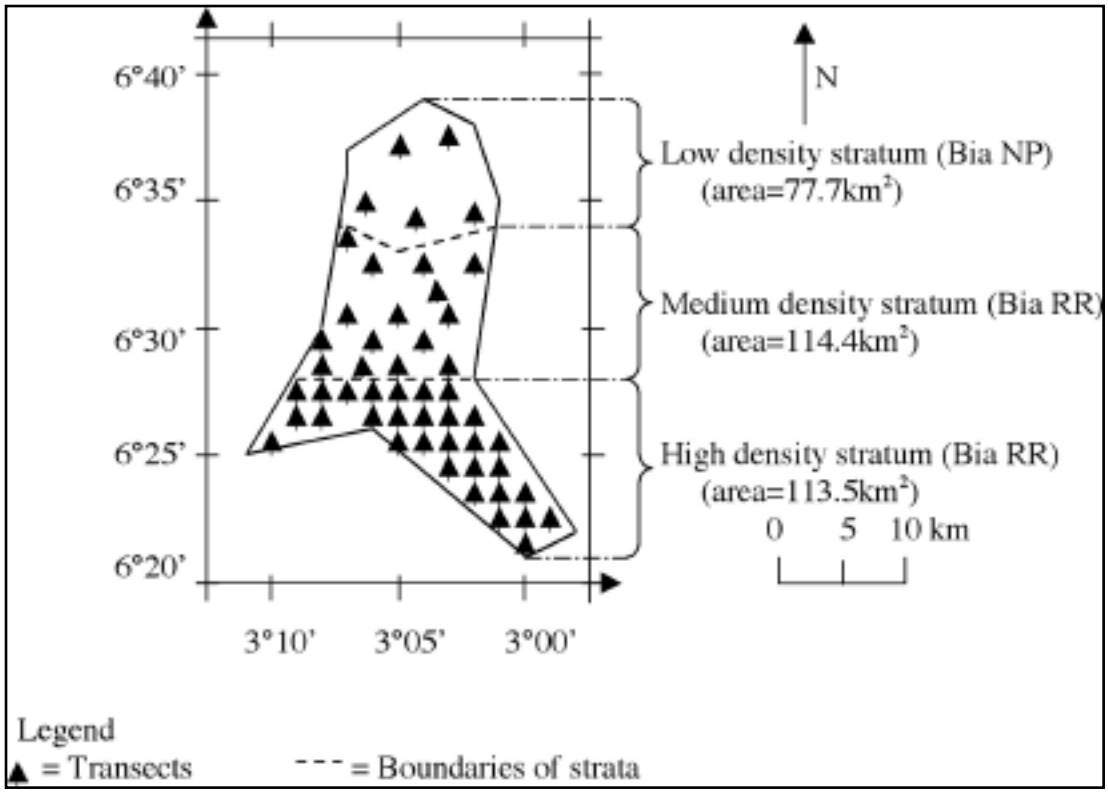
The proximity of farms to the conservation area has increased the possibility of clashes between farmers and elephants. As a result, farmers have resorted to using various methods to keep elephants away from their crops such as playing drums and violins for long hours into the night. It was curious to see that, while the farmers play their instruments, elephants seem to wait hidden in the forest just meters away on the other side of the reserve's border. The farmers know that once elephants enter into their farms they have no power to drive them off their land. What is more, as soon as the farmers tire of playing their instruments, elephants steal into the farms, spoiling the crops.

Results

Dung pile data collected in the field was analyzed with Stat View to get a quantitative understanding of the current factors affecting movement patterns of forest elephants. The data collected was correlated with the presence of any of the ecological factors mentioned in the methodology that may influence the elephants' moving patterns. These variables, with the exception of the presence of rivers, did not show a typical pattern, whereas raphia swamps and fruiting species were strong attractors for elephants in the forest.

Therefore, I proceeded to correlate the dung pile data collected with the presence of cocoa farms in the southern area of the BCA to possibly link human activities to changes in the elephant movement patterns. This analysis showed a better correlation with the fixed points obtained in the field. The strongest level of correlation found was between the dung piles and the presence of farms 0.781, then between and dung piles and the presence of rivers 0.659; while the rest of correlations values ranged from 0.433 to 0.05. When correlated with dung piles,

Figure 2. Bia Conservation Area showing transect distribution in the various strata



Source: Sam and Danquah 2004

raphia swamps and fruiting species, natural attractors of forest elephants, showed a value of 0.167 and 0.05 in the correlation matrix.

Discussion

There were a number of human activities around the southern border of the BCA, such as logging, ranching, and farming mainly located in the south border. Since buffer zones have been cleared for these purpose, humans and elephants are coexisting in a small area with little separation, which creates a serious threat to the species due to increased conflict with humans.

While I was working in the area, farmers told me that, at times, they hire a specialized elephant poacher to "get rid of the problem." They secretly divide and consume the meat, sell the ivory, and bury the body deep in the forest. These remarks were unexpectedly confirmed by one of the park rangers on my research team, an important admission given that it significantly increases concern for the viability of elephants in the area.

This covert activity creates a tremendous impact on the herd, since poachers typically take the head of the herd. In matriarchate social organizations such as that of the forest elephant, the leader is a female. This elephant is usually the best specimen for reproduction and is the one that passes the knowledge acquired through generations to the rest of the herd (Vidya and Sukuma 2005).

Conclusions

According to the study, elephants are spatially correlated with the presence of farms, concentrated in the south part of the BCA. Far from being disturbed by the presence of humans, forest elephants seem to be attracted to farms as food sources. Reports of crop raiding by elephants has increased in the vicinity of national parks in Ghana, particularly at cocoa farms (Sam and Danquah 2004).

Thus, there is an urgent need for further studies to complement the understanding of the BCA forest elephant conservation status and the causes of the human-elephants conflicts. These studies will serve as a basis for improved policies adapted to local needs. Studies must be focused on economic and ecologic zoning, on the conservation status of the forest elephant, and on economically viable revenue generators that do not threaten the species. Hence, solutions must include not only an improvement in regulations, monitoring, and enforcement but also an incorporation of a social approach that provides the farmers with profitable alternatives. Any viable alternative should mitigate the actual conflicts and serve as a platform for future changes.

There are successful experiences in other protected areas in Ghana that can serve as a guide to follow. The Kakum National Park is similar in extent and number of species, but in contrast to the BCA receives more visitors. This allows locals to develop proposals for new business opportunities like ecotourism and non-timber forest products, among other alternatives.

Elephant populations in the BCA have been isolated for a long time and their future viability will depend on realistic conservation policy recommendations. The implementation of these policies in the context of the social and economic dimensions will also contribute to population stability and mitigate the human-elephant conflicts at the border of the Bia Conservation Area.

Acknowledgements

I would like to thank Amity Doolittle of the Tropical Resources Institute and Peter Otis from the Career Development Office at Yale University for funding this study. Also my gratitude goes to for Godfred Ohene-Gyan MEM Class of 2006 for facilitate the coordination with the Ghanaian government representatives. Mr. Oheneba Amposanh Agyemang the Director of the Resource Management Support Center and Mr. Moses Sam from the

Wildlife Division for their support in Ghana and the editors of this volume for their comments and revisions to my document. Finally, my special gratitude to Emmanuel Danquah faculty of the Renewal Natural Resources school in the Kwame Nkrumah University of Science and Technology in Kumasi for his invaluable assistance in the field work as well as in the analysis of the data collected.

References

Barnes, R.F.W., and K.L. Jensen 1987. How to Count Elephants in Forests. *IUCN African Elephant Specialist Group Technical Bulletin* 1:1–6.

Blanc, J.J., C.R. Thouless, J.A. Hart, H.T. Dublin, I. Douglas-Hamilton, C.G. Craig. and R.F.W. Barnes. 2003. *African Elephant Status Report 2002: An Update from the African Elephant Database.* IUCN/SSC African Elephant Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. vi + 302pp.

Buckland, S., T.D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas, 2001. *Introduction to Distance Sampling. Estimating Abundance of Biological Populations*. Oxford: Oxford University Press.

Conservation International - Ghana 2002. *Endangered Bushmeat Species in Ghana* http://www3.niu.edu/niuabroad/Ghana.05.htm

Forestry Commission of Ghana 2006. Bia National Park & Resource Reserve/Biosphere Reserve http://www.fcghana.com/eco_tourism/bia.htm (accessed February 2006).

Martin, C. 1982. *Management Plan for the Bia Wildlife Conservation Areas, Part I*. Final report IUCN/WWF project 1251. Wildlife and National Parks Division, Ghana Forestry Commission, Accra, Ghana. Pp. 152

Sam, M. and E. Danquah 2004. *An Elephant Census in the Bia Conservation Area in Western Ghana*. Unpublished manuscript.

Vidya T. N. C. and R. Sukuma 2005. Social and Reproductive Behaviour in Elephants. Special Section: Animal behaviour. *Current Science* 89(7): 1,200-1,207.

Source: Rhind, William. 2004. **The Vegetable Kingdom.** ***Fine Rare Prints. Available at: www.finerareprints.com***

Modeling Soil Erosion Risk in Los Maribos Volcanic Chain, Nicaragua

by Richard Chávez, MF 2003

Introduction

Nicaragua is a country heavily affected by natural disasters, many of which are linked to land degradation and anthropogenic pressure on its natural resources, especially forests. On the Pacific side of Nicaragua, land transformation in rural areas is most prevalent where the expansion of agriculture practices is contributing to an unprecedented rate of land use change. Conversion of land from forest to agriculture has created both on and off site problems for rural people living in these watersheds. One of the most visible problems is soil erosion (Landa et al. 1997). Deforestation and land transformation have exposed soils to water erosion, increasing their susceptibility to natural disasters such as the landslides caused by Hurricane Mitch in 1998.

Land transformation, deforestation, and lack of soil conservation practices have made the Los Maribios volcanic chain one of the most degraded landscapes in the country; agribusinesses, subsistence farming, and cattle ranching have contributed to the increased soil erosion risk.

This research aimed to develop a tool that can be used to both model and monitor the effect of land use on soil erosion potential, given the physical conditions within the Los Maribios volcanic chain. The applied model is based upon the Universal Soil Loss Equation (USLE) (Wischmeier and Smith 1978) and is integrated with GIS.

The objectives for this study were: (1) to analyze existing rainfall data to generate a soil erosivity map; (2) to collect and analyze existing geographic information to develop a soil erodibility map; (3) to assess land cover and land use through both field visits (ground truthing) and satellite imagery analysis, in order to develop a land cover map; and (4) to analyze collected and processed information to identify areas of soil erosion risk.

Study Site

Research took place in four micro watersheds: Casitas, Cristo Rey, Las Marias, and Las Quemadas in the Volcanic Chain of Los Maribios. Most of the soils of this region are of volcanic origin and have textures varying from very sandy to sandy loam, with depths from superficial to greater than 90 cm (MAGFOR 1971).

Land use and land cover patterns in this region are the result of both natural and socioeconomic factors. In general, the top organic layer of these soils has been eroded, resulting in low productivity levels (Sharma 1990). Most families who inhabit the area rely on subsistence agriculture. The lack of available low elevation lands forces subsistence and marginal farmers to move to higher altitudes on the slopes of Los Maribios; this, in turn, results in further soil degradation.

Richard Chávez graduated from Yale School of Forestry and Environmental Studies in 2003. SInce then, he has continued to pursue research in.....

Agriculture in lowlands and highlands. Cordillera Los Maribios, Nicaragua. *Photograph by R. Chávez*

Methods

Data sources

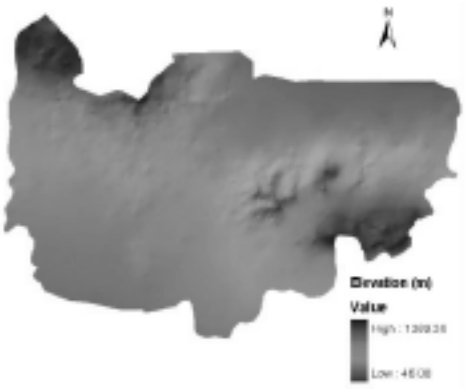
This research integrates the Universal Soil Loss Equation (USLE) (Wischmeier and Smith 1978) with the Arc Geographic Information System (GIS) to model soil erosion risk within the Los Maribios Volcanic Chain. The data used was obtained from weather stations, vegetation surveys, and topographic maps. GIS files were created for each factor of the USLE – precipitation, soil type, landcover, and slope – and combined by cell-grid modeling procedures in ArcGIS to predict soil erosion risk. Resolution was set to 30 meters by 30 meters.

Digital Elevation Model (DEM)

In many developing countries, spatial information data is limited or non-existent. It is therefore necessary to create digital spatial information, such as elevation models (DEM), by digitizing contour lines from topographic maps.

The DEM for this research was developed from vector contour lines using a topographic map scale 1:50,000 with Wise Image Pro5 software package. Interpolation of the elevation points to create the DEM was achieved using ArcGIS v8.2.; the interpolation method used was Kriging (Figure 1).

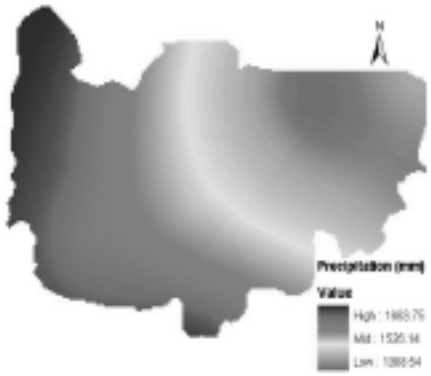
Figure 1. The Digital Elevation Model (DEM)



Rainfall

The precipitation surface was obtained by interpolating average rainfall during a 10-year period for twelve observation points within the study area. The interpolation method used was Kriging (Figure 2).

Figure 2. Precipitation surface (mean annual precipitation in mm)



Soil

Soil data was digitized from a map with scale 1:50,000 produced by MAGFOR (1987).

Figure 3. Soil type

Some of the soil types shown in the soil classification map (Figure 3) have not yet been classified using the USDA system. A nonmenclature was therefore developed based on their physical characteristics (Catastro e Inventario de Recursos Naturales 1971). For instance:

1. Qe (Lands with moderately steep slopes) includes soils with slopes between 15–30% that have not been classified in a specific class because they lack uniformity in their profile. However, these soils' type has been characterized based on deepness, texture, and gravel content.

2. Qeu (Lands with moderately steep slopes, very shallow soils, and slopes between 15–30%) are soils that vary in their textural characteristics, are very permeable, and have very low organic matter content. The soil profile is not well defined.

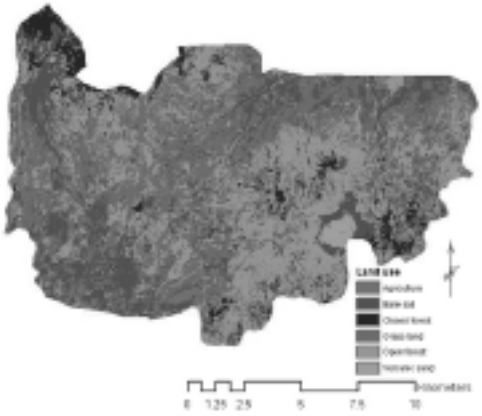
3. Qf (Steepest slopes) includes soils with slopes between 30–75% that have not been formally classified.

4. Qg are very shallow soils located in very steep slopes (greater than 75%).

Land cover

The land cover data used was derived from satellite imagery (Landsat-7 Thematic Mapper (TM) image, Path 017 Row 51, July 15th 2001) and classified using a supervised classification with the ERMapper software package. First, six different land use types were defined: (i) agriculture, (ii) open forest, (iii) closed forest, (iv) grass land, (v) bare soil, and (vi) volcanic sand. The training regions were defined using ground truth data collected during the summer of 2002 as well as other ground truth data, such as aerial photo land use classifications (MAGFOR 1999). An aerial photo of land use was used to assess the accuracy of the classifications (Figure 4).

Figure 4. Land cover



The Model

The four data layers and the subsequent derivation of the LS-, R-, K-, C-, and P-factors from these layers were created using the following technique (Figure 5):

Figure 5. GIS procedure for creating coverage for each USLE factor

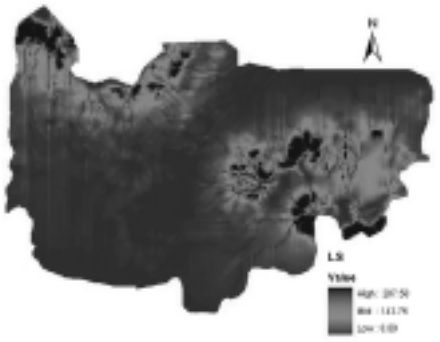
Slope length and Steepness factor (LS)

Calculating slope length presents the largest problem when using USLE as a model to predict soil loss within GIS. Schmidt (2001) created an extension for Arc-View 3x to calculate the slope length factor. The S factor was calculated using the DEM and Nearing's equation (1997) (Figure 6).

$$S = -1.5 + \frac{17}{1 + \exp(2.3 - 6.1\sin\theta)}$$

where θ is the slope angle in degrees. Nearing's equation (1997)

Figure 6. Slope Length and Steepness factor (LS)



Soil erodibility factor (K)

The soil erodibility factor (K) is the soil's resistance to erosion by water in units of ton $MJ^{-1}mm^{-1}hr$. A digital map of ecological regions developed by MAGFOR (not published) was used to identify the soil series in the study area.

K-factor values were estimated using the soil-erodibility nomograph (Wischmeier and Smith 1978). Since soil samples were not taken, the K values presented in this paper are estimations based on the physical characteristics of the soils described in the internal 1971 MAGFOR document (Figure 7).

Figure 7. Soil erodibility ton MJ^{-1} mm^{-1} hr

Cover-management factor (C)

The C-factor models the effect of cropping and management practices on erosion rates. C factor values were applied to five cover types identified in the study area. The USLE's cover and management factors (C-factors) corresponding to each land cover condition were estimated from the USLE guide tables (Morgan 1995; Wischmeier and Smith 1978). These values were used to reclassify the land cover map to obtain the C-factor map of the study area.

Figure 8. Cover Management Factor

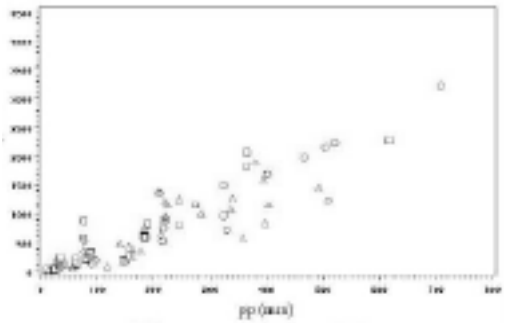
Rainfall and runoff factor (R)

The rainfall and runoff factor (R) represents the energy available to erode land in units of MJ mm $ha^{-1}h^{-1}y^{-1}$ (Wishmeier and Smith 1978).

The rainfall erosivity factor was determined by calculating storm erosivity indices using data from three weather stations (Leon, Chinandega, and Posoltega) [INETER 2002] over a four-year period. The index was calculated for the winter season only (May to November). The sum of monthly EI_{30} is the annual R-factor (Dissmeyer and Foster 1980; Renard and Freimund 1993; Yu et al. 2001).

$R = \sum EI_{30}$
Where:
R is the Erosivity factor
EI_{30} is the Erosion index

Figure 9. Linear relationship between monthly precipitation and the monthly erosion index



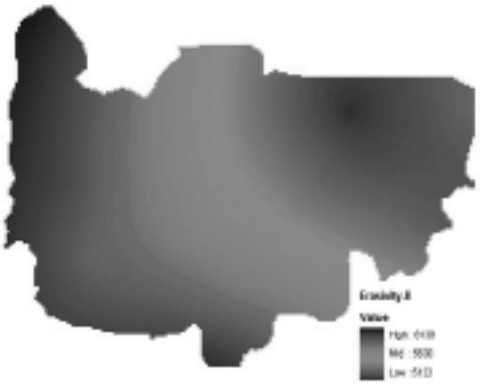
The regression equation to predict monthly EI_{30}, given monthly precipitation in millimeters, is:

$EI_{30} = 3.88pp - 37.23 \quad R^2 = 0.802$

Support practice factor (P)

Because no information in regard to the P-factor is available for this area, a value of 1 was assigned to the model presented in this study. A P-factor value of 1.00 represents no land-use influence.

Figure 10. Soil Erosivity factor map MJ ha^{-1} mm h^{-1} yr^{-1}



Results and Discussion

Soil erosion risk was modeled within Los Maribios volcanic chain, integrating the Universal Soil Loss Equation (USLE) with GIS. The quantitative data of predicted soil loss in each map (LS, R, K, C) was reclassified into qualitative data to identify areas that are the most susceptible to soil erosion within the study area.

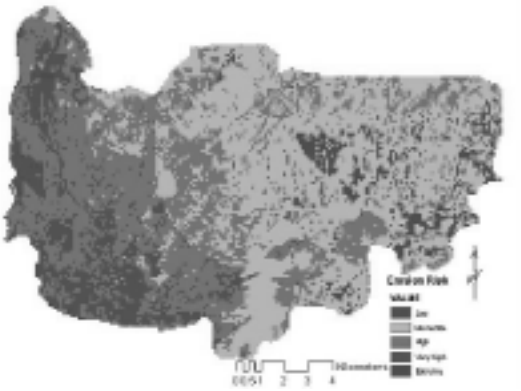
The model included only LS, R, K, and C factors. More research is necessary to characterize the effect of contouring and tillage practice as well as other soil conservation practices needed to develop a P-index.

Figure 11 shows erosion hazard in the upper and lower parts of the study area, which is expressed in five classes, ranging from low risk to extreme erosion risk.

Bare soils with clay contents ranging from moderate to high were estimated to have extreme to very high erosion. They showed higher values in slope-length and steepness. Some areas of lower elevation showed high erosion risk. This is because there is bare soil, high erosivity values, and high indices of erodibility. These areas of high risk in lower elevations are frequently cultivated areas.

More than 50% of the study area was considered to be at high to extreme risk of erosion (Table 1). Most of these lands were situated in the casitas site and were used extensively for

Figure 11. Soil erosion risk map



cultivated agriculture. In contrast, the moderate to low erosion risk areas were generally covered by grass, shrubs, and open forest.

Table 1. Area and Percentage Erosion Hazard

Erosion Risk	Area (ha)	Percent (%)
Low	1116.54	5.73
Moderate	8210.79	42.0
High	7766.64	39.74
Very High	2412.45	12.34
Extreme	39.51	0.20

Some of the maps used in this model might lack accuracy due to the insufficient information used in the interpolation. Accuracy of the precipitation surface would have improved if more data points were used in the interpolation.

Figure 11, depicting erosion risk is a qualitative description of erosion potential in the study area. Because the USLE/RUSLE requires a series of complex algorithms, the model makes it difficult to quantitatively characterize the area in terms of erosion risk while using GIS.

The characterization of the erosion risk map demonstrated the utility of the model as a conservation management tool where the relative comparison among land areas is more important than the absolute soil loss in any single cell.

Conclusions

This project developed and applied a simple methodology to predict a qualitative estimate of soil erosion risk in a format that can be understood and interpreted by any land manager.

This study further demonstrated the compatibility of integrating GIS with USLE to predict soil erosion risk. Although it was not possible to quantify soil loss in the study area, the classification of soil erosion risk used in the final map can help identify where alternative soil conservation practices would be best applied.

There were limitations in determining the P-factor when using USLE in this model. There were limitations in this study due to the lack of information on the P-factor in the USLE model. Further research is necessary to determine the appropriate P-factor for local soil conservation practices.

Acknowledgements

This work would not have been possible without the help of the following people and institutions: Professors Dana Tomlin and Timothy Gregoire, Abraham Parrish for his guidance, the Compton Fellowship Program, Latin American Association of Yale, the National University of Nicaragua-Leon, the Ministry of Agriculture and Forestry of Nicaragua, and the Tropical Resource Institute at the Yale School of Forestry and Environmental Studies.

References

Bartsch, K.P., H. Van Miegroet, J. Boettinger, and J.P Dobrowolski. 2002. Using Empirical Erosion Models and GIS to Determine Erosion Risk at Camp Williams, Utah. *Journal of Soil and Water Conservation* 57 (1): 29-36.

Catastro e Inventarion de Recursos Naturales-MAG. 1971. *Estudio de Suelos de La Region II del Pacifico de Nicaragua*. Doc. I, II, II.

Desmet, P.J.J. and G. Govers 1996. A GIS Procedure for Automatically Calculating the USLE LS Factor on Topographically Complex Landscape Units. *Journal of Soil and Water Conservation* 51: 427-433.

Dissmeyer G.E. and G.R. Foster, 1980. *A Guide for Predicting Sheet and Rill Erosion on Forest Land*. Technical Publication SA-TP 11, Forest Service, West Lafayette: USDA. 40 pp.

INETER (Instituto Nicaragüense de Estudios Territoriales). 2002. Acquisition of Precipitation Data.

Landa, R., J. Meave, and J. Carabias. 1997. Environmental Deterioration in Rural Mexico: An Examination of the Concept. *Ecological Applications* 7 (1), 316-329.

MAGFOR (Ministerio Agropecuario y Forestal). 1971, 1987, 1999. Regionalizacion Biofisica para el Desarrollo Agropecuario del Departamento de Chinandega.

Morgan, R.P.C. 1995. *Soil Erosion and Conservation*. Edinburgh: Addison-Wesley Longman. 198 pp.

Moore, I.D., and P. Wilson. 1992. Length-slope Factors for the Revised Universal Soil Loss Equation: Simplified Method of Estimation, *Journal of Soil and Water Conservation* 47 (5): 423-428.

Nearing, M.A. 1997. A Single, Continuous Function for Slope Steepness Influence on Soil Loss. *Soil Science Society of America Journal* 61 (3): 917-919.

Renard, K.G. and J.R. Freimund. 1993. Using Monthly Precipitation Data to Estimate the R factor in the Revised USLE. *Journal of Hydrology* 157 (1994) (1-4): 287-306.

Schmidt, F. 2001. Institute for Geodesy and Geoinformatics, Project 'Preagro.' TWI, Streampower Index and SL-factor are Based on Papers by MOORE. See TERRAIN ANALYSIS by Wilson and Gallant (New York: John Wiley, New York.

Sharma P.N. 1990. Report of Consultancy in Soil Conservation and Agroforestry. Project on "Natural Resource Conservation and Management with Community Participation in the Western Up-lands of The Maribios Mountains"-GCP/NIC/019/NET. Leon, Nicaragua.

Wilson, J.P. and J.C. Gallant. 2000. *Terrain Analysis. Principles and Applications.* New York: Wiley.

Wischmeier, W.H. and D.D. Smith. 1978. *Predicting Rainfall Erosion Losses, a Guide to Conservation Planning*. Agriculture Handbook, no. 537, US Department of Agriculture, Washington D.C.

Yu, B., G.M. Hashmin, and Z. Eusof. 2001. Estimating the R-factor with Limited Rainfall Data: A Case Study from Peninsular Malaysia. *Journal of Soil and Water Conservation*. 56 (2): 101-105.

Questioning the Road:

Local Perceptions and Trends Along the Bakili Muluzi Highway, Malawi

by Caroline Simmonds, MEM 2006

Introduction

Throughout much of the world, road-building is viewed as a neutral development tool favorable for rural farmers due to increased access to urban markets. The notion that roads have a uni-directional and beneficial flow from rural to urban, however, omits other considerations. Recent research indicates that roads have significant outcomes for rural inhabitants: bringing economic activities and creating substantial benefits for those who live on the roadsides, as compared with those living in inaccessible "off-road"regions (Fairhead 1992; Porter 1995; Porter 2002; Wilson 2004). Transportation services, market access, and increased mobility may result from living closer to a paved road than from living further away. Highway construction projects thus represent international development projects that have the potential to be powerful transformers, not only of the physical landscape they traverse, but of the *social landscape*.

This article investigates the social and environmental implications of a road-building project in Sub-Saharan Africa, Malawi, along the recently paved Bakili Muluzi Highway, a major transportation route for the country's eastern corridor. The study of an independent variable, the road, provides a useful lens with which to understand current socio-economic perceptions and trends. These trends are presented in terms of agricultural livelihoods, forest resource use, and increasing health concerns. Social and environmental impacts of the new highway are assessed based on research conducted in two Amachinga Yao villages that border the new highway.[1] I argue that varying perceptions and trends create a complex social landscape when road-building projects initially transform the physical landscape of a rural region. Local perceptions and trends along recently constructed highways are crucial to understanding the unintended "side effects" of development projects (Ferguson 1994).

Caroline Simmonds hails from Wyndmoor, Pennsylvania and completed her BA at Cornell University. She was an agroforestry Peace Corps volunteer in southeastern Malawi and for her master's research returned to the same area. She plans to work in natural resource management and international development issues in Africa upon graduation from F&ES.

Case Study

Malawi's early communication network was an intricate series of paths connecting villages (Baker 1971) and Arab slavers' tracks (Perry 1969). After European settlement, these networks were modified by rail and road-building initiatives. Beginning in the 1890s, Malawi's modern system of roads was built to connect British administrative centers and military outposts within the country with "supply points" along the Shire River (Baker 1971). Akin to Roman roads, Malawi's early roads were "generally planned as straight as the terrain would allow, seldom following the traditional paths" (Cole-King 1972: 86).

After Malawi became independent from the British in 1964, communications with neighboring countries became critical for transportation and trade development for the landlocked country. The Nacala rail line, built in 1970 through northern Mozambique, linked Malawi to the Indian Ocean ports. Today, Malawi is increasingly reliant on highways over

railways. The country has a total of 28,400 km of roads: 5,254 km are paved and 23,146 km remain unpaved.[2] According to a recent article in Malawi's national newspaper, *The Nation*, "road transport systems in Malawi have become a central component of economic development. By speeding up communications and the transport of goods and people, the systems have spawned a revolution in contemporary economic and social relations" (Thawani 2005).

The Bakili Muluzi Highway, named for the former president, was completed in April 2003. This 136 km paved highway parallels the Mozambique border and serves as a major transportation network for Malawi's southeastern region. The new highway bisects the indigenous miombo woodlands of the Namizimu Forest Reserve, which at 85,000 ha is the largest reserve in the Mangochi district and runs adjacent to many Yao villages.[3] The Bakili Muluzi Highway construction cost was $58 million, with 85% provided in foreign currency.[4] The new highway is an expansion and improvement of the old earth road that was originally built in 1954.

The Malawian government's official reasons for building the Bakili Muluzi Highway were to promote national economic, agricultural and social development, tourism, and transit between southern African countries.[5] The highway was also built to link with the Mozambican road that will be constructed

Table 1. Local Perceptions of the Bakili Muluzi Highway. Multiple reasons are listed in response to the survey question, "How has the paving of the highway made a change in your life?" Answers are quantified for each respondent per village, with total percentages

	Idusri Village	**Chowe Village**	**Percentages per 144 responses for 60 interviewees**
Reasons	78 (total)	66 (total)	100%
Travels easy/well	28	22	34..7
Feels happiness	14	5	13.2
Cheaper transport available	7	6	9.0
Less car accidents occurring	2	8	6.9
More bicycle accidents	1	10	7.6
More cars come to the area	7	2	6.3
Walking without fear	2	8	6.9
Absence of dust	7	4	8.3
People can start businesses	4	0	2.8
Donors coming to area to help	2	0	1.4
Quality of roads has started to deteriorate--potholes present	1	1	1.4
Children will use road in future	2	0	1.4
More visitors come to the area	1	0	0.7

from Mandimba to Quelimane, providing Malawi a highway route to the sea. According to a 1998 feasibility study conducted by Kuwaiti consultants, the new road will serve over 700,000 people, or 140,000 subsistence farming families (Unetec 1998). Local farmers retain an estimated 80% of their farm produce and sell the remaining 20%. The new highway will aid the transport of over 20,000 tons of food crops and 70,000 tons of tobacco for these farmers, in addition to aiding the large-scale tobacco and coffee growing estates (Unetec 1998). Estates in the area produce about 385,000 tons of tobacco, 110,000 tons of maize, nearly 18,000 tons of rice, and 55,000 tons of various crops like cotton, pulses, and potatoes (Unetec 1998). To some observers, the highway was built to benefit these large-scale estates that cover the eastern corridor of Malawi, which are reliant upon sound roads to transport products to market.

Methods

From late May through August 2005, I lived alongside the Bakili Muluzi Highway to assess local perceptions and trends along the new road. Research was conducted in two Yao villages adjacent to the highway, Idrusi and Chowe. This consisted of household and vendor surveys, key informant interviews, oral histories of older villagers, and in-depth interviews with traditional healers. Questions addressed agricultural livelihood strategies, market access for both vendors and residents, resource extraction and forestry management practices for the Namizimu Forest Reserve, and opinions about development in the area. Answers reported here are the general consensuses from these surveys.

Findings

The majority of surveys indicate positive local perceptions of the highway, though a complex array of environmental and health trends are evident. This complexity arises when roads change the physical landscape of a rural region and create myriad consequences for the people who depend upon the road.

Ninety two percent of all survey respondents feel that the new highway has made a change in their life. The most oft-cited change was the ability to travel well (*kujenda chenene*). This means that a person now travels with ease – previous obstacles like muddy or dusty roads or long waiting times for transportation services are less prevalent (see Table 1). Other impacts include increased happiness, cheaper transportation options, walking without fear of theft or wild animals, less car accidents, and more bicycle accidents. Observations indicate that the new highway is used for walking, bicycling, herding goats and cattle, selling clothes, sugarcane, and stacks of firewood daily, and for washing clothes. The new highway makes most Malawians I spoke with extremely happy. One traditional healer respondent who lives beside the new highway noted that since the paving, "our lives have changed. We are walking happily" (TH.1).[6] She added, "roads are good. They reduce accidents. The other goodness we are walking nicely. There is no dust. We do not get dirty. We are just walking on tar [the paved road]. You can go to Blantyre to buy things at a wholesale price, then you come back [home] to the village happily. You have traveled on a good road" (TH.1).

Villagers indicated other outcomes from the new highway construction. While the number of car accidents has decreased because of the road paving, the number of bicycle accidents has increased due to the increased attainable speed from riding on asphalt. One Chowe respondent estimated that there is a bicycle accident on the new highway every week. Those who did not feel that the new highway changed their life state that more things are needed than new roads to bring changes. "A person needs more things…in life one needs a lot of things, not only the road" (I.2). Another

respondent noted that the road "has not changed anything because even if I walk on nice road, I can still be hungry. Rather than walk on a nice road while hungry, it is better to not be hungry" (I.4). One Idrusi respondent noted that people whose houses were damaged during construction have yet to be reimbursed.

Many in-depth interviews revealed increasing health concerns in the area, from severe suffering (*kulaga*) to prostitution. Some speculate that sexually transmitted diseases have increased due to the rise in transportation and trucking through the eastern corridor. Bisected by the highway, the Namizimu Forest Reserve is facing unchecked environmental impacts: villagers increasingly are selling firewood to alleviate hunger. Tobacco estates remain unconstrained in their demand for firewood and are known to clear large tracts of the reserve for their flues.

Compared to the certainty of many of the above-stated perceptions of the new highway, villagers in Idrusi and Chowe are less certain about whether the road will impact the Namizimu Forest Reserve: 52% think the new highway *will not* impact the forest, 22% think the road *will* impact the forest, and 27% do not know. Many of those who think it will not impact the forest feel that the forest guards look after the forest and that people traveling the new highway do not go into the forest. Those who think the road will impact the forest, however, believe that the cutting and selling of firewood along the new road to buyers from Mangochi will create problems for the forest reserve. One such respondent noted that the "new road is destroying the natural resources. In the past [there were] more trees there, now there are less. More people come to buy because of the road. People are cutting trees because of the road – this will impact us. The climate will change, rains and firewood will be scarce. We will be suffering. Maybe the rivers will dry" (I.22).

Agrarian livelihoods

The southern region of Malawi holds the majority of Malawi's population. At 12.6 million people (UN 2005)[7] and 117 inhabitants per square kilometer, Malawi has the densest population in southern Africa (FAO 2003). The majority of the population (85%) depends upon agriculture as their primary source of income.

Like many other farmers in Malawi, Yao subsistence smallholder farmers in both Chowe and Idrusi villages grow maize, millet, sorghum, pigeon peas, potatoes, groundnuts, and cassava for consumption. Tobacco is grown as an export crop by both smallholder Yao farmers and by large estates. Fruit trees provide seasonal fruits for both local consumption and sale: mangoes, citrus, avocadoes, bananas, and *Uapaca kirkiana*, known locally as *masuku*, dominate the landscape.

Nearly all respondents noted that access to markets for selling seasonal vegetables and buying goods has improved since the paving of the highway. Ninety-seven percent of survey respondents feel that the Bakili Muluzi Highway is affecting local markets. The most common response was that people are now able to travel easily to local markets. In addition, respondents noted that goods and people are coming from outside areas to sell and that local vendors now sell more.

Though access has increased, surveys and interviews revealed that agricultural yields have not improved over time, and for many, harvests are failing because of drought and lack of fertilizer. During crop failure, *kulaga*, a state of suffering such as extreme hunger, results and poses a serious threat to the livelihoods of these smallholder farmers. In late 2005, it was estimated that over four million Malawians experienced massive food shortages and hunger.

Forest resource use

In Malawi, an estimated 94% of energy demands for fuel and charcoal are supplied by forests. Yet this is not their only use. A wide range of resources can be harvested from the

Women chatting alongside Bakili Muluzi Highway, Idrusi village
Photograph by C. Simmonds, 2005

miombo woodlands to meet both rural and urban needs, including traditional medicine, fodder, rope, fruit, and honey. The word for "medicine" throughout Malawi is the same root word for "tree" – *mtela* and *chitela*, respectively.

The majority of villagers in both Chowe and Indusri villagers go at least once a week to the forest closest to their home to collect firewood and other forest products. Half of all respondents use one headload of firewood per week that is two to three meters long and the other half use two or more headloads per week of the same size. The majority of surveys indicate a high level of dependence on the forest for livelihood (75 to 100% of household income is derived from the forest reserve).

Forest product use differs by gender in Malawi. Men collect bamboo, thatch grasses, *ilingu* or strings, ropes, and small sticks for house construction. They fell large trees for sawing into timbers and smaller trees for building fences and roofs. Men also gather medicines and palm leaves used for weaving grass sleeping mats and baskets. Women principally collect firewood -- 98% of responses from both villages state this, as well as collect grasses, mushrooms, mud for smearing houses during construction, medicines, wild *masuku* fruits, *ilingu* strings, grasses for making brooms, and large rocks for cooking or bathing room construction. When asked who uses the most forest resources, responses were inconsistent -- women and men were both mentioned, as well as the flue-cured tobacco estates that use indigenous wood to cure their harvest, brick makers, and people who sell firewood.

It is important to note that Yao villagers consider forests to be sacred and spiritual places. When asked the meaning of the local forest reserve Namizimu (directly translated to mean "place of the spirits"), responses varied, though most described variations of spirit presence, disappearances, getting lost, and general fears of the place. *Msolo* trees are historical sacred meeting places where gifts are offered to spirits and people ask for things from these spirits. Visiting these trees to *kupesyaga* (worship the spirits) is no longer a frequent practice in an area where Yao villages are predominantly Muslim.

Adjacent to the new highway, the Namizimu Forest Reserve faces encroachment from local villagers, brick burners, tobacco

estates, and harvesters of valuable timber. *Kulaga* is the principle reason villagers cut and sell firewood along the new highway, to earn cash to buy food staples like maize, tomatoes, and fish. The paved road helps to lessen *kulaga* because it provides ready access to markets, more frequent transportation, and market opportunities. Observational and historical findings show current amounts of wood harvested for domestic and commercial purposes are greater than in the past.

Wood is also harvested to furnace the burning of bricks – for household construction and sale. Increasingly tin-roof houses made of burnt brick face the highway, replacing the traditional thrown-mud construction of bamboo, pole, and three layers of termite-resistant soil (*nyumba yophoma*). According to one oral history, when asked to differentiate between the historical and current collection of forest products, "there is a difference now. People are cutting down more trees for burning bricks. More houses as of now they are made of bricks while in the past they were building their houses just using poles. That is the difference now" (OH.4).

Because commercial tobacco farmers require huge amounts of wood for their flues, they are known to clear large tracts of this protected indigenous forest reserve for their tobacco curing needs, in addition to using trees from their woodlots. One elderly assistant to the chief of Chowe village said "because the road is good, people who have cars and need firewood and other things from the forest, they are coming here. They are destroying our trees here. We are worried about this" (OH.5). Compared with the past, some villagers note that access to the forest is changing. "People go frequently – it is shorter to use the tarmac road to get into the forest. People sell firewood because of hunger. Twice a day they go [to collect wood]. This has changed because the business of selling firewood is good" (I.20). Another respondent blames the change on the government's abuse of the forest resources. "Now it is different than in the past because the government destroys resources. Forest guards cut trees and sell them carelessly. If they are given money, they will cut trees" (I.22).

Roads and rising health concerns

Throughout sub-Saharan Africa, a region highly dependent on road transport for trade, road networks pose a major threat to people's health. Studies have found that roads bring

Firewood for sale alongside highway, near Chowe village
Photograph by C. Simmonds, 2005

economic activities to remote areas, most notably trade, tourism, businesses, and prostitution (Chirwa 1998; Orubuloye et al. 1993). A Nigerian study found that 44% of male truck drivers reported having a sexually transmitted disease and having, on average, six regular partners in addition to his wife (Orubuloye et al. 1993). In Malawi, where 15% of the adult population suffers from HIV/AIDS and the average life expectancy is a mere 37 years old, it is crucial to acknowledge how new roads promote the spread of infectious diseases.

Traditional *sinyanga* healers speculate that diseases, like HIV/AIDS, are currently increasing in the area surrounding Malawi's Bakili Muluzi Highway due to the rise in urban-rural movements and the subsequent rise in prostitution. One *sinyanga* noted that "people who are coming from town, they go in the village and spread diseases like AIDS" (TH.1). To her, prostitution is the main contributing factor for this increase in sexually transmitted diseases. Overall, *sinyangas* note a trend that links increasing STDs to people moving more frequently between towns and villages. Furthermore, prostitution is increasing because of a breakdown in communication between parents and children. According to one *sinyanga*, "children are not following the advice from parents that they should walk well" (TH.1). They should, she means, take care of themselves and avoid sleeping with men.

Most *sinyangas* reported that sexually transmitted diseases have increased over time because of prostitution. Roads themselves are not viewed as paths for diseases to spread. *Kulaga* is the reason that some girls turn to prostitution. "Some girls, they are poor at their homes. They do prostitution in order to get help – in terms of food" (TH.1). Earnings from prostitution temporarily alleviate the state of *kulaga*, providing a means to buy maize and other domestic supplies.

What will be the long-term health impacts of opening this eastern corridor to trucking and transportation networks by the paving of the Bakili Muluzi Highway? One respondent feels that the number of prostitutes is decreasing as girls "have started listening because more people are dying with AIDS" (TH.6). While this sobering fact may be true, it is clear that the prevalence of diseases link the new highway to human health – a high prevalence of STDs results from prostitution, increasing urban-rural and rural-urban movements, *kulaga,* and a general break-down in communication and advice-giving between parents and children. Such shifts in Yao society are indicators of the road's impacts on a local community.

Conclusions: Roads and Their Unintended Side Effects

...roads link the village with the outside world in a way which is qualitatively different from the links implied by the flow of goods and people along local pathways – Fairhead 1992: 21

This research demonstrates the inherent linkages between agricultural livelihoods, forest resource use, health concerns, and the paving of a road in Malawi. Findings indicate that roads are complex constructions that not only change the physical landscape they traverse, but also deeply impact perceptions and trends, or the social landscape of a rural region. Local perceptions and local appropriation of the new highway appear to be the "unofficial outcomes" of this road building intervention in Malawi. The increasing spread of diseases, deforestation, and the rising rates of accidents are unintended "side effects" of road building (Ferguson 1994) that need to be acknowledged by the Malawian government.

Using the Bakili Muluzi Highway as a case study, it is necessary to question the process that brought the road to this place at this time. Why this route? Why now? For whom or for what purpose does this road truly serve? Clearly commercial tobacco interests are significant. Mr. Kumangirana, the Director of Roads, states that the Bakili Muluzi Highway was designed to

help transport tobacco because the area surrounding the highway has, "the best soils on tobacco and agriculture." For Kumangirana and the Malawian government, "transport was seen to be one of the headaches in that area." The Bakili Muluzi Highway, in his view, cures that headache. Roads, often espoused as being neutral constructions, are, in fact, economically and politically charged state interventions.

For the local villagers, the new highway symbolizes modernity and development to those who live beside the paved road. Idrusi and Chowe villages are now considered more developed and more like "towns" because of the paving of the Bakili Muluzi Highway. When one respondent was asked what change she expects to see in the area in the future, she said, "in twenty years time here it will be fine. We will be like in South Africa. It will be beautiful" (TH.1). The Bakili Muluzi Highway represents more than a new transportation artery. For many, it symbolizes a dirt-free modern link to the rest of the country. For others, it is a path where one must take caution and walk well.

The study of a road becomes the lens with which to view the movements and flows of the rural populace in Africa. Roads define the linkages between resource access, livelihoods, and social relationships. They are powerful change-agents: "the technology of road transport is such that it has greater potential for involving more people in a wider variety of endeavors than any other form of transport. It therefore has an influence on attitudes and abilities that cannot be captured in any calculation of net benefits" (Wilson 1966: 201). The space that roads create is more than mere pavement. It is farmers walking happily and selling firewood to passing cars. It is the unpredictable threats of prostitution and accidents. It is a remedy for transportation planners' and tobacco growers' headaches. Roads are myriad perceptions, trends, outcomes, and expectations.

Acknowledgements

This research was made possible with funding from TRI-ALAM, the Teresa Heinz Environmental Research Scholarship, the Program in Agrarian Studies, and the F&ES summer internship fund. I would like to thank the following people for their insight and assistance from the project's inception to its completion – Michael Dove, Amity Doolittle, Diane Russell, Ian and Wendy Dicks, Jim Anscombe, the Matola family, and the Mangochi family. Mathews Haward was my invaluable research assistant and without his help, this research would not have been possible. To the many people I interviewed, surveyed, and spoke with in Idrusi, Chowe, and Kwitunji villages and while walking and waiting along the roadside, I am indebted to you for your assistance, patience and wisdom. *Sikomo kwejinji wandu wosope*.

Endnotes

1 The 1.2 million Malawian Yao belong to three main clans: Amachinga, Amangoche, and Amasaninga. Research was conducted among the Amachinga who will be referred to simply as the "Yao" throughout the article. The Yao ethnic group comprises 13% of Malawi's population and is the predominant ethnic group in the southern region. The Yao, like the majority of Malawians, are smallholder farmers who tend 2-5 acre farm plots with maize, cassava, and sweet potatoes for household consumption and tobacco, a major cash crop.

2 http://www.cia.gov/cia/publications/factbook/geos/mi.html#Trans, viewed 10/25/05.

3 Malawi has a total land area of 9,408,000 ha with 27.2% of the country's land area in forest cover (FAO 2003). There are 82 forest reserves throughout Malawi that are managed by the Forestry Department. Miombo woodlands comprise 85% of Malawi's forests and contain a high diversity of plant species: 334 species are trees and 8,500 species of higher plants have been recorded with 54% endemic (Frost 1996).

4 Foreign investments were provided by BADEA, the Arab Bank for Economic Development ($27 million to be repaid in 25 years), the Kuwait Fund ($13 million), and OPEC ($13 million). The Malawian government contributed $5.24 million for the project.

5 http://ydmh.foreigntrade.gov.tr/pazar/AFRIKA/Diger/malawi.htm, viewed 4/30/05.

6 TH.1 is the first traditional healer interviewed, OH is oral history, and I.2 is Idrusi survey respondent number 2, etc.

7 http://news.bbc.co.uk/1/hi/world/africa/country_ profiles/1068913.stm#facts, viewed 4/15/05.

References

Baker, C.A. 1971. January. Malawi's Early Road System. *The Society of Malawi Journal* 24(1): 7-21. Blantyre, Malawi: The Society of Malawi.

Chirwa, W.C. 1998. Aliens and AIDS in Southern Africa: The Malawi-South Africa Debate. *African Affairs* 97: 53-79.

Cole-King, P.A. 1972. Transport and Communication in Malawi to 1891, with a Summary to 1918. Pp 70-90 in *The Early History of Malawi*, edited by B. Pachai. Evanston, Ill: Northwestern University Press.

FAO. 2003. *Forestry Outlook Study for Africa: Subregional Report - Southern Africa*. African Development Bank, Food and Agriculture Organization of the United Nations, European Commission.

Fairhead, J. 1992. Paths of Authority: Roads, the State and the Market in Eastern Zaire. *European Journal of Development Research* 4(2): 17-35.

Ferguson, J. 1994. *The Anti-Politics Machine: "Development," Depoliticization, and Bureaucratic Power in Lesotho*. Minneapolis: University of Minnesota Press.

Frost, P. 1996. The Ecology of Miombo Woodlands. Pp 11-57 in T*he Miombo in Transition: Woodlands and Welfare in Africa*, edited by B. Campbell. Bogor, Indonesia: Center for International Forestry Research (CIFOR).

Orubuloye, I.O., P. Caldwell, and J.C. Caldwell. 1993. The Role of High-Risk Occupations in the Spread of AIDS: Truck Drivers and Itinerant Market Women in Nigeria. *International Family Planning Perspectives* 19(2): 43-48 & 71.

Perry, J. 1969. July. The Growth of the Transport Network of Malawi. *The Society of Malawi Journal* 22(2): 23-37.

Porter, Gina. 1995. The Impact of Road Construction on Women's Trade in Rural Nigeria. *Journal of Transport Geography* 3(1):3-14.

Porter, Gina. 2002. Living in a Walking World: Rural Mobility and Social Equity Issues in Sub-Saharan Africa. *World Development* 30(2): 285-300.

Thawani, F. 2005 (18 May). "Road Safety: Shared responsibility," *The Nation.*

Unetec. 1998. *Economic Feasibility Study for Selected Rural Roads*. Kuwait: Unetec Consultants.

UN. 2005. Retrieved April 15, 2005 from http://news.bbc.co.uk/1/hi/world/africa/country_profiles/1068913.stm#facts.

Wilson, Fiona. 2004. Towards a Political Economy of Roads: Experiences from Peru. *Development and Change* 35(3): 525-546.

Wilson, G.W. 1966. Toward a Theory of Transport and Development. Pp 190-218 in *The Impact of Highway Investment on Development*, G.W. Wilson, B.R. Bergmann, L.V. Hirsch, M.S. Klein (eds). Washington, D.C.: The Brookings Institute.

Assessing Access to Potable Water in Rural Communities in Costa Rica

by Kristen Welsh, MESc 2006

Introduction

Water is one of the earth's most vital resources and central to everyday life, yet poor management threatens its finite supply (UNESCO 2003). In many countries, rivers serve as the most accessible resource for water consumption, which highlights the need for proper watershed management (UNESCO 2003). Without appropriate plans for its sustainable usage, water is at risk of increased scarcity and decreased quality. Watershed degradation is of particular concern in Central America (Johnson and Baltodano 2004). Specifically, Costa Rica has recently faced many watershed issues due to a rising population growth and an increased demand for clean drinking water, combined with unsustainable land use practices (Sanchez-Azofeifa et al. 2002). While 97.5% of Costa Ricans have access to water in their households, 40% of the water provided by municipalities or communities is not potable (Segura Bonilla et al. 2004).

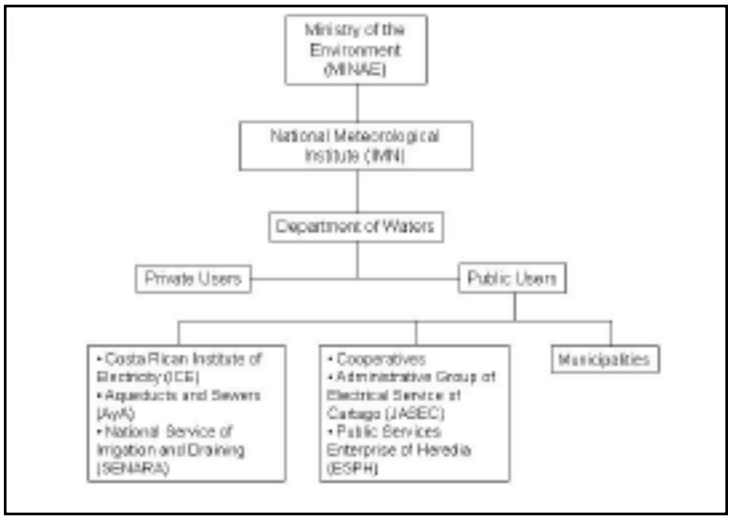
The government agency Aqueducts and Sewers (known by its Spanish acronym AyA) manages water provisions and services in Costa Rica. Municipality connections, overseen by AyA, are often implemented in large cities and towns, which are highly populated areas that benefit from these connections. However, since many remote towns in Costa Rica lack the resources to supply their residents with public water, I conducted a study in rural communities in the southwestern region of Costa Rica to assess household water usage and access to potable water. As a component of this research, I interviewed rural household members and representatives of several governmental agencies involved in water provision and legislation within Costa Rica. In addition, I sampled two local rivers and their tributaries to evaluate water quality, as people often access these for household consumption. This article will specifically address one aspect of my research: the information revealed about drinking water through interviews of government agencies and households.

Kristen Welsh is originally from Massachusetts and holds a degree in Spanish and Environmental Studies from Tufts University. She worked in the environmental consulting field prior to attending F&ES. Kristen is interested in pursuing water-related work in Latin America in the future.

Management of Water Services in Costa Rica

The administration of water provision in Costa Rica is conducted through the Water Department, a subdivision of the National Meteorological Institute (IMN), which is part of the Ministry of the Environment and Energy (MINAE). MINAE, which is similar to the U.S. Environmental Protection Agency (USEPA), oversees environmental regulation throughout the country. Figure 1 illustrates the organizational structure of water administration in the country. According to MINAE representatives, no existing laws address the issue of sustainable water management in Costa Rica (Alvarado, pers. comm., June 1, 2005), since Water Law No. 276 of 1948 only grants MINAE the power to regulate concessions and water permits. New legislation that would address water issues and infrastructure throughout the country, the Hydrologic Resource Law, is currently under review by the country's legislature (Alvarado, pers. comm., June 1, 2005).

Figure 1. Organizational structure of water provision in Costa Rica



Source: MINEA, IMN, and the Department of Waters. El Recurso Hidrico en Costa Rica. Informational Pamphlet

AyA functions separate from MINAE to provide drinking water to the country. Many municipalities provide water services to residents by requesting the concession of a water source from MINAE and then distributing this water to households (Alvarado, pers. comm., June 1, 2005). For those municipalities without established water services, AyA controls water provision. Table 1 lists the organizations that provide water coverage throughout Costa Rica.

In general, rural communities do not have municipal government systems that can oversee water provision for households. Historically, rural households have collected water from nearby streams and rivers, but AyA recently initiated a program in 2000 to support rural communities that wanted to institute water provision in their area (AyA 2005). Communities are required to organize into community association groups called Administrative Associations for Sewers and Aqueducts (known by their Spanish acronym ASADAS) to be eligible to receive AyA support to build and operate their system. AyA generally supplies tubes, accessories, and engineered designs, while the communities provide the manual labor and construction materials. AyA also trains local leaders who manage the associations (Arrieta, pers. comm., May 31, 2005). Although management rests largely with community members who, at times, do not have specialized knowledge of water provision services, the associations supply water provision. These associations now provide almost one-fourth of water provision in the country (see Table 1).

Study Area

This study focused on rural communities within the Path of the Tapir Biological Corridor (PTBC) in the southwestern region

Table 1. Provision of water in Costa Rica by operator (*adapted from Segura et al. 2004)*

Operator	Percent Coverage	No. of Aqueducts
AyA	46.3	170
ASADAS	23.7	1648
Municipalities	16.4	245
Private Operators	6.2	-
ESPH	4.7	6
Total	97.3	2069

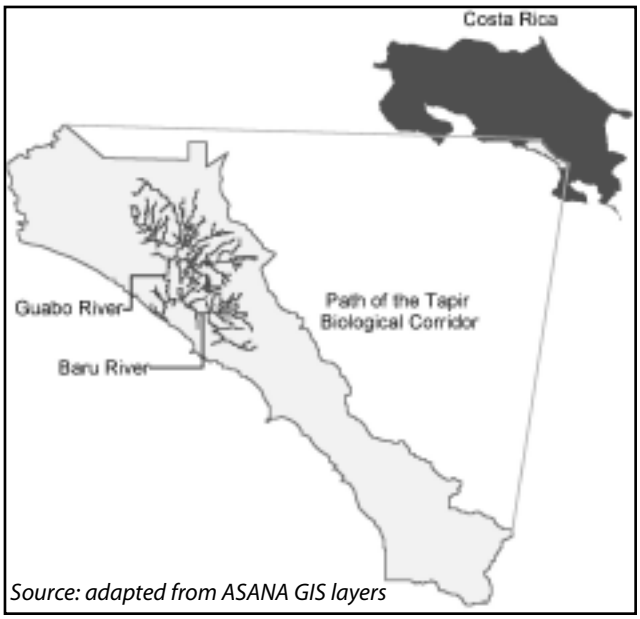


Figure 2. Location of the Baru and Guabo Rivers within the Path of the Tapir Biological Corridor in Costa Rica

of Costa Rica. The non-profit organization, Association of Friends of Nature of the Central and South Pacific (ASANA), the collaborator for this project, has developed programs to preserve natural habitats in the PTBC. The corridor is recognized as part of the Mesoamerican Biological Corridor, which was established to link critical habitats from Mexico to Panama to preserve biodiversity (Miller et al. 2001). Migration of many people to the area and the resulting increase in agriculture has caused a rapid loss of forest cover and the local extinction of several species (Ewing 2000). To protect this area of the country, a group of landowners formed ASANA in 1987 and, subsequently, the PTBC in 1996 (Ewing 2000).

In the heart of the PTBC lie the Baru and Guabo Rivers, which stretch for miles before converging and flowing together for another two miles until they empty into the Pacific Ocean near the town of Dominical. This study focuses on these two rivers and their primary tributaries, the Barucito River and the Caña Blanca River. I interviewed a total of 79 residents of the 15 major communities within these watersheds. I also interviewed an additional 10 households in two communities outside these watersheds. Figure 2 is an illustration of the region where this research was conducted.

These rivers were selected due to their importance in the region, in addition to environmental concerns associated with them. In particular, the Guabo River has experienced significant deforestation compared to the Baru River. Agriculture has become an important land use in recent years, and agriculture fields and cattle populate the landscape where trees once stood. At the rivers' confluence, the Guabo waters taint the relatively clear waters of the Baru with murkiness and turbidity. Residents in the area expressed concern about this seemingly dirty water.

Interviews

At each household, I asked questions that addressed water usage, water access, water quality, and potential impacts residents may have on local rivers, addressing the following topics:

Water Usage: type of personal water use, level of river water use

Water Access: type of service connection, access to potable water, water rationing, limitations of current system

Water Quality: aesthetics of household water, water-related illnesses, perception of household water quality

Impacts on Rivers: land use practices within watersheds, potential pollution of rivers

River Health: changes in conditions over the years, perception of river water quality

Results of Household Interviews and Discussions

Community members proved to be a valuable resource in identifying water quality problems. Interviews revealed that the majority of these rural residents receive their water by public means, either through municipal service or through local ASADAS, but nearly one in five people obtain water independently, directly from streams and rivers. In these households, the family typically places a tube in the nearest spring or stream and pipes the water to their home. For systems built by ASADASs, water is piped from springs to a holding tank (Figure 3), where it sits for many days to allow sediment to settle and chlorine to disinfect it.

Most household users, whether they have public or individual sources, perceive their water as clean, as 82% confirmed when asked if their water was potable. Considering that 40% of Costa Ricans do not have access to potable water, both in rural and municipal settings (Segura Bonilla et al. 2004), this number indicates that residents think their water is safe to drink, even if it may be of poor quality. The majority of people – 83% of those interviewed – did not treat their water, but those who did obtained their water both publicly and independently.

I asked each interviewee to rank the quality of their drinking water. After they spoke about unpleasant taste or color and bad service connections, it was surprising how highly people rated their drinking water. Approximately 84% ranked it positively (excellent, very good, or good), 11% ranked it regular, and only 3% ranked it negatively (bad, very bad, or worst). Of the 84% that ranked their water positively, 80% had at least one complaint. These numbers indicate that the majority of residents think their water is safe to drink, even if it may be of poor quality. One woman revealed that the nearest spring where she obtained her family's water was located alongside a pasture, but when asked whether she had concerns about the cattle that grazed nearby, she responded that the water was still clean. Minutes later, I met a man who was informing the neighborhood that this water source was in fact contaminated. This woman,

Figure 3. A storage tank built by one community's local ASADA. Water from a nearby stream is piped to this holding tank where chlorine is used to disinfect the water before it is distributed to households

Source: Kristen Welsh, 2005

and many others, either trust their sources or do not see room for improvement.

After receiving information that a nearby town, Hatillo, was experiencing problems with their water supply, I interviewed several households in the community even though it was outside my original study area. The community's ASADAS provided households with water from a nearby spring, but many people had contracted stomach aches and other related illnesses. One family explained how they "tested" their household water themselves one time by leaving a glass of water on the counter. After a few days, sediment had settled at the bottom of the glass, and bugs that were once miniscule had grown larger in the water. They now treat their water with a purifier, but they said that if they forget to use it, the children get very sick. Another mother reported concern for her three children because of the water supply. "I buy bottled water, but it doesn't matter. They give the children community water in school. The doctor said that they all have parasites in their stomachs because of the water."

Recommendations

While these interviews only represent issues faced by communities within the study area, the problems identified indicate that basic water provision is not succeeding in some rural regions of the country. Based on information provided by government agencies, regulation provided by the outdated Water Law No. 276 is lacking. As indicated by MINAE Water Department representatives, no other water legislation exists in the country, and this is a major failure between government and communities. An updated law, the Hydrologic Resource Law, is awaiting approval by the Legislative Assembly.

The establishment of ASADAS arose from the need to provide water to rural communities, but more government support is necessary to ensure success. ASADASs require construction, operation, and maintenance of the system to be performed by community members who often lack the appropriate knowledge and expertise. Through interviews with ASADAS representatives, I discovered that many people in charge of maintenance and water supply also hold full-time jobs. Although these individuals receive a small stipend for the work they perform, the system may be more effective if operated by full-time employees.

Twenty-one percent of families interviewed access water directly from local streams, and a small percentage of respondents (6%) with water connections said they access water directly from streams when they experience service disruptions. This illustrates the need to expand connections in rural communities and prevent lapses in services, which would discourage people from taking water directly from streams. Otherwise, river water quality needs to be improved or people need to start treating their water.

In a country with abundant water resources, a significant number of people are receiving poor quality water. In this region of Costa Rica, many households identified poor aesthetics, poor service, and family illnesses related to their water supply. This situation can be improved by giving AyA the responsibility for providing all households, both urban and rural, with water services and by requiring improved water treatment and more rigorous water quality testing by the ASADAS, which currently are required to submit only two water samples a year.

Finally, community members could be more proactive, by voicing their concerns to ASADAS when they experience service problems, and by otherwise getting involved in their local association. Such a change would require public education.

Acknowledgements

This project was made possible through the support of numerous individuals. I would like to thank Alvaro Redondo Brenes for his constant help throughout the entirety of this

project; Shimon Anisfeld for project advising; Cristian Valenciano and Jack Ewing for their collaboration; Quint Newcomer for the hours spent sharing his knowledge; Colleen Morgan for important feedback in drafts of this article; and Amity Doolittle, Dana Tomlin, Roy Schiff, Marina Campos, Jeffrey Nangle, and Marvin Obando for their consultation and assistance. This research was made possible through the Tropical Resource Institute and the Yale F&ES Summer Fund.

References

ASANA. 2005. Corredor Biológico Paso de la Danta. Data available at http://www.pasodeladanta.org. Accessed 21 October 2005.

Acueductos y Alcantarillados (AyA). 2005. Convenios de Construccion (AyA – ASADAS). Accessed 5 December 2005. Data available at http://www.aya.go.cr/images/ley8220/Cede_Central/htm/tl-4.htm.

Ewing, J. 2000. Speech to ASANA membership. In Rodríguez, ed., Corredor Biológico Paso de la Danta. The Nature Conservancy, San José, Costa Rica.

Johnson, N.L. and Baltodano, M.E. 2004. The Economics of Community Watershed Management: Some Evidence from Nicaragua. *Ecological Economics* 49: 57 – 71.

Miller, K., E. Chang, and N. Johnson. 2001. *Defining Common Ground for the Mesoamerican Biological Corridor*. World Resources Institute, Washington, D.C.

Sanchez-Azofeifa, G.A., R.A. Harriss, A. Leontien Storrier, T. De Camino-Beck. 2002. Water Resources and Regional Land Cover Change in Costa Rica: Impacts and Economics. *Water Resources Development* 18(3): 409 – 424.

Segura Bonilla, O., Miranda Quirós, M., Astorga Espeleta, Y., Solano Mora, J.E., Salas Pinel, F., Gutiérrez Miranda, M., Dierckxsens, M., Cespedes Mora, M.M. 2004. Agenda Ambiental del Agua en Costa Rica. Fundación CR-USA, Costa Rica.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2003. Water for People Water for Life: The United Nations World Water Development Report. Barcelona.

Source: Rhind, William. 2004. **The Vegetable Kingdom.** ***Fine Rare Prints. Available at: www.finerareprints.com***

Mitigation or Manipulation?

"Side Effects" of Dam Mitigation Measures on Indigenous Communities

by Ikuko Matsumoto, MESc 2005

Introduction

The negative impacts from dam construction have been discussed for many years. Thayer Scudder insists "[t]he adverse social impacts of large dams have been seriously underestimated" (Scudder 1997a: 63). Large dam projects have brought enormous criticism from civil society as well (McCully 2001). Due to this onslaught of criticism, dam project proponents now have to (1) recognize and manage the social and environmental impacts of construction and (2) legitimate dam construction with "appropriate" mitigation measures and a monitoring program which applies a participatory, bottom-up development process. Proponents of dam building are also attempting to create social development projects that generate "benefits" for the affected communities, which will counterbalance the present negative environmental impacts. The World Bank's Environmental Assessment (EA) policy "identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts" (WB 1999: 1). Development agencies also believe that adverse impacts can be mitigated and managed throughout project implementation (WB 1999). However, with the development of these mitigation measures, questions arise as to whether the negative impacts on local communities have been truly alleviated. Have communities received benefits, or have they been negatively impacted by these social development projects?

In the case of the San Roque Multi-Purpose Dam Project in the Philippines, mitigation measures and social development projects in the affected communities actually escalated corruption in the communities and created conflict among communities and families. This paper focuses upstream of the San Roque Dam Project on the indigenous communities in *barangay* (village) Dalupirip and *barangay* Ampucao (members of the Ibaloi indigenous tribe) in the Itogon municipality and attempts to uncover how mitigation measures failed to achieve their goals and why. Analysis is based on field research and interviews conducted in the Philippines and Japan from June to August 2005, documents collected during field research, and the author's involvement with advocacy activities on the San Roque Dam Project from 1998 to 2004 as a program director of an NGO in Japan.

Ikuko Matsumoto, born in Japan, has worked as a program director of Friends of the Earth Japan. She also has worked with local communities in the Philippines, Malaysia, Indonesia, and Thailand, and has advocated for the Japanese government to move towards more sustainable financial policies for developing countries.

Background

The San Roque Multi-Purpose Dam Project is located on the Agno River in northern Luzon Island, Philippines. The dam structure is located in Pangasinan province and its reservoir and watershed area are located in Benguet province, southern Cordillera mountain region. The earth and rock-filled dam creates a 12.8 km^2 reservoir area and the dam itself is 1,100 m long and 200 m high, making it the 12^{th} highest embankment dam in the world. Its

Barangay Dalupirip along the Agno River *Photograph by I. Matsumoto.*

estimated construction cost is $1.2 billion (Osmun et al. 2001; IWPDC 2001). The purpose of the project is power generation, irrigation, flood control, and water quality improvement. The dam is a privately-facilitated electricity project under the Philippine's National Power Corporation (NPC), which contracts with an international consortium, the San Roque Power Corporation (SRPC), and is financed by the Japanese Export Credit Agencies, the Japan Bank for International Cooperation (JBIC)[1] (RWESA et al. 2003).[2]

The dam is located at the foot of Cordillera mountain, home to around 1.2 million indigenous people collectively called Igorots, meaning "mountain people" (Molintas 2004: 4-5). The Ibaloi people are one group among the Igorots and are affected by the dam project. One of the affected indigenous areas, where *barangay* (village) Dalupirip was located, was called the "rice basket" of this region in the years of World War II (Afable 1999a). People created villages along the Agno River, and rice terraces spanned the whole valley. In addition to farming, people relied on gold panning, honey gathering, and eel fishing for subsistence and income. After the construction of two dams, Ambuclao Dam and Binga Dam on the Agno River in 1956 and 1960, many of the villages, rice paddies, vegetable gardens, and gold panning sites along the Agno River were lost. This was due to the accumulation of silt along the river bank upstream of the reservoir, which was mainly caused by mountain erosion and industrial mining. Therefore, the neighboring indigenous communities lost major sources of income due to the dam projects. The Philippine government, however, did not adequately compensate these people for their losses (Carino 2000).

In the 1950s, there was a proposal for another dam on the Agno River. After an appeal by the indigenous communities, however, President Magsaysay and a later president, Fidel Ramos, pledged that the new dam would not be built in the indigenous communities in Itogon (Afable 1999a). In the 1970s the Cordillera indigenous peoples widely rejected a World Bank-funded series of dams along the Chico River that would have displaced 90,000 Bantok and Kalinga people (Molintas 2004: 5). However, yet another Agno Dam, the San Roque Dam, was planned just a few kilometers downriver from Itogon municipality, "in politically much safer territory" (Afable 1999a). Local indigenous communities were strongly against the San Roque Dam and sought the help of national and international NGOs to support their opposition to the project (RWESA et al. 2003).

Mitigation Measures for Indigenous Communities

To persuade civil society and the local government and then gain political support for the project, the presidential office of the Philippines and JBIC required additional social and environmental standards for the project, particularly addressing indigenous people's issues. Ultimately, the San Roque Dam Project consisted of comprehensive, participatory mitigation measures and social development projects for the indigenous communities. However, how did these comprehensive mitigation measures work in the field? The outcome of land compensation, the watershed management project, and the social development projects are explored further in this paper.

Land compensation

The Philippine government committed to apply the Indigenous Peoples Rights Act (IPRA), a newly established law in 1997, to enforce land compensation for the Ibaloi indigenous community (NPC et al. 1999). IPRA is considered a landmark in legislation for indigenous people, recognizing what indigenous peoples in the Philippines have long been fighting for -- the right over their ancestral domain, social justice and human rights, self-governance, empowerment, and cultural integrity (Molintas 2004). Indigenous people's lands in Itogon are recognized as "public domain" since they are located within the governmentally designated "watershed area." Indigenous people, therefore, do not have any legal rights to the land they historically lived on (Prill-Brett 1994). However, to compensate for the San Roque Dam, the Philippine government decided to replace the land titles and then pay for the taken land by following indigenous land titles (NPC et al. 1999).

Watershed management project

The watershed management project was established to obtain Itogon municipality's endorsement of the San Roque Dam Project. Its formal purpose was to reduce erosion on the mountains. One of the conditions states that "the NPC and DENR (Department of Environment and Natural Resource) shall adopt [a] Watershed Management Plan using a bottom-up approach starting from the *barangay* level" (Municipality of Itogon 1999: 1). The project aims to achieve community forestry management and consists of forest protection, biodiversity conservation, land tenure improvement, soil and water conservation, livelihood projects (projects to improve household income such as skill training, livestock raising, cooperatives), research and development, and community organization. To address villagers' requests, the reforestation project also includes agroforestry projects to plant fruit trees, such as mango, coffee, banana, and papaya, in open areas (IIWMP 2001).

Social development projects

Other major mitigation measures for the dam project are social development projects in the affected communities, mainly in the Itogon municipality. The goal of these projects is to cover expenses for daily community needs and to create positive impacts from the dam project. They were implemented based on requests from either the Itogon municipality or each *barangay* and included projects such as paving roads between indigenous communities, creating an electrical grid in Itogon, fixing bridges, improving small scale irrigation canals, installing community-owned agricultural machines, improving school facilities, and supporting teachers' salaries.

Consequences of Mitigation Measures

At first glance, the San Roque Dam mitigation measures for indigenous communities were executed more carefully than other development projects in the Philippines. Even so, it is important to assess how these mitigation measures been

executed thus far. Despite the elaborate measures, the projects actually escalated corruption and conflict among indigenous communities.

Land compensation

Among the mitigation measures, the land compensation plan created the most serious conflicts and increased corruption among communities and families. Molintas, a lawyer in the Philippines working on indigenous rights issues, asserts that "the differences in the concepts of land ownership and management between the State and the indigenous peoples in the Philippines have led to a massive land grab of indigenous people's domain" (Molintas 2004: 14). Since the indigenous people's land certification process under the new Indigenous People's Rights Act (IPRA) was new to everyone, extremely complicated, and required many written documents, people had to hire lawyers to prepare the documents to obtain land compensation. The Cordillera People's Alliance, a regional alliance of indigenous people's organizations, raised concerns that "the process [of IPRA] is just as complicated, costly, time-consuming and exhausting as those provided for in earlier law" (CPA and DINTEG 1998: 15). Molintas states that "many indigenous peoples are not aware that there is such a thing as land titling" (Molintas 2004: 14). Thus, in the case of the San Roque Dam, middle class, well-educated people who have enough money to hire lawyers and a basic knowledge about the new legal system received certificates for indigenous people's land title and were compensated quickly for their land. This created serious conflict among communities. Many middle class people, regardless of whether they actually owned the land before, received certificates for land, which left many people who originally owned land without property. One villager said "they made money out of us."

There are now several legal cases regarding ownership of indigenous land. However, this is restricted to a certain number of people; most can do nothing about losing their land. The rapid application of IPRA changed and distorted local political power and created more serious problems in the indigenous communities.

Watershed management project

For many generations, people in southern Cordillera have raised cattle for a living. This has led to the burning of hillsides to allow for new forage to grow (Afable 1999b). Despite the community-based watershed management project, reforested mountains are burned two to three years after reforestation efforts, so there is no perceivable progress in the reforestation of the mountains. Thus, the mountains around Agno River are still bare of trees. In addition, it is said that some villagers light fires on the mountains to produce more reforestation jobs. The JBIC and its consultants found minimal improvements created from the watershed management project, which was attributed to negligible local community capacity to manage the project (JBIC 2005).

However, another cause of failure is due to indigenous people's skepticism about state control of their domain and land in the watershed management projects. From the Binga and Ambuklao Dams, Ibaloi people already experienced a reforestation project under the dams' Watershed Reservation Regulations, which led to the restriction of land use within the watershed reservation. The regulations state that "no person shall be allowed to enter and/or occupy watershed reservations and make *kaingin* (swidden farming) therein without the prior approval of the Ministry" (Carino 2000: 24). All watershed occupants were also threatened with the closure of watershed reservations from "exploitation, occupancy or development" whenever the Minister deemed it "in the public interest" (ibid.: 24). Therefore, for indigenous people, there is no motivation to cooperate in a process where the state occupies the people's domain and land under the name of "watershed management projects."

Social development projects

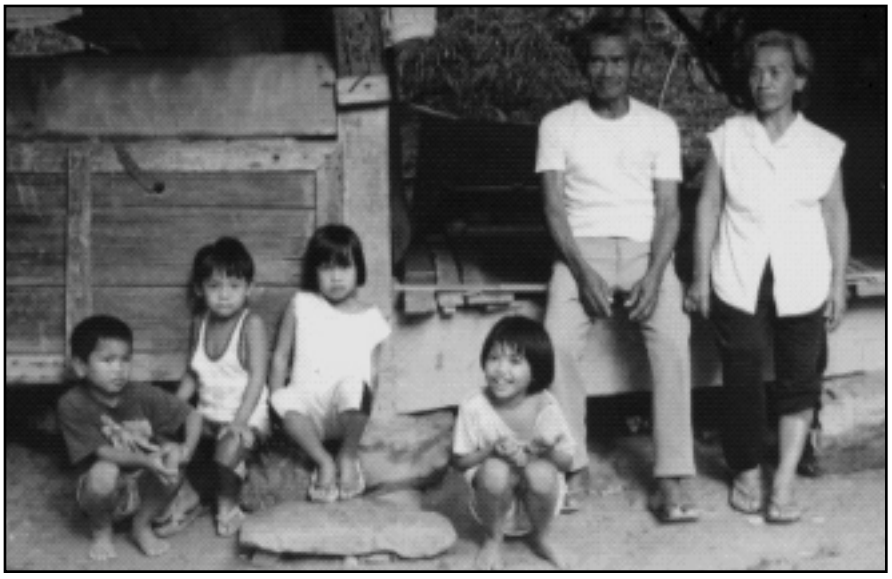
Dozens of social development projects were created to assuage the communities. However, villagers told me that municipality and *barangay* officials and associates have been pilfering money from each of the small development projects. Some villagers claim that because of the local government officials' lack of honesty, road-paving and bridge-fixing stopped in the middle of the project. Corruption within the social development projects has a large impact on the villagers due to their marginal income from subsistence farming and gold panning. The corrupt officials, suspected of using the laundered project money, built themselves large, new concrete houses that villagers called "San Roque houses." Thus, the relationships among local government officials, their associates, and other villagers took a turn for the worse.

Local perception of projects

Most locals believe that mitigation measures and these "beneficial" projects have a negative effect on communities. A resident in the *barangay* of Dalupirip, mentioned that it is a shame villagers are content with these short-term projects, since they and their descendants will suffer from the long-term effects of the dam project, such as river siltation. One of the *barangay* leaders in Dalupirip who opposes the dam said, "before several development projects came into Dalupirip together with the San Roque Dam, the community was more independent from the state government and we had rigorous autonomy in Dalupirip. We made decisions by ourselves and people supported and respected each other. However, after all these land compensation, watershed management project, resettlement project, and social development projects, Dalupirip are not Dalupirip like before any more." An elder of Dalupirip said "because of the San Roque dam project, I feel we have more negative impacts rather than the benefit in Dalupirip, even with abundant development projects."

Conclusion

Despite elaborate mitigation measures, the dam projects actually created conflicts among communities and families, strengthened government control, escalated corruption in the communities, and diminished indigenous peoples' autonomy. Patrick McCully argues that: "Some mitigation measures can reduce some of



Ibaloi Indigenous people in Daluprip
Photograph by I. Matsumoto

the harmful impacts of dams, others may be worse than useless" (2001: 49). Scudder also asserts through his study in Canada that, though there were several social development programs, "the overall impact has been negative" (1997b: 641).

Projects that were supposed to mitigate negative impacts and bring benefits to the communities led, in fact, to social deterioration. It is ironic that mitigation measures *per se* disturbed the dignity and rights of indigenous people. The application of IPRA for land compensation created serious conflicts among indigenous communities due to "land-grabbing" by "powerful individuals" (UN 2003). James Scott insists "in dictatorial setting[s] where there is no effective way to assert another reality, fictitious facts-on-paper can often be made eventually to prevail on the ground" (1998: 83). Indigenous land certification, obtained through a pile of legal documents, thus distorted customary land rights. The watershed management project has made little progress in reforesting the southern Cordillera mountains; however, it has strengthened state control of the indigenous people's lands. Ferguson insists that "development" achieves bigger political mandates through its "side effects" (1994). Ibaloi indigenous communities explicitly unified through "development" projects and the state strengthened its control over the southern Cordillera mountain region through watershed management projects. Paved roads, sturdy bridges, electric grids, new agriculture machinery, and more solid school buildings: these are tempting development projects for rural villages in the Philippines.

Indigenous communities tend to keep quiet about their opposition to mega-hydropower projects to obtain these social development projects and try to ignore the problem that siltation along the river will create in the future. Moreover, social development projects accelerated corruption and conflict among the indigenous communities.

Michael Goldman asserts: "The environmental projects are the legitimizing vehicle of the dam: without a strong public commitment to environmentally sustainable development, the World Bank and its counterparts would encounter robust resistance" (Goldman 2005: 201). The social and environmental mitigation measures of the San Roque Dam became not only propaganda from the Philippine government, the private sector, and the funding agencies, but also a tool to legitimize the project. In other words, mitigation measures for the San Roque Dam became a necessary and adequate tool for them to secure legitimacy for being involved in a destructive project and to avoid accusations from the public. These mitigation measures are also "facts-on-paper" (Scott 1998: 83) to avoid accusations from the public and tend not to work on the ground.

Moreover, the Philippine government, the private sector, and the funding agencies utilized mitigation measures to manipulate civil society. Robert Wade and Michael Goldman strongly criticize the "greening" and "green neoliberalism"[3] of the World Bank (Wade 2002; Goldman 2005). I argue that "green neoliberalism" is not only a "powerful framework for intervention" used by the World Bank, but also by other financial agencies to some extent, such as bilateral development agencies, Asian Development Bank, European Development Bank alike. While funding agencies push "civil society agendas" of social justice and environmentally sustainable development, they legitimize their lending to mega-development project and push neoliberal "financial ministry mandate"[4] with economic development. In the case of the San Roque Dam, one of the biggest missions of the JBIC is expanding overseas business opportunities for Japanese companies. That is nothing less than neoliberal economic policies of Japan. We need to urge international and bi-lateral financial agencies to ensure the civil, political, economic, social, and cultural rights of local communities on their develop-

ment and challenge them to reform their neoliberal "financial ministry agenda."

Acknowledgements

Many thanks to the people in Dalupirip, in particular Norma Mooy and Luisa Begitan, and all the staff of the Cordillera People's Alliance (CPA), in particular CPA's chair person Joan Carling. Thanks also to the Yale Tropical Resources Institute, the Yale Program in Agrarian Studies, the Council on Southeast Asia Studies at Yale, and the F&ES Summer 2005 Internship Fund, whose generous funding made this research possible. I also want to say thanks to my advisor, Carol Carpenter, and to the editors of this volume. James C. Scott and Michael R. Dove gave me profound comments on this paper and I want to say thanks for them.

Endnotes

1 JBIC established by merger between the Export Import Bank of Japan and Overseas Economic Cooperation Fund in 1999.

2 Since the Japanese companies Marubeni Co. and Kansai Electric are part of this international consortium, the Japanese government gave loans to this project through the Export Import Bank of Japan (JEXIM), currently named the Japan Bank for International Cooperation (JBIC) (RWESA et al. 2003).

3 According to Goldman, "Green neoliberalism" is pushing neoliberal economic mandates through social development, mitigation measures, environmental policies, and others.

4 According to Wade, "financial ministry mandate" is the economic policy aim to convince the world of the truth of liberal free-market ideology.

References

Afable, P. 1999a. "Notes on the History of the Agno River and the Dams." Baguio Midland Courier. January 31, 1999.

— 1999b. "History of the Rivers and Southern Cordi." Baguio Midland Courier. February 7, 1999.

Carino, J. K. 2000. Dams, Indigenous Peoples and Ethnic Minorities: A Case Study on Ibaloy People and the Agno River Basin, Province of Benguet, Philippines. *KALI*:, 1 (1): 11-33

CPA (Cordillera Peoples Alliance) and DINTEG (Cordillera Indigenous Peoples Legal Center). 1998. *IPRA Critique, A Critique of the Indigenous Peoples Rights Act (R.A. 8371) and its Implementing Rules and Regulations*. Philippies: CPA and DINTEG

Ferguson, J. 1994. T*he Anti-Politics Machine: Development, Depoliticization, and Bureaucratic Power in Lesotho.* Minneapolis and London: University of Minnesota Press.

Goldman, Michael. 2005. Imperial Nature: The World Bank Struggles for Social Justice in the Age of Globalization. New Haven: Yale University Press.

IIWMP (Itogon Integrated Watershed *Management Project). 2001. Itogon Integrated Watershed Management Project.* Benguet: IIWMP

IWPDC (International Water Power & Dam Construction) 2001. Environmental Groups Target San Roque Dam. *International Water Power & Dam Construction*, 53 (1): 6.

JBIC (Japan Bank for International Corporation). 2005. *JBIC June 2005 Environmental Follow-Up Mission for San Roque Multi-Purpose Dam Project: Fact-Finding Sheet (FFS)*. Tokyo: JBIC

McCully, P. 2001. S*ilenced Rivers: The Ecology and Politics of Large Dams: Enlarged and Updated Edition*. London: Zed Books

Molintas, J.M. 2004. The Philippine Indigenous Peoples' Struggle for Land and Life: Challenging Legal Texts. *Arizona Journal of International and Comparative Law* (21) 1: 269-306..

Municipality of Itogon. 1999. *Resolution Numbered 16, s. 1999: Resolution Favorably Endorsing the San Roque Multi-purpose Project*. Itogon: Municipality of Itogon.

NPC (National Power Corporation), San Roque Power Corporation, and Export Import Bank of Japan. 1999. *San Roque Multipurpose Project, Memorandum of Understanding among National Power Corporation, San Roque Power*

corporation, and the J-Exim Environmental Appraisal Mission. Tokyo: NPC, SRPC, and JBIC.

Osmun, W. D., M. Rawlinson, and M. Pavone. 2001. Redesigning the San Roque Dam. *Civil Engineering*; 71(4): 42-79.

Prill-Brett, J. 1994. Indigenous Land Rights and Legal Pluralism among Philippine Highlanders. *Law & Society Review*, 28 (3): 687-698

RWESA (Rivers Watch East and Southeast Asia), International Rivers Network, and Friends of the Earth Japan. 2003. *Development Disasters: Japanese-Funded Dam Projects in Asia*. Tokyo: RWESA, FoE Japan, and IRN.

Scott, J.C. 1998. S*eeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* New Haven: Yale University Press.

Scudder, T. 1997a. S*ocial Impacts of Large Dam Projects. In: Large Dams: Learning from the Past, Looking at the Future.* IUCN, World Bank.

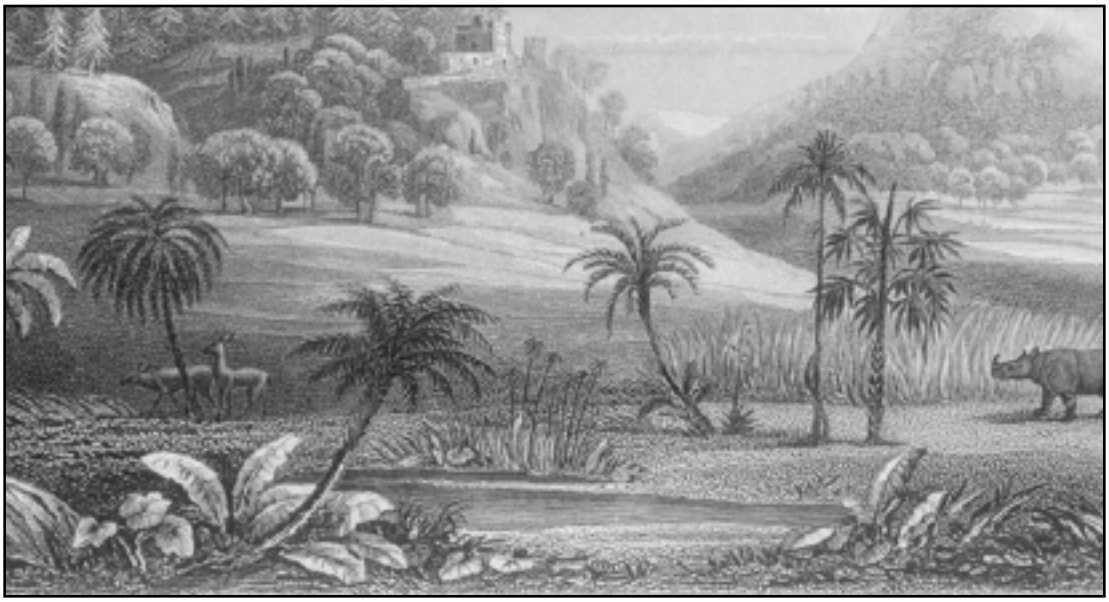
Scudder, T. 1997b. Social Impacts. Pp.623-665 in *Water Resources: Environmental Planning, Management, and Development*, edited by Asit K. Biswas. New York: McGraw-Hill..

UN (United Nations). 2003a. *Indigenous Issues, Human Rights, and Indigenous Issues: Report of the Special Rapporteur on the Situation of Human Rights and Fundamental Freedoms of Indigenous People,* Rodlfo Savenhagen, Submitted in Accordance with Commission Resolution 2001/65*, Addendum, Mission to the Philippines. Economic and Social Council, Commission on Human Rights, Fifty-ninth session, Item 15 of the Provisional Agenda. United Nation.

WCD (World Commission on Dams). 2001. *Dams and Development: A New Framework for Decision-Making.* London: Earthscan Publications.

WB (World Bank). 1999. *Environmental Assessment (OP 4.01): The World Bank Operational Manual.* Washington, D.C.: World Bank.

Wade, R. 2002. U.S. Hegemony and the World Bank: The Fight over People and Ideas. *Review of International Political Economy* 9(2): 201-29.



Source: Rhind, William. 2004. **The Vegetable Kingdom.** ***Fine Rare Prints. Available at: www.finerareprints.com***

Pulp Fact and Friction:

An Indonesian Pulp and Paper Company's Sustainable Forest Management Programs and NGO Interactions

by Linda Kramme, MF 2006

Introduction

During the past two decades, world-wide attention has been focused on threats to tropical forests and local communities in developing countries. As a result, many industrial forest companies operating in those countries have been increasingly pressured by non-governmental organizations (NGOs) to prove that they are practicing sustainable forest management.

One such company is Asia Pacific Resources International Holdings Limited (APRIL), one of Asia's largest pulp and paper companies, with primary operations on the Indonesian island of Sumatra. APRIL is actively promoting its commitments to sustainable forest management and is engaged in dialogues with both local and international NGOs.

I spent the summer of 2005 based at APRIL's mill site in the Riau Province of Sumatra, studying the company's sustainable forest management practices and community programs. I conducted interviews with APRIL staff, NGOs, and local communities and visited APRIL plantations and community development projects. My interest was to explore whether and how NGO pressures and customer concerns had influenced APRIL's commitments to sustainable forest management.

Linda Kramme has a degree in Geography from Bucknell University. She has worked on land conservation and stewardship projects for The Nature Conservancy in Maryland, Washington State, and Indonesian Borneo. Her goal upon graduation is to foster common ground between conservation organizations, industry, local communities, and governments toward sustainable forestry.

Background

Indonesia's tropical forests

Indonesia has some of the most biologically rich forests on earth, providing habitat for rare species such as the orangutan, the Sumatran tiger, and the Sumatran elephant (WWF 2003). But Indonesia's forests are also among the most threatened; between 1985 and 1997, the rate of deforestation in Indonesia doubled, and 20 million hectares of natural forest were lost. Experts have predicted that if these rates continue, intact tropical lowland forests in most of Indonesia may be completely lost by 2012 (Holmes 2002). Unsustainable and illegal logging practices, forest conversion, forest fires, and human settlement all have contributed to the decline.

Over the past two decades, there has been a phenomenal rise in plantation forestry in Indonesia, largely through conversion of natural forests (Barr 2001). Currently more than 2 million hectares across Indonesia are in plantation forests and 6.2 million hectares are targeted for plantation development (Nawir et al. 2003). Many plantations overlap with indigenous land claims or have had other detrimental impacts on local communities (Nawir et al. 2003).

Sustainable forest management and forest certification in Indonesia

The term "sustainable forest management" (SFM) is commonly used by environmental organizations, governments, and funding agencies to describe the use of forests in a way that maintains their ecological, economic, and social functions, for present and future generations (UNFF 2005). The term is being

Figure 1. Location of APRIL's primary operations

Source: APRIL 2004 Sustainability Report

used increasingly by industrial forest companies that are trying to market their practices as environmentally sound.

One way companies can prove their commitment to SFM is by pursuing forest certification. Forest certification was introduced in the early 1990s to address concerns about deforestation, especially in tropical regions (Rametsteiner and Simula 2003). Forest certification is a "non-state market-driven governance system" (Cashore et al. 2004), whereby forest managers can demonstrate their commitment to SFM through third-party independent audits. The most widely used certification criteria have been developed by the Forest Stewardship Council (FSC 2004). Currently more than 183 million hectares of forests are certified around the world under various systems; however, only two percent of these certified forests are located in the Asia-Pacific region, which includes Indonesia (Nussbaum and Simula 2004).

In 1998, the Indonesian government established its own national certification program known as Lembaga Ekolabel Indonesia (LEI). Although LEI standards are more general in some aspects than FSC criteria, there is a significant overlap in the systems (Meidinger et al. 2003). In Indonesia, no pulp plantations are FSC certified (Colchester et al. 2003). FSC will not certify plantations that were converted from natural forest areas after 1994 – a fact that infuriates many Indonesian Pulp and Paper companies. LEI is currently evaluating one company under its plantation certification system. That company is APRIL.

Asia Pacific Resources International Holdings Limited

Asia Pacific Resources International Holdings Limited (APRIL) is one of the largest pulp and plantation companies in Indonesia. Headquartered in Singapore, the company's primary operations are located in the Riau Province of Sumatra (Figure 1). In 1995, APRIL began operating one of the world's largest pulp mills, under a subsidiary known as Riaupulp, with a production capacity of 2 million tons per year (Matthew and van Gelder 2002) (Photograph 1). The company began paper production in 1998, under a subsidiary known as Riaupaper, and now produces 350,000 tons of paper per year (APRIL 2005a). Most of APRIL's pulp and paper is exported to Asia, but the company is broadening its customer base in Europe, Australia, India, and the

Photograph 1. APRIL's pulp and paper mill
Photograph by L. Kramme

Middle East (APRIL 2005a).

As of December 2004, APRIL had planted approximately 230,000 hectares of pulp plantations in Riau Province, primarily *Acacia mangium* (black wattle) on mineral soils and *Acacia crassicarpa* (northern wattle) on drained peatlands. APRIL is expanding its plantation areas at a rate of 35,000 to 40,000 hectares per year, with a goal of 420,000 hectares planted in Riau by 2012 (APRIL staff, pers. comm.). Currently, one-half of the wood that supplies APRIL's mill is plantation Acacia, and the other one-half consists of mixed hardwoods harvested from what APRIL describes as secondary or degraded forest (APRIL 2004).

Evolution of APRIL's Sustainable Forest Management Programs

NGO criticisms and market pressures

Shortly after APRIL initiated its Riau operations, local and international NGOs began criticizing the company. In the mid-1990's, the World Rainforest Movement published *Pulping the South* (Carrere and Lohmann 1996), which accused APRIL of widespread forest destruction and human rights violations. In 2002, the UK-based Friends of the Earth published a report entitled, "APRIL Fools: The forest destruction, social conflict and financial crisis of Asia Pacific Resources International Holdings Limited" (Matthew and van Gelder 2002). This report identified UK paper merchants that were buying APRIL pulp. Later that year, one of the UK's largest paper merchant groups that was targeted in the report announced that it would no longer purchase Indonesian paper until sustainable sourcing and legality could be independently verified (FOE 2003).

In 2002, World Wide Fund for Nature (WWF) also brought significant media criticism to APRIL after the company began building a road through the Tesso Nilo forest, one of WWF's highest conservation priorities. The Tesso Nilo forest covers almost 200,000 hectares in Riau province, representing the largest intact rain forest remaining on the island of Sumatra and one of the most biologically diverse forests on the earth (WWF 2001). WWF was able to convince CNN, the media network, to run several stories about what WWF described as APRIL's imminent threats to one of Sumatra's best tiger and elephant habitats (CNN 2002) (Photograph 5). In response to this negative publicity, some of APRIL's international customers terminated their contracts; others challenged APRIL to improve its practices (APRIL staff, pers. comm.).

APRIL response

On the heels of the CNN stories, APRIL agreed to a moratorium on cutting in the Tesso

Photograph 2. Harvesting operation on APRIL plantation *Photograph by L. Kramme*

Nilo forest. In 2003, APRIL and WWF formed a joint task force with the local government and the Ministry of Forestry to address illegal logging in the Tesso Nilo area (APRIL 2004). Since then, APRIL and WWF have met regularly, sometimes clashing, but more often having constructive dialogue. APRIL has also engaged in discussions with other local NGOs in Riau province, including Jikalahari, a consortium of 28 local NGOs, Hakiki, an environmental and social advocacy group, and Yayasan Riau Mandiri, which is especially concerned about the human health impacts of APRIL's operations.

APRIL Current "Sustainability Components" (APRIL 2004)

Wood Supply: APRIL has committed to source nine million tons of wood from plantations and community fiber farms by 2009, phasing out its use of mixed hardwoods from natural forests to meet the production capacity of its Riau mill (Photograph 2).[1]

Social Contribution: APRIL states that 100,000 people derive their income from the company's operations. The company spends $4 million annually on community empowerment programs, including agricultural and vocational training (Photograph 3), social infrastucture, and business loan programs (APRIL 2004).

Conflict Resolution: APRIL has a detailed land claims resolution process as part of its "Code of Best Practices". The company has made this system open to independent audits.

Environmental Responsibility: APRIL sets aside 20% of its total plantation areas for conservation. The company's Riau mill and plantations have achieved ISO 14001 certification.[2] APRIL has an independently audited system to ensure that Acacia and mixed hardwood species are separated for processing. The company recently committed to not harvesting any wood from "high conservation value forest" areas, as defined under FSC guidelines, in plantations developed after January 2005 (APRIL 2005b).

Photograph 3. A woman tending Acacia seedlings in APRIL nursery *Photograph by L. Kramme*

Certification: APRIL is pursuing LEI certification of its plantations; the company has passed the second phase of review, and will likely become Indonesia's first pulp plantation certified under LEI's Sustainable Forest Plantation certification system.

Continuing Collaborations

In May 2004, APRIL received a "Community Empowerment Award" from President Megawati Sukarnoputri from its community fiber farm program (APRIL 2004). In 2004, the company's community programs were featured on a UK program entitled "The Business of Development" (World Television/UNDP 2004). APRIL's sales in Europe and the U.S. have been growing on the heels of such positive publicity (APRIL staff, pers. comm.).

During my summer research, I visited a local community that is implementing an integrated organic farming system and cattle raising project with support from APRIL. Villagers I spoke with confirmed that APRIL's assistance has allowed them to pursue farming as an alternative and as a more stable livelihood than illegal logging.

APRIL and WWF are jointly lobbying the Indonesian government to designate an additional area of the Tesso Nilo forest as an elephant conservation area (APRIL 2004). In one of APRIL's plantation sectors abutting the park, APRIL recently allowed WWF to build a facility on one of APRIL's plantations to house its "Elephant Flying Squad" -- trained elephants that WWF uses to discourage wild elephants from leaving the park and raiding community gardens (WWF staff, pers. comm.) (Photograph 4).

Continuing Conflicts, Criticisms, and Challenges

Most international and local NGO representatives I interviewed agreed that APRIL has improved its environmental and social responsibility in recent years, more so than its largest competitor in the region. However, NGOs continue to criticize the company in three primary areas.

First, NGOs argue that APRIL's production and plantation expansion goals are unsustainable. They accuse APRIL of "greenwashing" its broader destructive forest practices. They urge APRIL to stop converting natural

Photograph 4. WWF "Elephant Flying Squad" on patrol *Photograph by L. Kramme*

Photograph 5. The Tesso Nilo forest is home to the endangered Sumatran tiger *Source: Sumatran Tiger Conservation Program*

forests, especially peatlands, to plantations. The APRIL staff I interviewed counter that their company's responsible management of the area, under a legal government permit, is much better than the alternative, which is to leave land in the hands of the corrupt government, illegal loggers, or unscrupulous companies (APRIL staff, pers. comm). Based on my experience in Riau, I agree that government land protection is woefully lacking and that APRIL is a better manager than other companies in the region. However, I share the concern of NGOs that the company's long-term production goals for Riau are unsustainable, especially on peatlands.

Secondly, some NGOs criticize APRIL for not doing more to combat illegal logging, saying that although APRIL has improved its procedures to ensure that trucks entering its facility have necessary permits, too often those permits are invalid or the trees are not from licensed area listed on the permit (Eyes on the Forest 2005). Based on my interviews and observations, I believe that APRIL staff and upper management are committed to limiting illegal logging and that the company has done much more to limit it than competing companies. APRIL staff emphasize that their "mixed hardwood supply chain control system," which ensures that no illegal logs enter the mill supply, has successfully passed independent audits with WWF serving as an observer (APRIL staff, pers. comm.). What seems essential is for the government to help communities find alternative income sources and to reduce the corruption that continues to make illegal logging so prevalent.

Third, some NGOs argue that APRIL must further improve its community relations and land claim resolution process. They described instances where APRIL had neglected to provide basic infrastructure improvements to some communities despite heavily impacting them and that significant conflicts ensued (local NGO staff, pers. comm.). Other groups urge APRIL to pursue more fiber farm partnerships with communities to plant degraded lands (local NGO staff, pers. comm). However, some local community members with whom I spoke indicated that they had benefited significantly from APRIL's assistance. APRIL staff report that the company regularly builds schools, mosques, and medical facilities in neighboring villages, but villagers are often dissatisfied with the amount of assistance (APRIL staff, pers. comm.). APRIL staff

members emphasize the company's commitment to resolving claims in a fair and transparent manner, following its Code of Best Practices (APRIL staff, pers. comm.). In addition, company officials note that all forest land in Indonesia is government-owned and many community conflicts arise because the government issues plantation permits to companies without first resolving land claims and delineating village areas (APRIL staff, pers. comm.).

Conclusion

This study indicates that despite the vastly different missions and perspectives of industrial forest companies and NGOs in Indonesia, company-NGO partnerships can be mutually beneficial. A combination of friction and collaboration between them can yield benefits for companies, communities, and conservation. For APRIL, NGO pressures have led to improved company practices; this has led to increased sales in the global "north". For NGOs, both pressuring and partnering with APRIL has yielded significant conservation and social improvements in Riau and raised global awareness of the urgent conservation needs in Sumatra. For such benefits to continue, maintaining this kind of healthy friction will likely be necessary.

APRIL's President, A.J. Devanesan, has stated: "For a company to be sustainable, anything it does has to be good for the people, good for the country, and good business. If you don't make money, you cannot do anything else" (World Television/UNDP 2004). This is a reality facing any business and one that conservationists must remember. Company-NGO partnerships should be considered as just one aspect of a larger conservation strategy needed to protect Indonesia's rapidly dwindling tropical forests and the species and communities that depend on them.

Acknowledgements

I am grateful to Carol Carpenter, Mark Ashton, and Amity Doolittle for helping me focus my research topic. Special thanks to Gary Dunning for encouraging me to pursue this project, and facilitating my contact with APRIL. I am grateful to the Charles Kao Fund, Coca-Cola World Fund at Yale, and the Tropical Resources Institute at Yale University, whose generous funding made this research possible. Finally, I thank APRIL staff, especially Jouko Virta, for allowing me to observe so many facets of APRIL's operations.

Endnotes

1 APRIL staff clarify that as a growth-oriented company, APRIL intends to continue establishing sustainably managed plantations for other markets; this may include converting secondary natural forests or degraded forest lands, mostly in Indonesia, to plantations, using mixed hardwoods within as "bridging raw material" (APRIL staff, pers. comm).

2 ISO 14001 is a set of standards developed by the International Standards Organisation. The standards specify requirements of an environmental management system that companies can follow to to minimize harmful effects on the environment. A company that complies with ISO 14001 can obtain a certificate issued by an independent auditing body that verifies such a system is in place. Source: www.iso.org

References

Asia Pacific Resources International Ltd (APRIL). 2005a. *Sustainable Forestry Environment*. <http://www.aprilasia.com/environment_sustainable.html>. Accessed April 3, 2005.

_____. 2005b. *APRIL's Commitment to Sustainability and the Protection of High Conservation Value Forests.* Position Statement by A.J. Devanesan, APRIL President, 29th September 2005. Asia Pacific Resources International Holdings Limited, Corporate Information. Singapore.

_____. 2004. *2004 Sustainability Report*. Asia

Pacific Resources International Holdings Limited, Corporate Information. Singapore.

Barr, C. 2001. P*olitical Economy of Fiber & Finance in Indonesia's Pulp & Paper Industries - Banking on Sustainability: Structural Adjustment and Forestry Reform in Post-Suharto Indonesia.* Washington DC: CIFOR and WWF's Macroeconomics Program Office.

Cable News Network (CNN). 2002. *Sumatran Forests Face Crisis, Says WWF.* <http://archives.cnn.com/2002/WORLD/europe/06/18/sumatra.glb/index.html>. Accessed November 30, 2005.

Carrere, R. and L. Lohmann. 1996. *Pulping the South: Industrial Tree Plantations and the World Paper Economy.* World Rainforest Movement & Zed Books Ltd.

Cashore, B., G. Auld, and D. Newsom. 2004. *Governing Through Markets: Forest Certification and the Emergence of Non-State Authority.* New Haven: Yale University Press.

Colchester, M., M. Sirait, and B. Wijardo. 2003. *The Application of FSC Principles 2 & 3 in Indonesia: Obstacles and Possibilities*. WALHI, AMAN, Rainforest Foundation

Eyes on the Forest. 2005. *APRIL's New Road Threatens Natural Forest in Kampar Peninsula*. EOF News 27 May 2005. <http://www.eyesontheforest.or.id>. Accessed August 30, 2005.

Forest Stewardship Council (FSC). 2004. *FSC Principles and Criteria of Forest Stewardship*. FSC reference code: FSC-STD-01-001. Forest Stewardship Council.

Friends of the Earth (FOE). 2003. "UK Paper Companies Supporting Indonesian Rainforest Destruction." FOE Press Release, 10 February 2003.<http://www.foe.co.uk/resource/press_releases/uk_paper_companies_support.html>. Accessed December 3, 2005.

Holmes, D. 2002. Indonesia: *Where have all the forests gone?* World Bank Discussion Paper. Environmental and Social Development, South Asia and the Pacific Region. Washington, D.C.: The World Bank.

Matthew, E. and J.W. van Gelder. 2002. P*aper Tiger, Hidden Dragons 2: APRIL Fools: The Forest Destruction, Social Conflict and Financial Crisis of Asia Pacific Resources International Holdings Ltd (APRIL), and the Role of Financial Institutions and Paper Merchants*. London: Friends of the Earth.

Meidinger, E., C. Elliott, G. Oesten. 2003. *The Social and Political Dimensions of Forest Certification.* Remagen-Oberwinter: Forstbuch.

Nawir, A., L. Santoso, and I. Mudhofar. 2003. *Towards Mutually-beneficial Company-community Partnerships in Timber Plantation: Lessons Learnt from Indonesia.* CIFOR Working Paper No. 26. Bogor, Indonesia: Center for International Forestry Research.

Nussbaum, R. and M. Simula. 2004. Forest Certification: A Review of Impacts and Assessment Frameworks. Commissioned Paper for The Forests Dialogue Certification Meeting, Maidenhead, England, October 19-21, 2004.

Rametsteiner, E. and M. Simula. 2003. Forest Certification – An Instrument to Promote Sustainable Forest Management? *Journal of Environmental Management* 67 (1) 87-98.

UNFF (United Nations Forum on Forests). 2005. What is Sustainable Forest Management? <http://www.un.org/esa/forests/faq.html#sfm>. Accessed November 15, 2005.

World Television and UN Development Programme. 2004. *The Business of Development: Corporate Social Responsibility in Developing Countries.* CNBC Europe Series, Program 8. Sponsored by UN Development Programme, Prince of Wales International Business Leaders Forum, and International Chamber of Commerce.

WWF (World Wide Fund for Nature). 2001. *Logging Activities and Forest Conversion in the Tesso Nilo Forest Complex, Riau, Sumatra, Indonesia* – AREAS Riau Project, December 2001. Jakarta: WWF-Indonesia.

WWF (World Wide Fund for Nature). 2003. "Elephant Forests on Sale: Rainforest Loss in the Sumatran Tesso Nilo Region and the Role of European Banks and Markets."

Opportunity in the Land of Conflict:
Mining, Peasants, and Changing Attitudes in Northern Peru

by Oscar Franco, MEM 2006

Introduction: The Conflict

In the early hours of the morning on July 28, 2005, a continuous stream of trucks began to arrive in the small city of Huancabamba, carrying peasants by the dozens. Huancabamba is the capital of a province by the same name, located in the northern Peruvian Andes. By noon, when their numbers were in the hundreds, the peasants held a peaceful demonstration in the town's main public square, the Plaza de Armas, demanding that Majaz Mining Company leave the northern part of the province, where it had set up a mining exploration facility.

Over the next few days, groups of *campesinos*[1] from different parts of the province continued to arrive in the Andean city, but their numbers never reached the climax of the first day. As some entered the city, others left to protest at the mining company campsite. This ten-hour journey north of entailed a five-hour truck ride and a five-hour walk.[2] A few days later, three hundred policeman clashed with two to three thousand peasants at the campsite, leaving two peasants dead and at least 60 wounded.

More than any other event, the July 2005 uprising brought the public attention to the growing unrest in local communities across the country that had been sparked by the presence of large-scale mining companies. This protest made headlines on the front pages of the national newspapers and continued to do so for several days – a rare achievement for a local conflict in a remote rural area. At the time this piece was written, nine months after the event, the uprising was still, and probably will continue to be, a matter of public debate.

For that very reason, the final outcome of the Huancabamba conflict has the potential to influence decisively the way in which mining companies interact with local communities across Peru. Given the strong environmental impacts that mining operations usually have, this, in turn, will have a major impact on the conservation of unprotected wildlands across the country. The sheer value of the land that is currently at stake, a stretch of land that lies across a portion of the Huancabamba Mountain Range is, by itself, enough to call the attention of the international conservation community to the final outcome of this ongoing conflict.

The Lands at Stake

The mining camp at the center of the peasant conflict is located in a remote corner of the Huancabamba Mountain Range (HMR), or Cordillera de Huancabamba, the name that local Peruvian residents near the Ecuadorian border give to the western branch of the Andes.

Traditionally, the low-lying and drier parts of the HMR has sustained large peasant populations. Within this landscape lies the city of Huancabamba, one of the earliest cities founded during the Spanish conquest. For centuries it has been a major commercial hub connecting the inner jungles on the east to the coastal plains on the west. In contrast, the much more humid higher regions of the mountain range, especially the northern part of the range, has been relatively free of human presence until recently. Despite the encroachment

A native of Lima, Peru, Oscar Franco has a bachelor degree in anthopology and ten years of work experience as a journalist and conservationist practitioner. His main interests are ecosystems in extreme danger and effective conservation practices.

Figure 1. Opportunity in the Land of Conflict: Mining and Peasants in Huancabamba, Northern Peru

The Huancabamba region lies in the middle of a string of protected areas at both sides of the Peruvian-Ecuadorian border. In the map, protected areas appear in dark grey, while the Huancabamba region appears in light grey and crossed by diagonal lines at the center of the "string". The map illustrates a proposed binational biological corridor. It is part of an effort to promote conservation in the area, in which the author of the article took part before coming to Yale. ***Source: Fundación Pro Naturaleza***.

by peasants in search of lands for pasture and crops, about 20,000 to 30,000 hectares of unfragmented montane forest and ungrazed alpine shrubby grasslands still remain, though the peasants hold the rights to this land. It is in the heart of these remaining natural ecosystems that the mining campsite is located.

But the real significance of this land from a conservation point of view goes well beyond the fact of it being the last wild space in the HMR. These forests and grasslands are located within two ecoregions – Cordillera Central Paramo and Cordillera Oriental Montane Forests – both are of top conservation priority in Latin America (Dinerstein et al. 1995). The HMR *paramos*[3] are among the least grazed and least altered by human presence across its entire range, from Venezuela to northern Peru. The quality of these forests is evidenced by the fact that Cerro Chinguela, a mountain relatively close to Huancabamba city, has been identified by Birdlife International as the second most important 'key area' for endangered endemic birds in Peru (Wege and Long 1995).

The HMR also holds a viable population of one of the most endangered South American mammals, the Andean tapir (*Tapirus pinchaque*) (Downer 1997). Moreover, it serves as a vital natural corridor for this and other wide-ranging species, such as the spectacled bear (*Tremarctos ornatus*), which live within a string of protected areas on both sides of the border – Tabaconas Namballe National Sanctuary in Peru and Colambo Yacurí Protective Forest and Podocarpus National Park in Ecuador. Neither of these individual areas is large enough by itself to support viable populations of these species. The preservation of the HMR corridor is thus crucial to their survival (Fundación Pro Naturaleza 2004).

The Legal Process: A Formula for Conflict

According to Peruvian law, the ground beneath the earth's surface is public property.[4] On behalf of the nation, the government can legally sell the exploitation rights of whatever resources are below the surface of the earth, regardless of what the owner of the land surface wants.[5] The only exceptions are urban spaces.

The Peruvian legal framework dictates that every mining company operating in the country try to reach an agreement with the landowner.[6] However, in the case where an agreement is not reached, the mining company can get an easement directly from the national government, specifically, the Ministry of Energy and Mining, or MEM, to access the underground resources. An environmental impact assessment (EIA) is also mandatory by law, but companies are required to present them only after completing the exploration phase. Thus, the official process to obtain a mining concession in Peru is basically a transaction between the MEM and the mining companies. No other groups or individuals are invited in the decision-making process. In other words, consultation with the actual owners of the land is not required.

The Owners of the Ground and the "Underground"

The mining company in the Huancabamba case is Majaz Mining Company, owned by Monterrico Metals, a small British company that operates only in Peru. In June 2003, Majaz obtained from the Peruvian government a mining concession for over 6,473 hectares on the northern end of the HMR. The mining project, called "Rio Blanco", is currently in its exploratory phase and, according to the company's website, aims to exploit about 200 million tons of copper ore through three open pit mines.

Figure 2. Land ownership in the Huancabamba Mountain Range

Peasant communities are in dark grey. The slightly lighter grey areas represent clusters of small private properties. *Source: Fundacion Pro Naturaleza*

Eighty percent of this concession land falls within the boundaries of the Segunda y Cajas peasant community, which spans 50,000 hectares, while 20% falls within the boundaries of the Yanta peasant community. In Peru, peasant communities are legally recognized social institutions, governed by legally established rules of collective and individual access to land. Because of the collective nature of ownership, they are differentiated from other forms of private property. As most of the communities in the region, Yanta and Segunda y Cajas were born out of the Agrarian Reform process thirty years ago. This law divided and distributed land previously owned by *hacendados*, or private plantation owners, among peasants who worked on the plantation.

The Permit Process, That is the Conflict

After obtaining the concession, Majaz gained permission from the Segunda y Cajas authorities to explore their land for minerals with little trouble. Although some *comuneros*[7] make their living from mining in small operations along rivers, there is no large-scale mining tradition in the region. People have vague ideas about the potential harmful environmental consequences of mining, but they also know that a mine's presence brings money and jobs for the region. Community authorities acknowledge they signed permission forms allowing mining exploration, however, they contend that they did not know the extent and details of the project because of their lack of ability to understand the forms and the project, implying that the mining company had taken advantage of them. However, it is likely that they did, in fact, know what they were doing, and signed the forms because they had expectations of the positive outcomes of the mining company's presence. It is also likely that the remote location of the mining camp, and the absence of agricultural lands there, helped to appease the community authorities.

The July 2005 conflict, in fact, started somewhere else. Near the end of 2003, city dwellers from Huancabamba discovered that another concession of about the same size had been given in the region, but this time it was not over remote forests, but over agricultural lands very close to the city. This resulted in a strong reaction from both peasants and local urbanites, who went on to protest at massive gatherings and demand that mining explorations be stopped. The company, Newmont Mining Corporation, decided not to oppose the people's will and left quickly.

This incident had apparently helped change the perception that the *comuneros* from Segunda y Cajas had towards Majaz. The *comuneros* were inspired by its outcome; as owners of the land, they had participated in the demonstration against Newmont. The community's authorities official version of the origin of the conflict, as explained to me by the vice-president of the community, was that the problem with Majaz began when the *comuneros* working for Majaz in the exploration complained about mistreatment. Reports confirm that the following year, in May 2004, a group of two to three hundred peasants from the community attacked the campsite of the company.

From that point on the peasant-mining conflict began receiving attention at the regional scale.[8] Newspapers in Piura, the region's capital, some two or three hundred kilometers to the west in the coastal plains, began writing about it. In previous years, a dramatic confrontation between another mining company and commercial farmers had taken place in one of the coastal plain towns, Tambogrande. This conflict was won by the farmers and had resounded tremendously at the national level. These same farmers joined to protest the mining operations in the HMR, arguing that it would affect them directly by contaminating the waters upon which they depend to grow their prized vegetables for exportation. The upstream poor peasants had gained their first influential allies.

The Catholic Church, represented by its regional authority, Monseñor Daniel Turley, also gave public support to the communities.

Despite these efforts, the company continued its operations and tensions mounted. Leaders from Tambogrande began having frequent contact with the leaders of Segunda y Cajas, Yanta, and other surrounding communities. This was very much facilitated by the fact that *rondas* are well-established across the region. *Rondas* are armies of vigilant peasants that communities create to defend themselves from threats such as cattle thieves. One of the legacies of the *rondas* system is the vast social and political network that unifies communities throughout the region (Diez 1998). The coordination among communities is a fundamental principle: in order to stop the theft of cattle in the community, control over the territory of neighboring communities must be secured.

This regional network was clearly at work last July when about 2,000 to 3,000 peasants from places as far as 100 km away made their way to the mining exploration campsite and attacked it. What was not so clear were their motivations. The discourse that the *ronderos*' leaders gave in the Plaza de Armas de Huancabamba were filled with arguments that had to do with the conservation of their forests and the rivers that originated there. The phrase "sustainable development" was mentioned several times.

The Huancabamba Mountain Range
Photograph by O. Franco

But the mining company immediately used the media to accuse protesters of being manipulated by the illegal narcotics trafficking network. Although this may seem like a hollow argument from the miners to belittle the peasants, the fact remains that the HMR is a little known, but very central route, by which opium latex travels from adjacent southern regions to Ecuador. According to the point of view projected by the mining company, peasants would be interested in ending mining development as a way to defend a livelihood that depends to a certain degree on selling the latex from poppy plants to traffickers.

The public, which paid much attention to the conflict, has generally supported the peasants' "conservationist" reasons, as shown by a survey conducted by the Universidad de Lima in August. This was facilitated by a public perception that mining harms the environment. In addition, the fact that the Catholic Church became an ally of the peasants ultimately played in favor of the latter, making their position more credible in the eyes of urbanites.

Conclusions

The mining-peasant conflict in the Huancabamba mountain range is far from over, but its impact has been enormous. News of the conflict has reached the front pages of national newspapers and put the relationship between mining, the environment, and local communities on Peru's national agenda. The mining sector in Peru has perceived this conflict as a decisive one. They have defended Majaz's position and are now trying to show that they have changed, claiming that they are environmentally responsible.

The fate of these lands is very uncertain. On the one hand the Peruvian mining sector perceives there is much at stake and given their considerable economic and political power, the probability that a mining operation will finally develop in the HMR are high. On the other

hand, peasant communities also have a strong position, backed by the sympathy of public opinion and the support of the Catholic Church and, perhaps in the future, of conservationist groups.

Whatever the final output of this dramatic process, the conservation of the forests and *paramos* of the HMR will be a political issue that the winner of the war will surely watch closely. To a certain degree, they will be obliged to conserve natural ecosystems as much as they can, whatever the outcome. This may, ultimately, result in the loss of what the winner has won, whether it is the company's right to exploit the minerals or the communities' right to continue to live as they have until now. In fact, both sides have begun saying, in private and outspokenly, that they will take concrete measures to conserve the ecosystem of the mountain region, by establishing private reserves.

Beyond this, the most precious legacy of this conflict is the opportunity that has been opened for reframing the legal process for obtaining mining concessions in Peru. This is a unique moment for conservationists to take advantage of and try to make a change that will have a long-lasting impact on the environment of Peru, a country where living and mineral treasures go hand in hand.

ENDNOTES

1 *Campesinos* – Spanish word for 'peasants'.

2 As part of my summer research trip I personally witnessed the scenes in Huancabamba described here. Having been given a tip from a *campesino* leader, I watched on the sidelines the events in Huancabamba unfolded before me.

3 *Paramos* – the Spanish word for alpine shrubby grasslands that grow in the high altitude regions of the Andes mountains, from northern Peru to Venezuela.

4 Peruvian Constitution, article 66; Peruvian Civil Code, article 954.

5 Peruvian Constitution, General Mining Law, article 2.

6 Peruvian Constitution, Law of Lands and Peasant Communities, article 7.

7 *Comunero* – Spanish word for a member of a peasant or indigenous community.

8 A *region* is the political unit equivalent to a state in the U.S. It is divided into provinces. There are 7 provinces in the Piura region.

References

Bernex, N and B. Revesz. 1988. *Atlas Regional de Piura*. Lima, Peru: CIPCA – PUCP.

Clark, Timothy W. 2002. *The Policy Process*. New Haven: Yale University Press.

Diez, Alejandro. 1998. *Comunes y Haciendas*. Cuzco, Peru: CIPCA - CBC.

Dinerstein, E., Douglas J. Graham, Eric Olson, Graham, Douglas J., David M. ,Webster, Avis L. Primm, and Steven A. Bookbinde, 1995. *Una Evaluación del Estado de Conservación de las Ecoregiones Terrestres de América Latina y el Caribe.* Washington, D.C.: WWF and World Bank.

Downer, C. 1997. Status and Action Plan of the Mountain Tapir (*Tapirus pinchaque*). Pp: 10-22 in *Tapirs – Status Survey and Conservation Action Plan*, edited by D.M. Brooks, R.E. Bodmer, and S. Matola. Gland, Switzerland and Cambridge, UK: IUCN.

Flanagan, J. and W. Vellinga. 2000. T*res Bosques de Neblina de Ayabaca - Su Avifauna y Conservación.* Piura, Peru: ProAves Perú.

Fundación Pro Naturaleza. 2004. Informe Final del Proyecto "Conservación Privada en el Corredor de las Américas. Corredor Biologico Tabaconas – Podocarpus, Sector Peruano". Lima, Peru: Unpublished document.

Rodríguez, L. (ed). 1996. *Diversidad Biológica del Perú. Zonas Prioritarias para su Conservación.* Lima, Peru: FANPE/GTZ/INRENA.

Wege, D.C. and A.J. Long. 1995. Key Areas for Threatened Birds in the Neotropics. *Birdlife Conservation Series* No.5. Cambridge, U.K.: Birdlife International.

Announcing the 2006-2007 Fellows

Once again TRI Fellows have an exciting line up of research projects around the world. **TRI Endowed Fellowships** are designed to support Master's and Doctoral students interested in conducting independent research in tropical countries. This year twenty-two students received TRI Fellowships for summer research. The 2006 recipients and the countries where they plan to conduct research are:

Heather Arrowood, Tanzania
Erin Barnes, Brazil
Catherine Bensen, Papua New Guinea
Scott Berendt, Mali
Tracy Botero, Costa Rica
Brent Frey, Nepal
Monisha Gangopadhyay, India
Rachelle Gould, Nepal
Laura Jensen, Costa Rica
Ruoting Jiang, China
James Leslie, Peru and Mozambique
Jennifer Lewis, Brazil
Mira Manickam, Thailand
Christopher McManus, South Africa
Kate Neville, Phillipines
Elizabeth Pickett, Hawaii
Camille Rebelo, Papua New Guinea
Alvaro Redondo-Brenes, Costa Rica
Laura Robertson, Sulewesi
Krishna Roka, Nepal
Colleen Sullivan, Ecuador
Brandon Whitney, Ecuador

The World Agroforestry Centre (ICRAF), for the fifth year will sponsor a Master's student interested in pursuing research on the interface of agroforestry and conservation. This year's recipit of this award is **Kerry Dooley**, who will perform an integrated assessment of local uses for *Guira senegalensis*.

The Compton Foundation's Program aims to contribute to the capacity-building of young professionals from Central America and Sub-Saharan Africa, to improve policies and program relating to peace, population, sustainable development and the environment. This year's recipients and their home countries are:

Melofy Ocloo from Ghana
Yves Paiz Merinio from Argentina