# TROPICAL RESOURCES

**The Bulletin of the Yale Tropical Resources Institute**

**2008 Volume 27**

In this issue



**Please access the 2008 Bulletin at www.yale.edu/tri/bulletin.html in order to view maps, graphs, photographs, and figures in color.**

# 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 through 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 Friends of TRI:

Each year, I am continually impressed by the quality, diversity and insightful interdisciplinary projects of our students' submissions to the TRI Bulletin as well as their Masters' projects overall. This issue proves no exception. Projects span from Erin Barnes's market analyses of commercial fisheries along the Madeira river in Bolivia and Brazil to Brenna Vredeveld's demographic and land use change analyses in peri-urban regions of Quito, Ecuador. The quality of all of TRI's supported field studies—based only on a few summer months—again surpasses my expectations. I commend Dr. Amity Doolittle and the student editorial assistants Alicia Calle and Laura Frye-Levine who have been instrumental in compiling this volume. Yet again, you have set a high bar for the next class!

Our International Society of Tropical Foresters ISTF Student Chapter conference in March was again organized and implemented solely by graduate students, and demonstrated the exceptional abilities of such a collective. This year, the central themes involved Reducing Emissions from Avoided Deforestation in Developing Countries (REDD) coupled with the biofuel buzz. The ISTF team raised valuable questions about the compatibility of such initiatives. During the two day symposium, a series of international speakers addressed many pressing questions of global concern with analyses, research and debate.

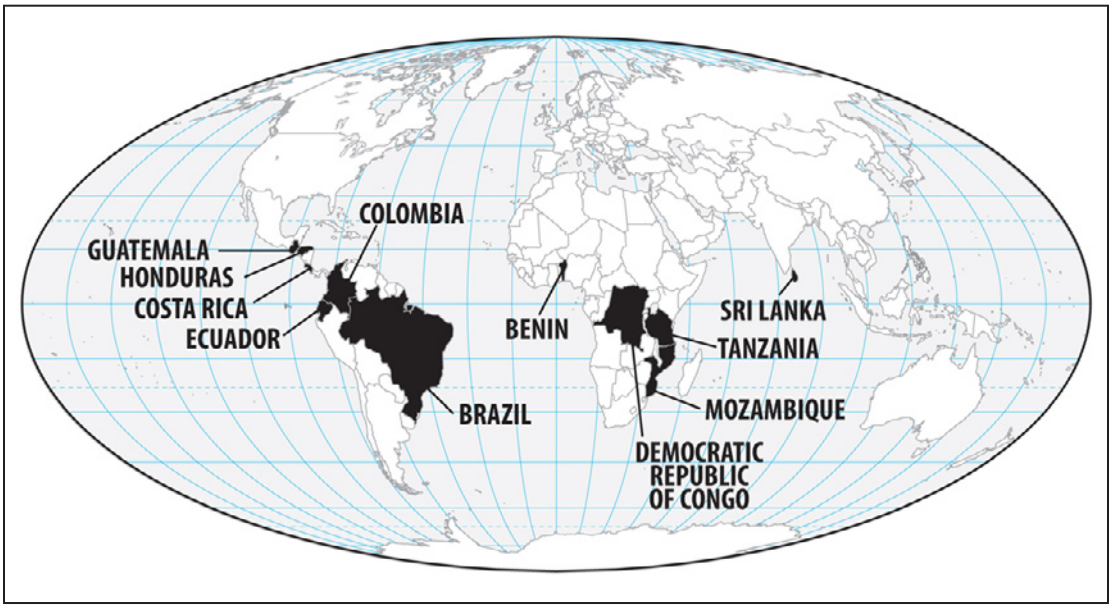
For over 25 years, TRI has been a leader in stimulating such outstanding interdisciplinary and applied problem-solving research among Master's and first-year PhD candidates at Yale. We are able to encourage and respond to pressing issues, provide timely support for researchers and allow for creativity in problem-solving within an international setting. Most importantly, these summer research projects provide students with practical skills and often new awareness for the difficulties and the joys of conducting field studies. Students aim to apply classroom knowledge with direct application and most often experience constraints and unforeseen challenges to address during this process. Then they return to campus invigorated and eager to explore new avenues of learning.

This summer, over 20 students will be exploring their studies in 16 countries under TRI sponsorship. Many projects are focusing on issues of climate, carbon and communities. These projects embrace the complexity of issues from environmental justice, governance and contested resource claims to global food security, biofuel and rural livelihoods. We look forward to following our new graduates' activities and welcome all to maintain ties and support for TRI.

Best wishes,

**Lisa M. Curran**
Professor of Tropical Resource Science
Director Tropical Resources Institute
Yale School of Forestry and Environmental Studies

# 2007 TRI Fellows in this issue




| | |
|---|---|
| **Brazil:** | Erin Barnes |
| **Benin:** | Natalie Ceperley |
| **Colombia:** | Alicia Calle |
| **Costa Rica:** | Georgia Basso |
| **Democratic Republic of Congo:** | Innocent Liengola |
| **Ecuador:** | Brenna Vredeveld |
| **Guatemala:** | Micha Rahder |
| **Honduras:** | Laura Frye-Levine |
| **Mozambique and Peru:** | James Leslie |
| **Sri Lanka:** | Chisato Tomimura |
| **Tanzania:** | Baruani Mshale |

Dear Readers,

The present issue of the Tropical Resources Bulletin reflects the lively disciplinary interaction that takes place within the Yale School of Forestry and Environmental Studies. The eleven TRI fellows featured here have diverse cultural and academic backgrounds but a shared interest in the environment. Their work is the product of using a multidisciplinary approach to tackle important environmental issues across the tropical regions of the globe. These articles illustrate an impressive range of tools and methodologies and reveal the application of environmental managements skills in a variety of contexts where some common themes emerge.

Several fellows examine how stakeholder participation affects the stewardship of the natural resources on which whole communities rely. Alicia Calle explains how early adopters set an example in the use of sustainable ranching practices in Colombia, and underlines their contribution to large-scale diffusion efforts. Micha Rahder analyses the conflicts that arise when social hierarchies interfere with the integration of scientific and local forest knowledge in a conservation setting in Guatemala. James Leslie uses contrasting examples from Mozambique and Peru to illustrate the importance of legitimate leadership and stakeholder participation in building resilient conservation strategies. Baruani Mshale takes a close look at how social attitudes towards conservation can be undermined by institutional inefficiency and failure to deliver results in Tanzania.

A group of authors focus on the natural sciences recognizing that ecosystem disturbances can have fundamental and often unanticipated consequences for conservation. Chisato Tomimura examines the effectiveness of fast-growing tree plantations to restore forests, and finds that theory and practice do not always coincide. Innocent Liengola combines on the ground and remote sensing methods to understand how invasive vegetation may be affecting the habitat of an endangered gorilla species in the Democratic Republic of Congo. Natalie Ceperley compares forest structure and function along riparian forests in central Benin, and then explores the social causes of those differences as influenced by the presence of sacred sites.

The intersection between conservation and economics is another area of increasing concern to the TRI fellows, who approach this issue from a variety of scales. Erin Barnes estimates the market value of a commercial fishery doomed to be lost to a dam in the Brazilian Amazon as an example of the quantifiable consequences not previously accounted for. Laura Frye-Levine examines the repercussions of a globalized conservation discourse in the context of a remote Honduran village, including the foregone opportunities of community ownership. Brenna Vredeveld takes a multi scale approach to understand the complexity of urbanization and land use management in Quito, Ecuador, and argues the need for a strategy that articulates the disjoint efforts of various local stakeholders.

The articles that we present in this issue reflect more than just interest in topical conservation and willingness to head to the field. They are evidence of the author's committment to the overwhelming task of sorting out, organizing, analyzing and presenting these results in a concise and engaging manner. The authors have struggled with the numbers, the words and certainly the tight deadlines, but they can be proud of the results. We hope you enjoy it!

**Alicia Calle, MESc 2008 and Laura Alex Frye-Levine, MESc 2008**

*Source: http://www.oldbookillustrations.com/index.php?lng=en*

# What Makes an Early Adopter?

## Transforming Landscapes One Farmer at a Time

*by Alicia Calle, MESc 2008*

Forests of high biodiversity and endemism once covered the Andean region of Colombia, today the country's most densely populated area. Fragmentation occurred over the past century as the landscape was transformed into an agricultural mosaic. Shade coffee became the dominant land use along the La Vieja River watershed, between the Quindío and Valle del Cauca departments, but it was later replaced by sun exposed, higher yielding varieties. Eventually, crises in the global coffee market resulted in conversion of most lands to cattle pastures; loss of productivity and soil degradation followed rapidly (Calle and Piedrahita 2007).

Contrary to popular belief, cattle ranching need not be detrimental for the environment. Agroforestry systems for animal production have been developed as alternatives to make it sustainable. The large-scale adoption of such systems in the tropical Andes could potentially transform the landscapes from barren pastures into providers of key environmental services like carbon sequestration and biodiversity protection. But as for other innovations, adoption rates for these techniques remain low.

The Regional Integrated Silvopastoral Ecosystems Management Project (RISEMP) was a Global Environmental Facility-funded pilot attempt to promote better ranching practices along the La Vieja River watershed. Beginning in 2002, participant farmers were introduced to a variety of sustainable alternatives and apprised to their ecological, economic and social benefits. Technical assistance and small payments were provided to encourage their adoption. Within five years, forest cover increased and land management practices improved, achieving a substantial transformation of the study area. Understanding the factors that motivated farmers to adopt these systems will be instrumental in designing strategies to scale up this initiative.

*Alicia Calle is a Colombian biologist and graphic artist. Her past work has combined art and science to develop environmental education strategies targeting diverse publics including children, rural communities, technicians and academia. She hopes to contibute to tropical ecosystem conservation by helping rural landowners find alternatives to make a more sustainable use of their lands.*

### Technology adoption and the role of early adopters

The decision to adopt a new technology or *innovation* is driven by a complex combination of household preferences, resource endowment, market incentives, biophysical factors and risk and uncertainty (Pattanayak et al. 2003). Innovations are subjectively associated with higher risks, so before *adoption* can happen they need to be tested, modified and adapted to the specific context in order to minimize risk perception. Only then will large scale diffusion occur as the innovation spreads through a region by combining with or displacing the alternatives (Mercer 2004).

Adaptation of new technologies usually entails costs that only a few innovators are willing to bear. These *early adopters* play a fundamental role in technology diffusion, assuming the most risks and incurring the highest costs. This article focuses on the motivations and decisions made by two early adopters within the RISEMP. In learning by doing, they generated a wealth of knowledge about how to make silvopastoral systems work under local conditions, facilitating

their adoption by other less adventurous farmers. Their stories illustrate the characteristics that define early adopters.

## Methods

To get a sense of the degree of adoption, I visited over 30 participant farms. I accompanied farmers (owners or workers) on transect walks during which they described the farm's baseline condition, explained the implemented innovations and discussed the benefits and difficulties of the process. I also conducted semi-structured interviews to understand their motivations for change, their environmental attitudes and their comprehension of the differences between traditional and sustainable practices.

Data was complemented with key informant interviews conducted with the project's on-the-ground personnel, access to the land use change monitoring database and participant observation notes taken during field activities.

## What makes an early adopter?

Three things became evident early on during my interviews. First, most farmers had persevered in implementing the proposed systems even after facing unexpected challenges. Second, farmers were much more comfortable trying systems they had seen working elsewhere. And third, two particular farmers—Don Olimpo and Don Iván—had emerged within the group as examples to follow.

Olimpo and Iván could not have more different personalities: one is outgoing, outspoken and impulsive, the other is shy, soft spoken and reflexive. The land use histories of their farms and the systems they chose to implement also have little in common. Yet these two farmers were early adopters in the project and as such, had a huge impact on the diffusion process. The characteristics they share that made them commit to adoption early in the process can help identify other innovators.

### *Strong motivation*

Motivation is fundamental in the decision to adopt an unfamiliar technology. In itself, the RISEMP's economic incentive was not enough, so early adopters needed to have other reasons. In strictly financial terms, the high price of land in Quindío should encourage farmers to sell the farms and move elsewhere. But because of their strong ties to the region and to their lands, many farmers chose to stay and try to remain profitable by intensifying production.

Like many farmers in the region, Olimpo turned to cattle in the 90's when he accepted the government's subsidy to cut his coffee trees and permanently change activity. He soon realized ranching would not be sustainable, as his farm's soils were rapidly depleted and dependence on expensive inputs increased year after year. Iván, on the other hand, was always a rancher managing his lands in the traditional way: open pastures divided by dead fences, a few isolated trees, cattle grazing even on the steepest slopes and generous use of herbicides. But Iván too witnessed a steady decrease in his farm's productivity. He was aware that without the massive applications of urea fertilizer commonly used throughout the region, his pastures would remain insufficient and his profitability would be at risk. Despite the different land use histories of both farms, soil degradation had led to a drop in productivity in what were once considered some of the best soils in the country. Recovering productivity and thus profitability was a strong motivation for these two farmers.

### *Taking the risk*

Beyond their motivation, Iván and Olimpo also share a common personality trait: they are curious and inquisitive, and when they see potential in an innovation they are willing to take the risk.

Olimpo had already been researching soil fertility, the benefits of trees, nutrient cycling and soil degradation when the RISEMP came to the region. He had realized that "we are taught

**BOX 1**

## Advantages of *Inga* trees in silvopastoral systems

Native *guamo (Inga sp.)* trees traditionally provided the shade for coffee in Quindío. *Inga* trees are legumes that fix atmospheric nitrogen through their roots providing natural fertilization. They shed leaves constantly, creating a layer of nutrient-rich leaf litter that protects soils from erosion and maintains moisture even during the summer. Insects, worms and microorganisms that live in this environment recycle the nutrients into the organic matter preventing the loss of fertility. *Inga* trees also foster biodiversity; pollinators are attracted to their flowers, birds seek the fleshy fruit and a variety of insects, many beneficial, frequently visit their extrafloral nectaries (Photographs 1 and 2).

When planted at high densities in pastures, these trees eliminate the need for expensive chemical fertilizers. One hectare planted with 70 *Inga* trees can produce 6.5 tons of leaf litter every year, containing about 120 kg of nitrogen, plus phosphorus and calcium (Cardona and Sadeghian 2005). Cattle dung cycling underneath these trees is extremely fast due to the presence of an active soil biota that processes the nutrients back into the soil in a matter of days. Improved soil quality delays the flowering of the grasses allowing for longer rotations. Pruning is required to guarantee enough sunlight for the pastures, but the excellent charcoal produced from these cuttings brings extra income to the farm.

**Photographs 1 and 2.** *Inga* trees have showy flowers and extrafloral nectaries that attract many birds and beneficial insects.

to nourish the pastures using chemical fertilizers, but what we really need to nourish is the soil so that there is decomposition of organic matter." From his experience as a coffee grower he deduced "…if coffee under *guamo* shade needed no fertilization or chemical inputs, why don't I plant some *guamo* trees in the pastures?" Following his instinct, he gave up chemical fertilization and planted *guamo* trees *(Inga sp.)* in the pastures instead (see Box 1). "Everybody said I was crazy, that underneath the trees pasture would not grow, that this would become a wetland…" So Olimpo was relieved when the project supported his idea and encouraged him to continue. With someone to turn to for further advice, Olimpo has since perfected his tree-planting designs and techniques.

Iván had taken a more skeptical approach. The thought of using trees—not chemical fertilizers—to increase pasture productivity seemed

**Photograph 3.** Establishing trees in pastures is not simple, especially when cattle find them palatable. Building and maintaining protective corrals like these is costly and time consuming, and only committed farmers persevere.
*Finca Pinzacuá*

ridiculous to him at first. Nevertheless, his curiosity made him join the first group who visited a demonstration farm. His persistent questions to the owner about every topic prolonged the visit for several hours, and no one has forgotten his entry in the visitor's book: "Thanks to this visit, 5 *cuadras* of *guadua* forest in Quindío have just been saved."[1] He meant it, and upon returning to his farm he cancelled the order to cut down a bamboo stand, marking the beginning of a transformation that changed his productive system as well as his attitude.

### *Try and err… and try again*

Failure when trying an innovation often leads people to conclude that the problem lies in the innovation. But early adopters, usually impatient to see results, often take a more hands-on trial and error approach. They are also perseverant: they fail once, learn from their mistakes, make adjustments and try again, frequently several times. By assuming the costs of learning by doing, they facilitate the task and reduce the risk for later adopters.

Olimpo personally supervised the implementation of the desired changes in his farm. He fenced off and reforested all water courses with native tree species and giant bamboo and he planted a timber forest on the steepest slopes of his farm after removing the cattle. But he mostly focused on establishing hundreds of trees in his pastures (Photograph 3). This proved to be a major challenge since trees planted in pastures face several threats: competition with aggressive grasses, structural damage by cattle, herbivore attacks, desiccation, nutrient deficiencies and in his case, a hardened layer of clay that prevented root penetration. Olimpo patiently devised methods to overcome each of these challenges and came up with his own tree planting strategy. He uses east-west facing, double-fenced lines of trees every 20 m, mixing timber species with ornamentals and other valued species, especially *guamos*. But developing this method came at a cost in time, labor and resources.

Iván trusted his employee, Efrén, to execute the changes in his farm. They protected and reforested all water sources and established several kilometers of live fences. They also decided to establish an intensive silvopastoral system (SPS), a high density plantation of the leguminous tree *Leucaena leucocephala* combined with pastures (see Box 2). This type of SPS had been successfully used elsewhere but its adaptation to the specific conditions of Quindío required time and investment. Armed with only some general instructions, his observation and tree-planting skills and Iván's support, Efrén made several

successive trials. Eventually they were the first to successfully establish the system by direct planting, skipping the nursery stage (Photograph 5). Since then, they have consistently improved the technique and reduced the costs. For Iván, persevering in the establishment of this system despite the initial failures meant not only a big investment but a huge departure from the days when "paying labor for planting or caring for trees was a waste of money and time."

### *Making the less obvious links*

Early adopters are keen when evaluating their results. They can cite specific figures of costs and productivity, but they are often also aware of benefits that go unnoticed to others. This attention to detail is best explained by the risk involved in their investment and their first-hand experience with the systems.

Olimpo's high tree density pastures provide an excellent example. Visitors are impressed by the intense green of the grass growing underneath the *guamo* trees, where no urea fertilizer has been applied for years (Photograph 6). But the farmer also understands—and clearly explains—other less visible benefits: how the *guamo's* shade and litter favor nutrient cycling and provide habitat for manure-processing

**BOX 2**

## Intensive silvopastoral system with *Leucaena*

Intensive silvopastoral systems combine high densities of *Leucaena leucocephala*—more than 10,000 shrubs $ha^{-1}$—with enhanced pasture varieties. *Leucaena* is a sun-loving shrub native to Mexico, which can fix between 150 and 400 kg of nitrogen $ha^{-1}$ each year through an association with *Rhizobium* bacteria in its roots (Photograph 4). This natural fertilization eliminates the need for chemical inputs, supporting high biomass production even during the dry months. The plant is hardy and flexible and resists repetitive browsing, providing high quality animal feed and shade that helps reduce heat stress in the cattle. The system is highly productive and long-lived as has been demonstrated in Colombia, where intensive SPS established 25 years ago are still in full production (Murgueitio et al. 2006).

The *Leucaena* system also has many environmental benefits. Lack of chemical fertilization enables the presence of beneficial organisms that work the soil enhancing its structure. The dense matt of *Leucaena* roots helps reduce the impact of cattle trampling and their quick decomposition after browsing creates tunnels that prevent soil compaction. Roots penetrate the deeper soil layers, cycling nutrients vertically and facilitating infiltration of rainfall. This helps recharge aquifers and prevent erosion by runoff, especially in steep slopes. The dense system also provides good habitat for small mammals like agoutis and armadillos.

**Photograph 4.** Nodules in the roots of *Leucaena* containing nitrogen-fixing bacteria.

**Photograph 5.** During establishment, *Leucaena* seedlings are susceptible to flooding, attack by ants and shade from weeds. Once established, intensive SPS with *Leucaena* are resistant and very productive, and require no fertilization.
*Finca La Ramada*

microorganisms; why well nourished pastures delay their flowering and allow for longer rotations and high energy feed; how the presence of trees supports fungi that control cattle ticks reducing the need for chemical baths; or how the increased lizard habitat reduces the presence of annoying insects.

For Iván, the realization of these unexpected benefits occurred suddenly months after having established an area in intensive silvopastoral system. He was desperate when he discovered a worm outbreak that threatened his substantial investment, but soon made an amazing observation: the birds that now nest in his recently planted live fences were eating those worms (Photograph 7). Still excited, he showed me the birds: "those guys are the ones giving me a hand with the *Leucaena* worm; we were about to start spraying pesticides when they came." Iván has also realized that better pastures grow fewer weeds, fewer weeds demand less herbicides, and less herbicides enable the natural regeneration of the same tree species he once struggled to establish.

**Photograph 6.** The shade of *Inga* trees provides a favorable environment for pastures. The moist soils support a range of rich biota that quickly recycles all of the nitrogen rich leaf litter, so pastures are well nourished and grow faster.
*Finca Pinzacuá*

**Photograph 7.** These birds, known as *chamones,* visit the farm's recently established live fences and help control the worms that attack Iván's recently established SPS. *Finca La Ramada*

### *Generosity to share knowledge*

No matter how successful, early adopters will not affect the diffusion process unless they have a fundamental characteristic: the generosity to share what they have learned. Throughout the project, Olimpo and Iván gladly shared the failure and success stories of their persistent trials and errors, sparing other less adventurous farmers the risk and costs of experimentation. Most of my interviewees mentioned one of these farmers as important sources of information for their own land use changes. Several farmers now use some version of Olimpo's mixed-species tree lines or Iván's direct planting method, and express their desire that their systems someday resemble those seen in the early adopters' farms.

Iván and Olimpo are recognized leaders within the project. Their formerly degraded lands are now examples of how recovering productivity can go hand in hand with environmental sustainability. National and international visitors come to their farms to see the transformation for themselves. Nevertheless, their curiosity and desire to learn new ways to improve their farms remain intact, as does their enthusiasm to share seeds, seedling and ideas with other farmers.

## Conclusions

Combining technical assistance and economic incentives, the RISEMP successfully promoted the use of agroforestry systems for animal production in the La Vieja River watershed. Early adopters contributed to facilitate this process. The two farmers described here shared their strong motivation to find productive alternatives, the willingness to assume risks, the persistence to overcome failed attempts, the ability to see beyond the obvious benefits and the generosity to share their knowledge. Both are proud of what they have accomplished so far and even if neither is yet profiting—at least economically—from the implemented systems, they remain confident that their investment will give fruit. In the end, this may be what sets these two men apart: they envision their farms as long-life projects and leaving a better land to their children as an attainable goal that needs to be started today. The example set by innovators like them could spark the transformation of tropical landscapes from areas of declining productivity to increasing providers of environmental services.

## Endnotes

1 1 *cuadra* = 0.64 hectares.
*Guadua* is a native giant bamboo.

## Acknowledgements

Andrés Felipe Zuluaga assisted me in the field with unrivaled enthusiasm, facilitating the contacts and generously sharing his wealth of knowledge about this project; the Center for Research on Sustainable Agriculture Production Systems CIPAV provided instrumental guidance and support in Colombia; participating farmers welcomed me to their farms and willingly shared their experiences. This research would not have been possible without their help. Amity Doolittle and Florencia Montagnini offered valuable insight and guidance throughout the process. Funding was provided by the Compton Foundation and Yale's Tropical Resources Institute.

## References

Calle, Z. and L. Piedrahita. 2007. ¿Cómo diseñar estrategias para el manejo de plantas de interés para la conservación en paisajes ganaderos? *Agroforestería en las Américas* 45: 117-122.

Cardona, D.A. and K.S. Sadeghian. 2005. Ciclo de nutrimentos y actividad microbiana en cafetales a libre exposición solar y con sombrío de *Inga spp. Revista Cenicafé* 56(2): 127-141.

Gutiérrez, Iván. Owner, finca La Ramada, Quimbaya, Quindío. Personal communication. August 14, 2007.

Mercer, D.E. 2004. Adoption of Agroforestry Innovations in the Tropics: A Review. *Agroforestry Systems* 61: 311-328.

Montes, Olimpo. Owner, finca Pinzacuá, Alcalá, Valle del Cauca. Personal communication. June 18, 2007.

Murgueitio, E., P. Cuéllar, M. Ibrahim, J. Gobbi, C.A. Cuartas, J.F. Naranjo, A. Zapata, C.E. Mejía, A.F. Zuluaga and F. Casasola. 2006. Adopción de sistemas agroforestales pecuarios. *Pastos y Forrajes* 29(4): 365-382.

Pattanayak, S.K., D.E. Mercer, E. Sills and J. Yang 2003. Taking stock of agroforestry adoption studies. *Agroforestry Systems* 57:173-186.

*Source: http://www.oldbookillustrations.com/index.php?lng=en*

# Ignorance or Exclusion?

## Forest Knowledge and Social Hierarchies in Community-Level Conservation in the Petén, Guatemala

*by Micha Rahder, MESc 2008*

### The Petén and the Maya Biosphere Reserve

The Petén, the northernmost department (state) of Guatemala, is home to part of the largest remaining tract of tropical forest in Central America—the Maya Forest—which stretches across national borders into Mexico and Belize. Historically, the Petén was seen as the most 'backwards' and inaccessible department in Guatemala due to the dense lowland jungle. Despite containing approximately one third of Guatemala's land area, the region held a population of less than 30,000 people before 1970 (Schwartz 1990, Nations 2006). This population, a mix of *Ladinos* (Spanish-speakers) and indigenous Itza Mayas, built a small extraction-based economy, carving their living out of the forests while leaving it largely undisturbed (Schwartz 1990).

In the late 1960s, the Guatemalan government attempted to relieve the pressure of major national land inequality by opening up the Petén for colonization, building roads into the forest and encouraging landless peasants to settle on the thin, clayey soils. A huge number of Ladino and Q'eqchi' Mayan migrants flooded in, and the population is now estimated variously between 500-700,000 people, representing about a twenty-fold increase in a little over 30 years (Nations 2006). These migrants cut down forest as they went to clear land for agriculture, and were closely followed by cattle ranchers, larger landowners, and timber and oil companies, eager to exploit the possibility of untapped profits in this newly accessible landscape.

As a result of this sudden population boom, approximately 50% of forest cover in the Petén was lost over the course of 30 years (Meyerson 1998). In 1990, in response to this overwhelming environmental change, the international conservation community convinced the Guatemalan president to set up the Maya Biosphere Reserve (MBR) (Sader et al. 1997). Since its inception, the MBR has drawn a large amount of international attention and funding to the area, and most major international conservation organizations have worked or continue to work in the area. In 1992, Conservation International (CI) started a Guatemalan branch, ProPetén, to work in the MBR on integrated conservation and development projects aimed at local communities. In 2002 CI pulled its funding, but ProPetén continued to work as an independent Guatemalan organization, largely following the previous program and objectives laid out by CI.

### ProPetén, scientific research and local conservation

ProPetén's mission statement includes the objective to "generate [scientific] research and integrate it with the local knowledge to respond to the needs of Petén" (ProPetén 2004). In order

*Micha Rahder, originally from Toronto, completed her Bachelor's degree in biology and anthropology at Reed College in Portland, Oregon. After working in the medical research field in Portland for two years, she reconnected with her passion for tropical landscapes and the people on them and came to Yale to get a Master's of Environmental Science. Micha plans to continue her studies in environmental anthropology, and will be beginning a PhD program next year at UC Santa Cruz.*

to fulfill this goal, ProPetén maintains a biological research station, the Estación Biológica Las Guacamayas (EBG) within Laguna del Tigre National Park, on the northwestern side of the MBR. To reach the station, you must drive for several hours on a poorly maintained dirt road to a small Q'eqchi' Mayan village, Paso Caballos, which is itself just inside the boundaries of the park, and from there travel 20 minutes by boat down the Río San Pedro. While the national laws governing the Biosphere Reserve outlaw human inhabitants in the park, Paso Caballos has a signed agreement—which ProPetén was instrumental in negotiating—that allows them to stay as long as they comply with certain boundaries and strict rules regarding agricultural practices, such as following detailed protocols before burning their land parcels for traditional *milpa* (slash-and-burn) agriculture.

ProPetén has been regularly involved in conservation and development activities in Paso Caballos since the building of the biological station in 1996. Projects implemented by ProPetén over the past ten years include health and family planning initiatives, agronomic development projects, agroforestry promotion and the establishment of an ecotourism program. After ProPetén lost CI support, funding for many of these projects was jeopardized, but the organization has worked to find new donors to continue their work. However, it was unclear what role the EBG played in these programs, and whether or not ProPetén was achieving its goal of integrating scientific and local knowledge. Given the importance of both scientific research and local input to successful conservation, my study investigated these issues, evaluating the relations between the research station and the community, and assessing ProPetén's integration of science and local knowledge in their conservation programs.

## Methodology

I spent two months living in the Petén, dividing my time between Paso Caballos and the Estación Biológica Las Guacamayas. At the station, I used a combination of participant observation and unstructured interviews with staff to address questions on scientific research, other uses of the station, the history of the EBG and ProPetén, the station's relationship with Paso Caballos and conservation. In Paso Caballos, I used participant observation and, with the

**Photograph 1.** A Q'eqchi' woman from the village of Paso Caballos spreads squash seeds to dry in the sun.

**Photograph 2.** The village of Paso Caballos.

aid of a translator, conducted 65 interviews with many villagers who only spoke Q'eqchi'. These interviews focused on local livelihoods, forest knowledge and use, the town's relationship with the EBG, and people's participation in ProPetén's and other conservation programs and trainings. Finally, I conducted an interview with the coordinator for the EBG in his ProPetén office in Flores (the capital of the Petén), gathering more in-depth information on the history of the station and ProPetén's involvement in Paso Caballos.

## A social hierarchy of forest knowledge

Once I traveled into the field and visited the biological station, it became clear that the "current scientific research" advertised in ProPetén's mission statement has fallen behind, despite significant research use of the station during the organization's earlier years. I visited in the rainy season, and the majority of scientific researchers visit in the dry season, simply due to issues of transportation (the road to Paso Caballos is unpaved, and becomes muddy, heavily rutted, and at times impassable during the six-month-long rainy season). But in my conversations with workers at the EBG and with ProPetén staff, the lack of funding for research at the station came up again and again. The research that does still happen is conducted independently of ProPetén's programs and staff, mostly by foreign researchers, and focuses primarily on local biodiversity and wildlife population surveys.

Currently, the biological station serves primarily as a destination for ecotourism, volunteer tourism, university and corporate retreats, and environmental workshops and trainings, most of which are aimed at generating revenue rather than research. The staff of the station has been reduced in recent years from twelve to five regular workers, whose time is dominated by simple upkeep of the station—rethatching roofs, sweeping out dusty dormitories, replacing broken bathroom pipes and the never-ending battle of machete against encroaching grassy weeds. These workers are part of the small minority who were born and raised in the Petén and whose families had been in the region for generations. All of them worked in extractive industries as harvesters of non-timber forest products before the arrival of the biosphere reserve and its associated profitable jobs in conservation.

These workers took great pride in their familiarity with the forest, and regaled me with

dramatic stories of snakebites and near-poisonings in the forest, with death averted at the last moment by the fortuitous collapse beneath a particular tree species that was the needed antidote. These forest stories stretched back generations and revealed a complex and nuanced understanding of local flora and fauna, and the workers expressed frustration with some scientific researchers who relied on their local knowledge and expertise without acknowledging the help, or who may have even treated them as ignorant. Talking to me, the EBG staff acknowledged that visiting scientists have a lot of theoretical and book-knowledge of the forest, but that without the staff's practical knowledge and guidance these researchers would be hopelessly lost in the jungle. The workers expressed interest in an exchange of ideas and experience, a give-and-take relationship in which both sides would emerge more knowledgeable about the Petén's forests.

On the other hand, the five Ladino workers at the biological station consistently valued their own knowledge of the forests as more valid and legitimate than the Q'eqchi' migrants living in Paso Caballos. While their ancestors may have been from the vastly different environment of the Guatemalan highlands, villagers in Paso Caballos have been living in a close relationship with the lowland forests for over 15 years and some have been in the Petén much longer than that. Their knowledge of the forest—based on subsistence and livelihood uses instead of the extractive industries of the Petén's past—is no less "local" or practical than the knowledge of the EBG staff. In general, the staff of the EBG refer to the population of Paso Caballos as ignorant, with one even going beyond forest knowledge to tell me "they don't know anything about agriculture," which is of course the primary source of village livelihoods.

## Understanding and ignorance, or inclusion and exclusion?

In the village of Paso Caballos, people have absorbed not only the teachings and ideas of ProPetén's environmental and development programs, but also the idea that their experience and knowledge do not count for anything. Forty three percent (28/65) of people I interviewed told me that they didn't know the local

**Photograph 3.** A worker at the Estación Biológica Las Guacamayas clears the encroaching forest undergrowth from a path.

forest. However, when I responded to that statement with a question about what the forest was for, 100% of interviewees were able to answer, with uses ranging from daily needs (materials to build our houses) to ecosystem-level function (the trees provide important fruits for the animals, which we hunt) to environmental services (the forest purifies the air and water) to purely aesthetic values (we need to leave the forest so our children can see its beauty). People's lives in Paso Caballos are intimately tied to the land and forest, and while some of their ideas likely have origins in ProPetén's environmental education programs, their experience and knowledge of the local forested landscape is still important to building this understanding.

A major trend that emerged over the course of my interviews in the village was the distinctions between the groups of people who got included in ProPetén's trainings and projects, and who therefore received the primary benefits of these activities, and those who did not. ProPetén frequently provides training and education programs, *capacitaciones*, that range from training as ecotourism guides to agroforestry techniques or forest fire prevention. Nearly all of these capacitaciones are aimed at bringing money into the community, and even when the people trained are supposed to go back and pass along their education to the rest of the village, the actual participants end up gaining the most benefits by far. Despite the fact that the more than half of villagers spoke only Q'eqchi'—40 out of my 65 interviews required translation—capacitaciones are only offered in Spanish, without translators. This almost entirely excludes women from participation as well, considering that very few Q'eqchi' women can speak more than a few rudimentary words of Spanish. Finally, many people in Paso Caballos mentioned that capacitaciones require a serious time commitment, perhaps two days per month, and only those members of the community who already have enough financial security to give up a day's labor are able to take part.

## Conclusions

Despite the lack of connection between scientific research at the EBG and ProPetén's projects in Paso Caballos, there is a strict hierarchy of who's forest knowledge is considered legitimate, running from (often foreign) scientific researchers to Ladino ProPetén staff to Q'eqchi' migrants. Instead of recognizing Q'eqchi' experiences and working to build inclusive strategies for conservation and development, this locally developed knowledge is written off as ignorance and used as the basis for exclusion. Time and again the workers at the biological station differentiated those people friendly to the station—those who participated in capacitaciones or worked in ProPetén's ecotourism group—referring to them as "those people that understand." But my conversations with a wider group of people in Paso Caballos revealed that understandings of conservation aren't really all that different. Instead, people are excluded from the benefits of ProPetén's programs on the basis of economic status, gender, and language, and this exclusion is hidden beneath the broad label of "ignorance."

These problems are not unique to this village or organization, but reflect the larger social and political fabric of Guatemala. Environmentalists working from inside and outside Guatemala established the Maya Biosphere Reserve in 1990, six years before peace accords were signed that put an end to the country's 30-year civil war. Violence and persecution of indigenous communities, including the Q'eqchi', was rampant during this period, and structural inequalities between Ladinos and Maya groups has not been adequately addressed. By bringing in foreign scientific expertise without addressing the internal inequalities of Guatemalan society, ProPetén and other environmental groups have only added conservation to the long history of exclusion of Q'eqchi' and other indigenous groups.

## References

Meyerson, F. 1998. Guatemala burning. *The Amicus Journal* 20: 28-31.

Nations, J.D. 2006. *The Maya Tropical Forest: People, Parks, and Ancient Cities*. Austin: University of Texas Press.

ProPetén. 2004. *About ProPetén.* Retrieved November 2007 from http://www.propeten.org/about.htm

Sader, S.A., C. Reining, T. Sever and C. Soza. 1997. Human migration and agricultural expansion. *Journal of Forestry* 95: 27-32.

Swartz, N. 1990. *Forest Society, a Social History of Petén, Guatemala*. Philadelphia: University of Pennsylvania Press.

## Acknowledgements

Many thanks to ProPetén, the staff of the Biological Station, and the people of Paso Caballos who welcomed me into their lives and shared their stories and food with a freakishly tall gringa. Thanks especially to my translator in Paso Caballos, Miguel Xol, and to my good friends Antonio and Raquel at the station. I would also like to thank the Tropical Resources Institute and the Yale Program in Agrarian Studies for their generous support, without which this project would not have been possible. Finally, Carol Carpenter, the editors of the TRI bulletin, and friends near and far have provided insightful and thought-provoking feedback on my work, and they all deserve more than this small gratitude for their efforts.

*Source: http://www.oldbookillustrations.com/index.php?lng=en*

# Conservation in Flux:
## Pursuing Social Resilience in Mozambique and Peru

*by James Leslie, joint MESc-MBA 2008*

Biodiversity conservation is not static. Despite the rhetoric of permanence and perpetuity, protected areas and land easements are vulnerable to ever-evolving pressures. The social system is constantly shifting to exert new stresses as well as present unanticipated opportunities that can impact biodiversity conservation efforts. Consequently, conservation strategies need to be re-examined regularly to ensure that they are meeting their objectives.

Local stakeholder participation, robust cross-scale linkages of institutions and organizations and effective leadership can contribute to conservation success (Folke et al. 2005). In this paper, I suggest that the articulation of these elements contributes to socially resilient conservation. Resilience is the capacity of a system to absorb repeated natural and human shocks and continue to maintain the same function, structure, identity and feedbacks (Folke et al. 2005, Walker et al. 2004). In this context, participation is understood as a continuum of engagement—of local people by outside organizations—from information transfer to co-decision making to supporting local initiatives (Wilcox 1996). Meanwhile, maintaining linkages and collaboration across scales allows for the distribution of impacts and risks associated with shocks or perturbations to the ecological or social system (Folke et al. 2005). Effective local leaders are able to not only manage a dynamic decision-making process with their constituents but also act as conduits of information and liaisons with organizations at other scales.

I draw on field observations from protected area management in Mozambique and Peru to illustrate the relationship among these key elements as well as my evolving perceptions of conservation as process, ever-vulnerable to change. The two field sites were selected because of their explicit emphasis on strengthening local organizations in order to engage communities in conservation. In both cases, WWF invested significant resources to facilitate the creation of protected areas and natural resource management by the neighboring indigenous communities.

### Bazaruto Archipelago National Park, Mozambique

My research partner Julia Urrunaga and I traveled to Mozambique in summer 2007 to study the Bazaruto Archipelago National Park, 600 kilometers north of Maputo. Originally established in 1971, the park was expanded in 2001 to include all five of the archipelago's islands, three of which are home to seven indigenous communities and approximately 3,500 people (Taylor 2003). Having initiated support for the management of the protected area in 1989, the World Wildlife Fund (WWF) recently completed the first phase of the communi-

*James Leslie received a BA in Biology and a secondary teacher's certificate from Brown University. He volunteered with the Peace Corps in Paraguay and worked in South America, most recently for the WWF Peru. At Yale, he has focused on participatory governance structures in natural resource management, conducting field research in Mozambique and Peru. James was a World Bank consultant with the Nicaraguan Forest Authority (INAFOR), providing assistance to strengthen the governance and improve the sustainability of the forest sector. After he completes his joint degree at Yale, James hopes to re-engage in international development and conservation programs in the tropics.*

ty-based natural resource management project with the seven communities. The goal of the effort was to ensure that "community-based organizations are actively participating in the protection, management and sustainable use of the [BANP] and its natural resources" with the park administration and private sector (WWF Mozambique 2005:6). In other words, WWF recognizes that the long-term sustainability of the protected area hinges on the community's support.

The seven communities are socially heterogeneous in terms of their economic activities, education levels and use patterns of natural resources and appear to lack strong traditional institutions and authorities. Particularly because of this lack of traditional authorities, sense of community and formal education level of the local population, WWF opted to partner most closely with state representatives—the park administration. At the same time, WWF staff attempted (with limited success) to engage the local population in conservation activities. In the most recent phase, it supported the creation of the Association Thomba-Yedhu and coordinated with its partners the selection and training of participants in the association. According to Thomba-Yedhu's current president, the organization was established in order to administer the funds received as part of the revenue-sharing scheme related to the park entrance fees. Nonetheless, when asked, local residents were unaware of the association's purpose, activities or even who among their neighbors were participants in some capacity.

In supporting the development of Thomba-Yedhu, WWF can be considered a bridging organization between the communities and larger scales of decision-making, such as that at which the Park administration operates.

**Photograph 1.** A woman from Bazaruto Island produces *utchema* (palm wine). The sap from the native *Hyphaene coriacea* and *Phoenix reclinata* provides an important income source to families on the island.
*Photo: J. Urrunaga*

**Photograph 2.** Local fishermen with their fish harvest. The fish is dried prior to transport to markets on the mainland.
*Photo: J. Urrunaga*

However, this opportunity to strengthen linkages across scales is mostly lost, because of the unclear definition of the local partner. Based on our interviews with community members, association participants and park staff, we perceived that Thomba-Yedhu was not representative of the local population. For example, the president was once a military officer who recently returned to the island, and the previous president, a tourism resort manager who had migrated from South Africa. At the same time, the lack of existing traditional institutions and weak traditional leadership left a void of a local partner in conservation decision-making. Should WWF and its partners have invested more effort in strengthening remnants of traditional institutions with questionable current social relevance? Or was its strategy to establish Thomba-Yedhu noble but perhaps not executed in such a way to maximize ownership by the local population?

## Alto Purus, Peru

In Peru, the study site forms part of WWF's Amazon Headwaters Initiative that commenced in the Purus province, as well as in neighboring Bolivia and Brazil, in 2003. Julia and I traveled to this isolated corner of Peru in August 2006. Almost two years before, the Peruvian government issued a Supreme Decree establishing the 2,510,694 hectare (ha) Alto Purus National Park and the 202,033 ha Alto Purus Communal Reserve (WWF Peru 2005) (Figure 1). In response, WWF awarded the prestigious Gift to the Earth award to then Peruvian President Alejandro Toledo and the Federación de Comunidades Nativas del Purús, FECONAPU, the local indigenous federation. Eight indigenous groups comprising 3,200 people in 41 communities live within the park's buffer zone (Photogragh 3). WWF's main objectives for the area include strengthening "the capacity of indigenous com-

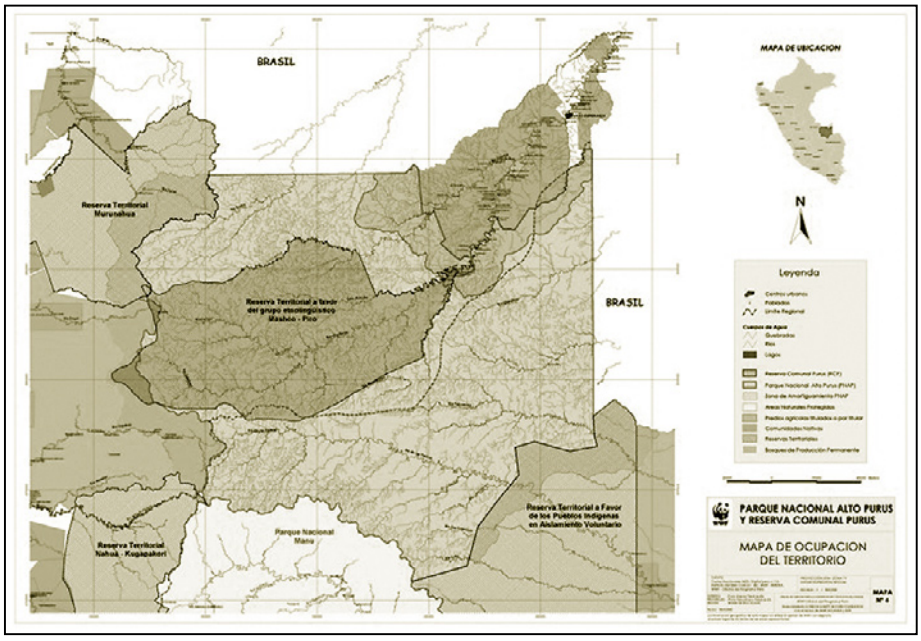



**Figure 1.** This map delineates the recently established Alto Purus National Park, the Purus Communal Reserve and the Territorial Reserve in favor of the Mashco-Piro ethno-linguistic group. The 41 communities are located in the northeast quadrant.
*Source: WWF Peru*

munities to manage the natural resources in the buffer zone" (WWF Peru 2004:1).

Motivated by the Purus region's rich biodiversity, WWF engaged FECONAPU as a partner in its conservation strategy. WWF chose FECONAPU as its partner because it was an already established organization with a mandate to represent the 41 communities. After several years of investing in the administrative and managerial capacity of FECONAPU, WWF saw its partnership begin to sour in early 2007. Following several changes in FECONAPU leadership that coincided with the election of the first indigenous mayor in the region, FECONAPU reversed its policy in support of WWF and the National Park. It called for an immediate withdrawal of WWF from the region and dissolution of the Alto Purus National Park and Communal Reserve (Parroquia Purus 2007). Through a newly minted alliance between the local municipality, FECONAPU and the Catholic Church's local parish, an unusual assembly of all of the communities was held in March 2007. During this meeting, representatives of the 41 communities strongly rejected FECONAPU's proposal. Only three of approximately 200 delegates voted in its favor (Herrera, pers. comm. 2007).

These events hint at the illegitimacy of the FECONAPU leadership, which opted to place personal gain before communal interests. The communities began to realize that the illegal logging mafia was driving the new policy within FECONAPU and pressured its leaders as well as the office manager of the newly elected mayor to leave the region. The communities—exercising their role in FECONAPU—demanded the accountability of the organization's leaders. At the same time, WWF moved to distance itself from FECONAPU, citing that both that organization and the municipality no longer represented the local population (Herrera, pers. comm. 2007). WWF appeared to weather this fracture in the relationship with FECONAPU as a result of the trust developed between the staff and the individual communities.

## Discussion

These cases in Mozambique and Peru exhibit a distinct mix of local participation, cross-scale linkages and leadership. Given the importance of these elements for social resilience, how may conservation organizations contribute to situations where legitimate partners emerge or can be readily identified to foster the articulation of these elements at the local level? Brechin et al. (2003:14) define legitimacy as referring to "any behavior or set of circumstances that society defines as just, correct, or appropriate". In this context, society is the local population affected by the conservation strategy.

In Mozambique, there appear to be few formal mechanisms to provide supportive linkages between local communities and the state or others about land use and property rights. Further, because of the lack of a legal framework to ensure local participation in resource management, local power can be described as "simple privileges given and taken at the discretion of state authorities without real transfer of decision-making powers to local communities" (Salamao 2002:5). While current laws have clear mechanisms to ensure upward accountability—for example, the state-sanctioned paradigm of rule enforcement and supervision—there are none to guarantee downward accountability, which can be a measure of legitimacy of local authorities (Salamao 2002).

Real devolution of administrative responsibilities can approximate legitimacy. However, devolution—whether by the state through formal decentralization or an NGO through meaningful participation—exposes the conservation initiative to ecological and social shocks, such as an unexpected withdrawal of support by local participants. The result is an inherent dilemma for conservationists. On the one hand, they wish to facilitate local participation to ensure long-term sustainability; on the other hand, there exists the temptation to exert influence on participatory processes in order to limit the vulnerability of the conservation initiative. While it may hamper efficiency or increase confusion, sharing management responsibilities—even overlapping them—can bolster resilience of the system to abrupt or turbulent change (Folkle et al. 2005, Ostrom 2005).

In both the Peruvian and Mozambican sites, WWF aspired to devolve responsibilities and project ownership to local communi-

**Photograph 3.** On the bank of the river Purus, plantains await transport from the community of Pankirentsy to Esperanza. *Photo: J. Urrunaga*

ties. That said, the NGO and its government partners did not rush to relinquish control of decision-making, perhaps because they valued the importance of cross-scale collaboration. In Mozambique, the careful selection of local representatives for Thomba-Yedhu allowed WWF to maintain influence over management decisions in the short term. In contrast, WWF in Peru was able to devote its energy to strengthen the traditional institutions and leadership embodied by FECONAPU. In the long term, illegitimate local representation in Thomba-Yedhu may potentially inhibit the transition to a resilient local governance system.

In Peru, as in other Latin American societies, a strong social movement by the indigenous peoples has provided them with a voice and more explicit linkages through which to interact with the state and others. As Agrawal and Gibson (1999:632) remark, there is an "increasing prominence of indigenous and ethnic claims about the stewardship role of native populations in relation to nature… the capacity of states to coerce their citizens into unpopular development and conservation programs is limited."

In Peru, the indigenous communities acquired a voice by organizing themselves at multiple scales. At the local level of Purus, the federation FECONAPU was established to provide voice to a group of 41 communities otherwise isolated from the larger social movement. FECONAPU in turn coordinates with regional and national-scale indigenous organizations (ORAU and AIDESEP, respectively)[1]. The role of WWF has been to assist each of these organizations in communications as well as formulating scale-appropriate actions.

Ultimately, as conservationists, we need to understand the sources of social resilience at multiple scales that influence the social-ecological system of interest. We then need to leverage our strengths as bridging organizations to promote linkages between legitimate leaders and relevant stakeholders at other scales. Strong local participation, legitimate and accountable leadership and robust linkages across varied geographic and institutional scales will increase the likelihood that a social system will be able to weather unanticipated shocks and abrupt change.

## Endnotes

1 ORAU, the Regional Organization of AIDESEP, Ucayali, supports 12 local affiliate organizations including FECONAPU. AIDESEP is comprised of 6 regional organizations, including ORAU. A total of 57 local organizations such as FECONAPU are represented by AIDESEP.

## Acknowledgements

I would like to express my sincere gratitude to A. Doolittle, M. Dove, C. Carpenter and H. Leslie. This research would not have been feasible without the support and participation by my wife and research partner, J. Urrunaga. I would also like to recognize the collaboration of the Sitone and Pankirentsy communities, the BANP Administration, the World Wildlife Fund offices in Peru and Mozambique, and in particular J. Herrera, K. Soudre, F. Prins and H. Motta. Funding for this study was provided by the National Science Foundation, the Tropical Resources Institute, the FES Summer Internship Fund and the WWF/FES Internship Fund.

## References Cited

Agrawal, A. and C. Gibson. 1999. Enchantment and disenchantment: The role of community in natural resource conservation. *World Development* 27(4): 629-649.

Brechin, S.R., P.R. Wilshusen, C.L. Fortwangler and P.C. West. 2003. *Contested Nature.* New York: SUNY Press.

Folke, C., T. Hahn, P. Olsson and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30: 441-473.

Herrera, J. 2007. Personal communication. Lima, Peru.

Ostrom, E. 2005. *Understanding institutional diversity*. Princeton, NJ: Princeton University Press.

Parroquia Purus. 2007. *Revista Palabra Viva* 3(23). Puerto Esperanza, Peru.

Salamao, A. 2002. *Participatory natural resources management in Mozambique: An assessment of legal and institutional arrangements for community-based natural resources management*. World Resources Institute, Washington D.C.

Taylor, J. 2003. *A brief social overview of the island communities in Bazaruto Archipelago National Park.* Consultant report prepared for WWF Mozambique cooperation office, Maputo.

Walker, B., C.S. Holling, S.R. Carpenter and A. Kinzig. 2004. Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society* 9(2): 5.

West, H. and S. Kloeck-Jenson. 1999. Betwixt and between: 'traditional authority' and democratic decentralization in post-war Mozambique. *African Affairs* 98(393): 455-484.

Wilcox, D. 1996. *The guide to effective participation.* Brighton, England: Partnership Books.

WWF (World Wildlife Fund) Mozambique. 2005. *Bazaruto Archipelago National Park, Mozambique. Mid-term internal review of Bazaruto multiple resource use project, 2001-2005 and Bazaruto CBNRM project, 2003-2005.* Mozambique.

WWF (World Wildlife Fund) Peru. 2004. *Forest protected areas conservation. South western Amazon moist forests ecoregion. Semester technical report: November 2003 -January 2004.* Peru.

WWF (World Wildlife Fund) Peru. 2005. *Forest protected areas conservation. South western Amazon moist forests ecoregion. Semester technical report: July 2004 -January 2005.* Peru.

.

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

# Understanding Stakeholders' Values and Concerns:
## The Path of the Tapir Biological Corridor, Costa Rica

*by Georgia Basso, MESc 2008*

### Introduction

Real estate development booms are occurring in rural regions across the globe. Although development is typically promoted as a means of invigorating rural economies, local landowners often feel a sense of loss, fear and helplessness in its wake (Slattery 2003, Walker and Fortmann 2003). Rampant development is a pressing issue in Costa Rica's Path of the Tapir Biological Corridor (PTBC), where government enforcement is weak and wealthy developers have an immense amount of power. Both local and foreign landowners express concern with the social and environmental effects of real estate development in this region. This research examines landowners' values and responses to real estate development in the PTBC. The paper concludes by suggesting strategies that could be used to uphold common values and influence the course of development in the corridor.

### Study area

The Path of the Tapir Biological Corridor is one of Central America's most diverse regions (Photograph 1). Stretching for 50 km along Costa Rica's central-southern Pacific Coast (Figure 1), the PTBC connects the Osa Peninsula and the watershed of the Golfo Dulce to the south, with the Los Santos Forest Reserve and Talamanca mountain range to the north (Redondo-Brenes 2007, Rodríguez 2000). The PTBC is formally recognized as a component of the Mesoamerican Biological Corridor, an initiative to create a biological bridge between North and South America (Ewing 2005).

The broad goal of the PTBC is "to capture social and economic benefits from the sustainable management of the region's resources" (Newcomer 2002). The original idea for its establishment emerged in 1987 when a small group of community members met to discuss conservation on private lands. After this initial meeting, larger groups met and discussed connecting agriculture, tourism and conservation in an economically viable way. In 1994, the PTBC was formally established to coordinate these efforts (Newcomer 2002). The *Asociación de Amigos de la Naturaleza* (ASANA) is the grassroots conservation organization that formalized and continues to administer the PTBC initiative.

Newcomer (2002) identified three groups that participated in the early stages of the PTBC: community organizations (including local, national and international NGOs), key local individuals and government agencies. In recent years, real estate developers and foreign landowners have emerged from "key individual" roles and grown into their own broader participant groups. The influx of real estate developers and foreign landowners has caused a major demographic shift, from a majority of Costa Ricans owning large parcels in the corridor's

*Georgia Basso holds a BS in Entomology and Applied Ecology with concentrations in wildlife conservation and art from the University of Delaware. Prior her arrival at the Yale F&ES, Georgia spent two years in the Central Valley of California working as an endangered species biologist for California State University Stanislaus, Endangered Species Recovery Program (ESRP), leading invertebrate research projects and developing the outreach program. Georgia will continue working on land conservation and strategic cross-sector collaboration through corporate social responsibility initiatives.*

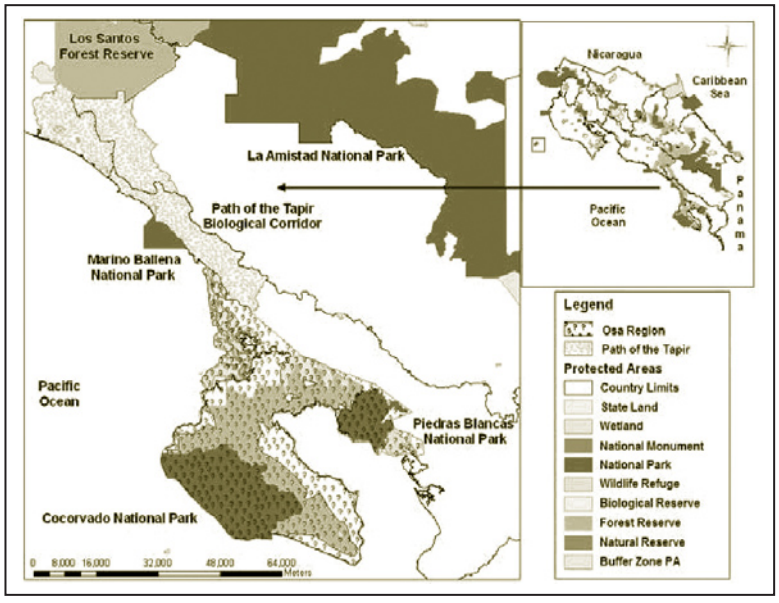
**Photograph 1.** The PTBC is among the most diverse regions in Central America, providing habitat for the endangered scarlet macaw, 2,700 plant species, Costa Rica's four monkey species and numerous invertebrate species.
*Photos: Scarlet macaw, Encyclopædia Britannica Online. Flowers, monkey and butterfly, Freddy Cascante.*

early days to a heavy presence of North Americans owning second homes on smaller parcels today (Photograph 2). According to Newcomer (2002) understanding stakeholders' perspectives is especially important as changes in land use and perspectives with regard to the environment will affect the fate of the corridor.

## Methods

A total of 52 Costa Ricans and 47 foreigners participated in this study between May and August 2007, either through interviews, surveys or both. Individuals represented all five participant groups (e.g. Costa Rican landowners, community organizations, government agencies, real estate developers and foreign landowners). Data collection took place in 14 communities within the corridor (CoopeSilencio, Hatillo, Playa Guapil, Laguna, Plataneo, Dominical, Escaleras, Playa Hermosa, San Josecito, Uuvita, Ojochal, San Buenaventura, Coronado and Tres Ríos) and in government offices in San José and Cortés. Participants were questioned on broad

**Figure 1.** The PTBC and surrounding areas in Costa Rica's central-southern Pacific Coastal Region.
*Source: Redondo-Brenes (2007)*
*InBio 2006, ASANA GIS layers*



**Photograph 2.** A day spa being constructed on a one-acre parcel of land in the biological corridor.

topics including land and land tenure, accessibility of information resources and perceptions of real estate development and ecological conditions in the corridor. In addition to surveys and open-ended interviews, the results of this study are also based on ethnographic field notes and comprehensive literature reviews. Ethnographic notes were taken during community meetings including zoning planning and ASANA board and general member meetings. The literature review included previous research, local newspapers, magazines and web sites.

## Results

While most Costa Rican respondents have owned their land for over 20 years, the influx of foreign landowners seems to be relatively recent, with most foreigners interviewed having lived in the corridor for less than ten years. Within the sample, the corridor's largest landowners were American real estate developers followed by owners of private wildlife refuges (both Costa Ricans and foreigners) followed by rural Costa Rican families with large plots (more than 50 ha). Most foreign homeowners in the corridor owned less than 2 ha of land.

Diverse PTBC landowners shared some key values (Table 1). As defined by Clark (2002) a value is simply a desired object or situation. The majority of foreigners and Costa Ricans said that they valued the corridor's natural environment. Foreigners reported living among Costa Ricans as their second most important value.

**Table 1.** Stakeholders' responses to the question "What do you value the most about living here?" Total number of respondents: 27 Costa Ricans, 32 foreigners.

| Values stated | # of Costa Ricans who stated the value | # of foreigners who stated the value |
|---|---|---|
| Nature | 23 (85%) | 28 (88%) |
| Relaxed, peaceful lifestyle | 9 (33%) | 10 (31%) |
| Occupation | 4 (14%) | 0 |
| Open space | 3 (11%) | 3 (9%) |
| Living among Costa Ricans | 0 | 14 (44%) |
| Freedom from US gov't regulation | 0 | 8 (25%) |

This is relevant to note because without specific plans to uphold this value, development in rural landscapes tends to push out local people (Photograph 3).

In addition to values, landowner's shared common concerns. Seventy one percent of the landowners expressed serious concern with current real estate development in the corridor (Figure 2), but their reasons vary (Table 2).

Generally, Costa Ricans were more worried about the short term effects of development while foreigners tended to focus on longer term effects. Environmental destruction was the most frequently mentioned concern among both groups. The second main concern of Costa Rican landowners was being pushed off their land and out of the corridor. The third most common reaction to development among Costa Ricans was the positive response that development provides good jobs. Foreigners' main concerns were the lack of regulation and real estate developers' viewing the corridor solely as a business pursuit (Photograph 4).

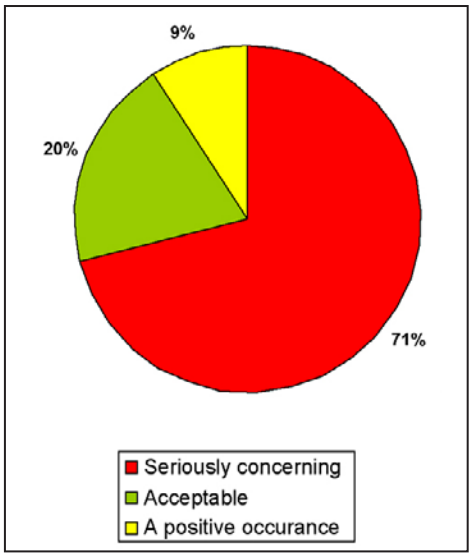
## Discussion and conclusions

The results of this study indicate that landowners share several key concerns and values including the corridor's natural environment, peaceful lifestyle and local people. These values are not being upheld: development is pushing out both nature and Costa Ricans and rising cultural tensions undermine the relaxed, peaceful atmosphere. Moreover, continued environmental degradation and uncontrolled development could ultimately mean the loss of common ground among stakeholders whose shared interests are mainly nature-orientated. Drawing on existing shared values and strengthening trust networks could help landowners collectively address concerns like environmental destruction and Costa Rican emigration in a timely, effective manner (Clark 2002).

Converging values are an important component of trust building and the development of effective gatherings of people (Fukuyama 1995, Kumar et al. 1995). Collective action inspired by converging values started the corridor in the 1980s. Thereafter, collaboration among stakeholders has been a challenge due to factors including a lack of coordinated effort to identify shared goals and act to uphold common interests (Newcomer 2002). Geographic separation of communities further complicates the situation. However, several emerging conditions may facilitate greater communication

**Photograph 3.** Families who have farmed in the corridor for generations are selling large parcels of land to developers and moving into the cities.

**Figure 2.** Stakeholders' perspectives on current real estate development in the PTBC. Total number of respondents: 30 Costa Ricans, 36 foreigners.




and collaboration among corridor stakeholders. As roads and communication systems improve throughout the corridor, collective action and awareness of shared values may increase. Furthermore, important cross sector dialog has recently begun between local conservation leaders and large developers. Additionally, ASANA could successfully advance collective action on a broader scale. ASANA has a proven role as a communication facilitator among local and national organizations. They are a well-known, trusted and reputable organization within the corridor. Initiatives led by ASANA would most likely be well received. However, ASANA's role as a communication facilitator has been limited due to inconsistent funding, high turnover of board and staff members and shifting conservation objectives. Funding and management stability would help ASANA utilize their strategic position to advance communication between stakeholder groups. Moreover, new PTBC residents bringing conservation values and experience could help increase local leadership and reduce pressure on ASANA directors to carry the load.

Collective action could help to address Costa Rican emigration. Local emigration is due to several factors including dramatic rise in land price, influx of foreigners and Costa Ricans' desire for better living standards (A. Redondo-Brenes, pers. comm. July 2007). Both Costa Ricans and foreigners value locals' presence and are concerned with the massive emigration, however little to no collective action upholds this value. The preservation of human diversity in the corridor will occur only if stakeholders recognize and intentionally plan to uphold their common interests. Land planning tools (e.g. certification systems, cooperatives, land trusts) can be cost effective means through which to promote shared values. Ghazoul (2007) writes, "….a broadening of conservation goals and approaches will be necessary in increasingly human-dominated landscapes." In light of the

**Table 2.** Stakeholders' responses to the question "Why do you feel as you do about real estate development in the corridor?" Total number of respondents: 29 Costa Ricans, 34 foreigners.

| Reason | # of Costa Ricans who stated reason | # of foreigners who stated reason |
|---|---|---|
| Environmental destruction | 12 (46%) | 18 (78%) |
| Ousting Costa Ricans from their land | 10 (36%) | 6 (17%) |
| Helps Costa Ricans economically | 7 (23%) | 2 (5%) |
| Lack of rules | 6 (19%) | 13 (46%) |
| Sole profit motives | 4 (12%) | 11(36%) |
| Crowding | 0 (0%) | 6 (17%) |


**Photograph 4.** Signs of development are evident throughout the PTBC.

corridor's shifting demographics and increasing population, the suitability of innovative legal tools should be explored.

A real estate certification system is an example of a low cost, market driven tool that has strong potential to work well in the corridor. Investors and new residents are ecoconscious individuals with disposable income. A market niche for certified, sustainable products most likely exists. Additionally, the Costa Rican Tourism Institute (ICT) has established a sustainable tourism certification program (CST) with growing participation (77 participating hotels and 13 travel agencies in 2007, with approximately 30 new hotels signed up for evaluation in 2008). Adding a new category certifying real estate developments would likely receive political support from ICT. Lastly, one of the largest real estate developers in the region has expressed interest in working with an advisory board to implement large-scale land conservation programs.

Costa Rica has experience implementing other certification systems for industry and tourism (Gentry 1998, Mora 2007). However certification systems are not without drawbacks. They often require strong institutions and some government support and may not address social and environmental issues to the extent that corridor landowners desire. Despite these and other weaknesses, a certification system may fit well with current corridor conditions and be used to uphold values like environmental integrity and economic opportunities for Costa Ricans. Voluntary conservation programs like certification can reduce regulatory burden, create more effective compliance, and encourage innovation by offering flexible alternatives to traditional command and control regulation (Steelman and Rivera 2006). While ASANA may not have the capacity to implement such a program, they could partner with other institutions to increase capacity. For example, the Rainforest Alliance has extensive experience implementing certification programs and partnering with grassroots organizations in Central America. A certification system could be designed to address many landowner concerns by including stipulations for sustainable development, local labor and equitable conditions—which are currently not closely monitored. A corridor certification system is not a panacea, but rather a tool which if used in conjunction with other tools in an atmosphere of collective action, could forward landowners' common interests.

Currently, the decisions of a powerful few are affecting many social and environmental components in the PTBC region. It is not clear that the broader community is benefiting from or in agreement with these decisions. Ghazoul (2007) writes that cooperating groups are more likely to accept decisions that benefit the whole,

therefore conservation may best be advanced by reducing conflict and building trust among stakeholders. Identifying and upholding shared values are first steps in steering development in the PTBC in more sustainable, broadly accepted directions. In the formation of the PTBC, diverse community members displayed the ability to organize and work together toward commonly held objectives. It is this community-driven collaborative action on which the future of the corridor rests.

## Acknowledgements

I owe a debt of gratitude to the participants in the Path of the Tapir Biological Corridor for allowing me into their lives. Their time and knowledge made this study possible. For their guidance and encouragement I thank Quint Newcomer, Alvaro Redondo-Brenes, Jack Ewing, and Professors Susan Clark, William Burch and Jonathan Reuning-Scherer. I extend warm gratitude to Cheryl and Richard Margoluis who were instrumental in the development and design of this study. Thanks to Alicia Calle and Laura Alex Frye-Levine who graciously offered valuable feedback on this manuscript. Funding for this research was provided by the Doris Duke Charitable Foundation and the Tropical Resources Institute at Yale.

## References

Clark, T.W. 2002. *The Policy Process: A Practical Guide for Natural Resource Professionals.* New Haven, CT: Yale University Press.

Ewing, J. 2005. *The Mesoamerican biological corridor: A bridge across the Americas*. Retrieved September 2006 from www.ecowrold.com.

Fukuyama, F. 1995. *Trust: The Social Virtues and the Creation of Prosperity*. New York, NY: The Free Press.

Gentry, B. (Ed.). 1998. *Private Capital Flows and the Environment Lessons from Latin America*. Northampton, MA: Edward Elgar Publishing Inc.

Ghazoul, J. 2007. Placing humans at the heart of conservation. *Biotropica* 39: 566.

Kumar, N., L. Scheer and J. Steenkamp. 1995. The effects of perceived interdependence on dealer attitudes. *Journal of Marketing Research* 32: 348-356.

Mora, R. 2007. Costa Rica's commitment on the path to becoming carbon-neutral. *UN Chronicle Online.* Retrieved January 2008 from http://www.un.org/Pubs/chronicle/2007/issue2/0207p42.htm

Newcomer, Q. 2002. Path of the Tapir: Integrating biological corridors, ecosystem management, and socioeconomic development in Costa Rica. *Endangered Species UPDATE* 19(4): 186-193.

Redondo-Brenes, A. 2007. Implementation of conservation approaches in human-dominated landscapes: The Path of the Tapir Biological Corridor case study. *Tropical Resources* 26: 7-13.

Rodríguez, K. (Ed.). 2000. *Corredor Biológico Paso de la Danta.* Rapid Ecological Assessment prepared for Asociación de Amigos de la Naturaleza del Pacífico Central y Sur (ASANA). The Nature Conservancy, San José, Costa Rica.

Slattery, R. 2003. Sin City keeps its fringes wild: Las Vegans rally in an unprecedented fight to preserve open space. *High Country News.* Retrieved October 2007 from http://www.hcn.org/serclets/hcn.Article?article_id=14241

Steelman, T. and J. Rivera. 2006. Voluntary environmental programs in the United States; Whose interests are served? *Organization and Environment* 19: 1-21.

Walker P. and L. Fortmann. 2003. Whose landscape? A political ecology of the 'exurbant' Sierra. *Cultural Geographies* 10: 469-491.

# Natural Succession in Caribbean Pine Plantations in Sri Lanka

*by Chisato Tomimura, MFS 2008*

It has been suggested that plantations of fast-growing trees facilitate secondary succession and thus are useful in the restoration of degraded lands. Studies indicate that plantations moderate the harsh environment of degraded land, making it more suitable for the regeneration of native species (Cusack and Montagnini 2004, Lamb 1998). Through the last decade, the use of the fast-growing exotic trees has become increasingly common in the practice of restoration. In accordance with this trend, a previous study in Sinharaja, Sri Lanka reports that plantations of Caribbean pine (*Pinus caribaea*) provide a favorable environment for native plant seedlings (Ashton et al. 1997b). This suggests that the Caribbean pine plantations established in the 1980s may have been facilitating the regeneration of native vegetation in the previously disturbed areas of the buffer zone of Sinharaja Man and Biosphere Reserve. In this study, I examined the vegetation currently growing in the pine plantations adjacent to natural forests in Sinharaja. Caribbean pine is planted world wide, but much about the species' potential as a nurse tree for restoration remains to be studied. Thus, the findings of this study will contribute to a better understanding of its ecology and its usefulness in restoration projects.

*Chisato Tomimura graduated with an undergraduate degree in Biology (plant science) and East Asian Studies (Chinese language) from Oberlin College, Ohio. She subsequently worked as editorial assistant in Nature Japan—the Japan office of the science publisher Nature—for two years before starting her Masters program. At Yale she works as editorial assistant for the Journal of Sustainable Forestry. She aspires to work for tropical forests in Southeast Asia after her graduation in May 2008.*

## Background

Plantations of fast-growing tree species in degraded lands have become increasingly common in the last decade as a tool for ecological restoration. A number of studies from around the world report that plantations improve soil quality and assist recovery of biodiversity by ameliorating the microclimate in their shade (Lugo 1992, Ashton et al. 1997b, Fang and Peng 1997). In places where invasive grasses dominate degraded sites and the succession is arrested by recurring fire, plantations can effectively suppress the grasses and prevent fire (Carnevale and Montagnini 2002, Hooper et al. 2005). With the new environmental paradigm that plantations can be made to play an active role to benefit native biota, there is a growing interest in their ecological impact on local biodiversity.

The effectiveness of a plantation to facilitate secondary succession differs markedly with attributes such as plantation style (pure vs. mixed plantation), proximity to the natural forest that serves as seed source and tree species used (Parrotta 1995, Haggar et al. 1997, Cusack and Montagnini 2004, Jones et al. 2004, Lemenih et al. 2004, Lemenih and Teketay 2005). Studies suggest that the main factor determining effectiveness in seed recruitment capacity is the plantation's attractiveness to birds, the major seed dispersers. Trees that provide resources (e.g. edible fruits) for animal dispersers are consistently found to be more efficient in the recruitment of seeds into the plantation (Holl 1999, Healey and Gara 2003, Florentine and Westbrooke 2004, Jones et al. 2004, Redondo-Brenes and Montagnini 2006).

Caribbean pine is a fast-growing timber species indigenous to lowland Central America. It is planted worldwide including the neotropics, tropical Africa, Pacific Southeast Asia and South Asia, and is considered the most important pine species for commercial plantations in the lowland tropics (Lamb 1973). Its seedling establishes easily and grows even on hot, dry, infertile sites owing to the adaptability of its root system to a range of soil water regimes. Its great resistance to fire makes it especially valuable in dry lands where fire is a barrier for the establishment of vegetation.

Because of its ability to grow fast and vigorously in degraded lands, this species is potentially useful in restoration. Caribbean pines are said to improve soil nitrogen status, and their light crown structure allows more light to penetrate into lower strata than other tropical lowland pines (Lamb 1973). Furthermore, in evermoist climates Caribbean pines tend not to produce seeds. While this trait makes it less attractive as a commercial timber species, it reduces the species's potential to become invasive and makes it more suitable for use in the restoration context.

In Sri Lanka, a large-scale reforestation program with Caribbean pine variety *hondurensis* was carried out in degraded lands throughout the country starting in 1965. Prior to this effort, these lands suffered severe erosion, which prevented any notable natural succession from occurring. Consequently, Caribbean pine was planted at large scale to control erosion due to its unique capacity to grow in such barren lands. By 1987, more than 25,000 ha of land had been reforested with Caribbean pine (Pereira 1988). Today these pines have been growing for 20-40 years: about a common rotation age for this fast-growing species that attains maturity in about 15 years (Lamb 1973, Gunasena 1988). It is hoped that these pines host regeneration of sufficient native vegetation, which will eventually form secondary mixed forests (Tilake 1988).

## Site description

This research was conducted in Caribbean pine plantations in the buffer zone in the western edge of the Sinharaja Man and the Biosphere Reserve in southwest Sri Lanka (6°21'-27'N, 80°21'-38'E) (Figure 1). Designated as a Natu-

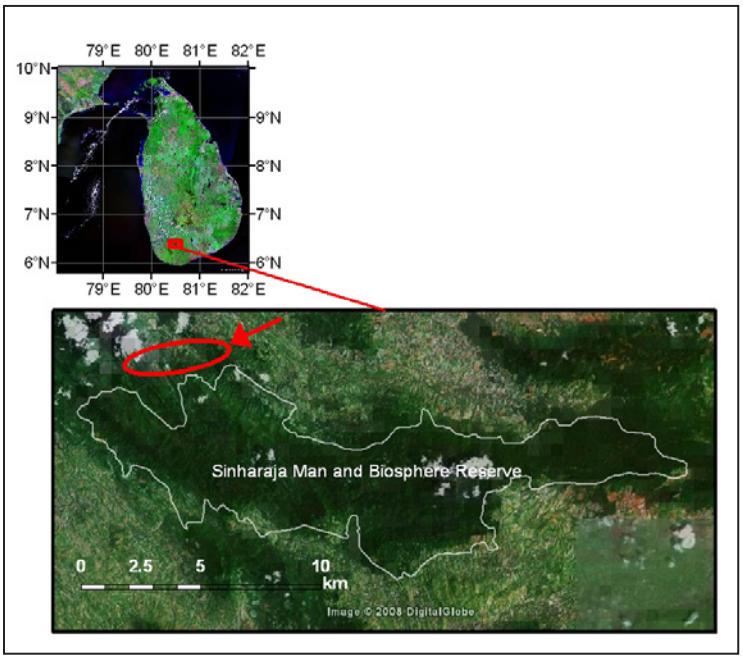



**Figure 1.** Map of Sri Lanka and Sinharaja Forest Reserve. Data were collected in the area surrounded in the ellipse pointed by an arrow.

ral World Heritage Site and a National Heritage Wilderness Area, this reserve represents the largest intact lowland rainforest remaining in the country. The reserve ranges from 450 to 1,000 m above the sea level. The climate is aseasonal tropical with a minimal seasonal temperature fluctuation around 25 °C. Rainfall is consistent throughout the year, with an annual mean of 5,000 mm. Monthly average precipitation varies between 198 mm in February and 666 mm in May (Gunatilleke et al. 2004). The soils are characterized as Ultisols (Ashton et al.1997b, Gunatilleke et al. 2004, Shibayama et al. 2006). Sixty-nine percent of the flora in the forests is endemic, and currently there are no reports of anthropogenic activity affecting the ecological integrity of the reserve.

Caribbean pines were planted at 2x2 m spacing in 1978-1982 for site rehabilitation on abandoned shifting cultivation sites. The size of the stands varies widely from less than 1 ha up to 10 ha (Ashton et al. 1997b, Ashton et al. 2001). All vegetation underneath the pines is assumed to have grown naturally since no silvicultural treatment has been practiced in the area except for small-scale, experimental treatments (Ashton, pers. comm. Nov. 2006).

## Methods

In June-August 2007 a total of 15 50 m long transects were made from the edge of the natural forest-plantation boundary to the interior of the plantation, in seven pine plantation stands. Within each transect, five 10x10 m overstory plots were made from the edge into the plantation stands to collect mid-story and overstory vegetation data. In each plot, except lianas, all plants taller than 1.3 m were identified to the species level, and diameter at breast height (dbh) to the nearest 0.1 cm was recorded for each plant. Plant height was measured with a clinometer. Basal area of pines and other trees was assessed using the variable radius plot method. A soil sample was collected at the center of each plot. Within each overstory plot, a 1x1 m subplot was made in the corner closest to the plantation edge. The number of plants shorter than 1.3 m and all lianas were recorded by species in the subplots.

## Results

A total of 127 species were identified in 75 plots in total, where no regeneration of Caribbean pine was observed. Most plants were either pioneer-type, rainforest understory or subcanopy species. Several rainforest canopy species were found in small numbers. Common species found in the overstory plots and understory subplots are listed in Tables 1 and 2, respectively.

In the overstory plots *Schumacheria castaneifolia,* a native pioneer tree, was most common. The reversed-J shaped curve of height and diameter distribution suggests successful regeneration of this species in the pine plantations (Figures 2 and 3). However, neither of the two most common species—the small tree *S. castaneifolia* and the shrub *Thottea siliquosa*—ever reach the canopy. On the other hand, *Alstonia macrophylla*, the third most common species, often reached the canopy, attaining the height of 20 m or more. This naturalized exotic pioneer tree from Malaysia (Ashton et al. 1997a) seemed to be the only species consistently growing into the canopy; 18 trees of *A. macrophylla* reached the height of 15 m, whereas 16 trees of other 12 identified species did. The majority of these species were pioneer species that typically occur in rainforest gaps and fringes, although a few rainforest subcanopy species also reached the canopy.

In the understory, the exotic shrub *Clidemia hirta* was observed in 95% of the subplots and all transects. It often occurred in overwhelming abundance reaching a maximum of 98 plants per $m^2$, completely overshadowing anything underneath. The abundance of *C. hirta* was negatively correlated with both understory species richness and mid-and overstory

**Table 1.** Ten most common species found in overstory and midstory in10x10 m plots. All species except *Alstonia macrophylla* are native.

| Species | Total number of plants | Frequency among plots | Frequency among transect |
|---|---|---|---|
| *Schumacheria castaneifolia* | 412 | 0.85 | 1.00 |
| *Thottea siliquosa* | 217 | 0.43 | 0.80 |
| *Alstonia macrophylla* | 193 | 0.61 | 0.93 |
| *Gomphia serrata* | 162 | 0.57 | 1.00 |
| *Dillenia triquetra* | 116 | 0.60 | 1.00 |
| *Eurya acuminate* | 83 | 0.49 | 0.87 |
| *Litsea longifolia* | 78 | 0.40 | 0.80 |
| *Hedyotis fruticosa* | 67 | 0.37 | 0.60 |
| *Wendlandia bicuspidata* | 56 | 0.47 | 0.93 |
| *Chaetocarpus castanocarpus* | 55 | 0.37 | 0.80 |

species richness, as shown in Figures 4 and 5, respectively, suggesting the negative impact of *C. hirta* on the colonization in the plantation understory.

## Discussion and conclusions

If the objective of planting pines was to rehabilitate the land so as to enable the natural colonization of vegetation in previously denuded soils, it was successful at least in some sense for as many as 127 species—mostly natives—were growing in the plantations. However, many pine plantations were found to be seriously encroached by invasive species. In fact, *A. macrophylla*, the only species found to be consistently reaching the canopy, is an exotic pioneer species. Few other tree species attained the canopy height, even though the plantations are already 25-30 years old.

In many stands, overabundance of *C. hirta*, another exotic, appears to impede the growth of other species, impacting the successional dynamics under the pine trees. This exotic shrub is actually highly invasive in Pacific Asia, where it has caused serious ecological problems (Gelarch 1993). The damage it has caused to the native ecosystems made it one of the 100 most invasive species in the world as listed by IUCN (IUCN n.d.). Although it is unlikely that pine plantations promote the invasion of *C. hirta*, they do seem to provide more favorable environment for its growth than the natural forest, where *C. hirta* is rare.

**Table 2.** Seven most common species found in understory in 1x1 m plots. All species but *Clidemia hirta* are native.

| Species | Total number of plants | Frequency among plots | Frequency among transect |
|---|---|---|---|
| *Clidemia hirta* | 2070 | 0.95 | 1.00 |
| *Chrysopogon aciculatus* | 100 | 0.32 | 0.87 |
| *Piper sylvestre* | 65 | 0.31 | 0.60 |
| *Schumacheria castaneifolia* | 18 | 0.16 | 0.53 |
| *Cryptocarya wightiana* | 10 | 0.12 | 0.53 |
| *Nepenthes distillatoria* | 10 | 0.07 | 0.27 |
| *Thottea siliquosa* | 8 | 0.09 | 0.33 |

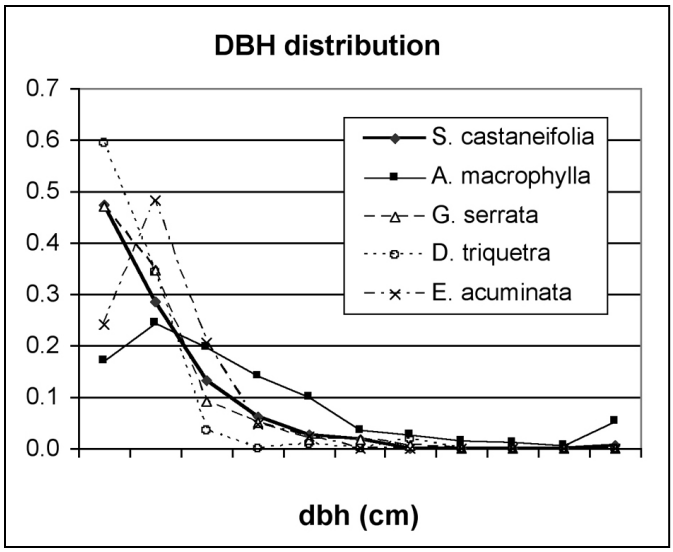



**Figure 2.** Height distribution of five of the six most common tree species. *Thottea siliquosa* is excluded because it is a shrub. The peak in the height class of 2-4m is an artifact of smaller range of the smallest height class (1.3-2cm). Four species other than *A. macrophylla* did not grow 15m or above.

Due to the dominance of *C. hirta*, the secondary succession under the pine plantations has probably not proceeded as much as it could have without the invasive. With a relatively small number of late-successional species currently occurring, it does not seem feasible that the pine plantations will naturally shift into mixed secondary forests, as originally hoped. The removal of the pine canopy cover will only promote the proliferation of the invasive shrub and many plantation stands may become degraded shrub lands. Before the pines are removed or die out, appropriate measures should be taken to avoid this worst-case scenario.

The results of this study reveal a risk of exotic species invasion when using Caribbean pine plantations for restoration, even though the plantations do seem to have facilitated colonization by native vegetation when compared with their original disturbed state. Consistent with this result, Keenan et al. (1997) also found that plantations of Caribbean pine in Australia tend to support more weeds than plantations of rainforest trees. These pines form a more open canopy than native rainforest trees, creating a more light-abundant understory that may favor light-demanding weeds such as *C. hirta* instead of more shade-tolerant native woody species.

**Figure 3.** DBH distribution of five of the six most common species in the overstory plots: *Shumacheria castaneifolia, Alstonia macrophylla, Gomphia serrata, Dillenia triquetra, Eurya acuminata.* The second most common species *Thottea siliquosa* is excluded because it is a shrub.

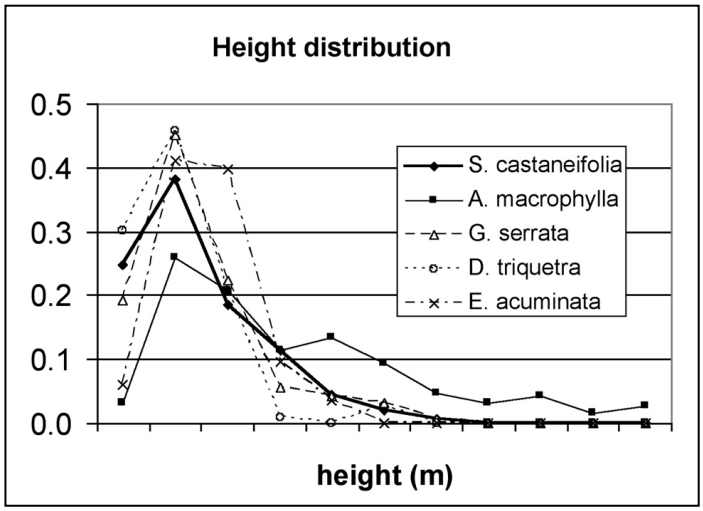


**Figure 4.** Scatter plot of understory species richness versus abundance of *C. hirta* showing the negative correlation between the variables (R= -0.26, P=0.026).

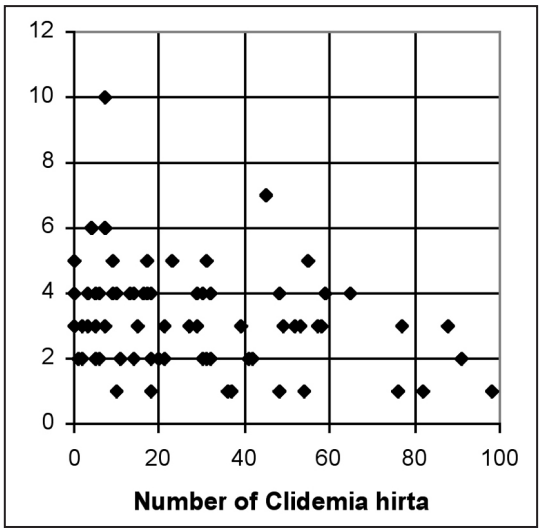
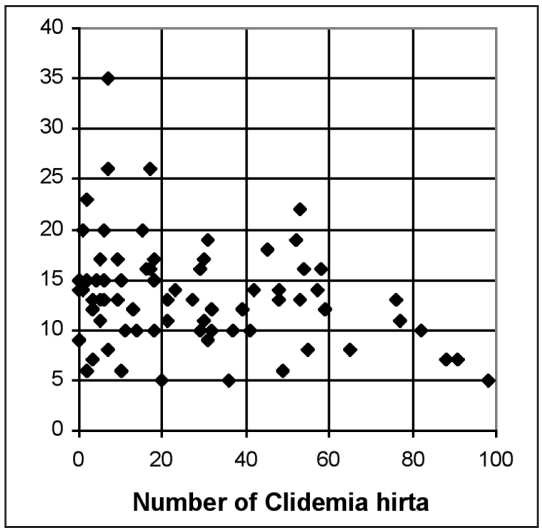



**Figure 5.** Scatter plot of over- and midstory species richness versus abundance of *C. hirta* showing the negative correlation between the variables (R=-0.28, P=0.016).




Prevalence of *C. hirta* in the buffer zone poses a serious concern to the ecological integrity of the adjacent nature preserve. Although undisturbed tropical forests are known to be highly resistant to invasions by exotic species (Fine 2002), thickets of *C. hirta* were found along the trails that run through the reserve. In Silhouette Island, Seychelles, *C. hirta* has been displacing native vegetation by growing in gaps, threatening indigenous species like *Melastoma malabathricum* (Gerlach 1993), which is also native in the natural forests in Sinharaja.

The outcome of this study calls for vigilance for *C. hirta* in the protected area and caution to remove the pines. At the same time, it highlights the vulnerability of plantations to invasions by exotic species and the importance of taking appropriate measures to control invasives in order for restoration projects to succeed. However, more study is needed to assess the effectiveness of Caribbean pine plantations in facilitating the development of vegetation and to understand the mechanism and dynamics of invasions by exotics.

## Acknowledgements

I am indebted to Professor Mark Ashton and Professor B. M. P. Singhakumara for their valuable advice and support for this study and to the Tropical Resources Institute for the funding. I am also grateful to S. Nimal Dharmasiri and Lanka Weerasinghe for their help in field and with daily life in Sri Lanka; to local researchers including Nimal Tennakoon, Anura Tennakoon, T. M. Ratnayake, D. G. R. Sirimanna and R. H. G. Ranil for their help with plant identification.

## References

Ashton, M.S., C.V.S. Gunatilleke, B.M.P. Singhakumara and I.A.U.N. Gunatilleke. 2001. Restoration pathways for rain forest in Southwest Sri Lanka: A review of concepts and models. *Forest Ecology and Management* 154(3): 409-430.

Ashton, M.S., S. Gunatilleke, N. de Zoysa, M.D. Dassanayake, N. Gunatilleke and S. Wijesundera. 1997a. *A field guide to the common trees and shrubs of Sri Lanka.* Colombo, Sri Lanka: WHT Publications (Pvt.) Ltd.

Ashton, M.S., S. Gamage, I.A.U.N. Gunatilleke and C.V.S. Gunatilleke. 1997b. Restoration of a Sri

Lankan rainforest: Using Caribbean pine *Pinus caribaea* as a nurse for establishing late-successional tree species. *Journal of Applied Ecology* 34(4): 915-925.

Carnevale, N.J. and F. Montagnini, F. 2002. Facilitating regeneration of secondary forests with the use of mixed and pure plantations of indigenous tree species. *Forest Ecology and Management* 163(1-3): 217-227.

Cusack, D. and F. Montagnini. 2004. The role of native species plantations in recovery of understory woody diversity in degraded pasturelands of Costa Rica. *Forest Ecology and Management* 188(1-3): 1-15.

Fang, W. and S.L. Peng. 1997. Development of species diversity in the restoration process of establishing a tropical man-made forest ecosystem in China. *Forest Ecology and Management* 99(1-2): 185-196.

Fine, P. V. A. 2002. The invisibility of tropical forests by exotic plants. *Journal of Tropical Ecology* 18: 687-705.

Florentine, S.K. and M.E. Westbrooke. 2004. Evaluation of alternative approaches to rainforest restoration on abandoned pasturelands in tropical north Queensland, Australia. *Land Degradation and Development* 15(1): 1-13.

Gelarch, J. 1993. Invasive Melastomataceae in Seychelles. *Oryx* 27(1): 22-26.

Gunatilleke, C.V.S., I.A.U.N. Gunatilleke, A.U.K. Ethugala and S. Esufali. 2004. *Ecology of Sinharaja rain forest and the forest dynamics plot in Sri Lanka's natural world heritage site.* Sri Lanka: WHT Publications (Pvt.) Ltd.

Gunasena, H.P.M. 1988. Symposium Objectives. In H.P.M. Gunasena, S. Gunatilleke, A.H. Perera (Eds.), *Reforestation with* Pinus *in Sri Lanka: Proceedings of a symposium organized by University of Peradeniya and The British High Commission,* pp.iv-v. 15-16 July.

Haggar, J., W. Kevyn and R. Fisher. 1997. The potential of plantations to foster woody regeneration within a deforested landscape in lowland Costa Rica. *Forest Ecology and Management*. 99: 55-64.

Healey, S.P. and R.I. Gara. 2003. The effect of a teak (*Tectona grandis*) plantation on the establishment of native species in an abandoned pasture in Costa Rica. *Forest Ecology and Management* 176(1-3): 497-507.

Hooper, E., P. Legendre and R. Condit. (2005). Barriers to forest regeneration of deforested and abandoned land in Panama. *Journal of Applied Ecology* 42(6): 1165-1174.

Holl, K.D. 1999. Factors limiting tropical rain forest regeneration in abandoned pasture: Seed rain, seed germination, microclimate, and soil. *Biotropica* 31(2): 229-242.

IUCN. n.d. *100 of the world's worst invasive alien species.* Retrieved December 2007 from http://www.iucn.org/places/medoffice/invasive_species/docs/invasive_species_booklet.pdf

Jones, E.R., M.H. Wishnie, J. Deago, A. Sautu and A. Cerezo. 2004. Facilitating natural regeneration in *Saccharum spontaneum* (L.) grasslands within the Panama Canal Watershed: Effects of tree species and tree structure on vegetation recruitment patterns. *Forest Ecology and Management* 191: 171-183.

Keenan, R., D. Lamb, O. Woldring, T. Irvine and R. Jensen. 1997. Restoration of plant biodiversity beneath tropical tree plantations in Northern Australia. *Forest Ecology and Management* 99(1-2): 117-131.

Lamb, A.F.A. (Ed.). 1973. *Pinus caribaea* Vol.1: Fast growing timber trees of the lowland tropics no.6. CFI, Oxford.

Lamb, D. 1998. Large-scale ecological restoration of degraded tropical forest lands: The potential role of timber plantations. *Restoration Ecology* 6(3): 271-279.

Lemenih, M., G. Taye and D. Teketay. 2004. Effects of canopy cover and understory environment of tree plantations on richness, density and size of colonizing woody species in southern Ethiopia. *Forest Ecology and Management* 194: 1-10.

Lemenih, M. and D. Teketay. 2005. Effect of prior land use on the recolonization of native woody species under plantation forests in the high-

lands of Ethiopia. *Forest Ecology and Management* 218(1-3): 60-73.

Lugo, A.E. 1992. Comparison of tropical tree plantations with secondary forests of similar age. *Ecological Monographs* 62(1): 1-41.

Parrotta, J.A. 1995. Influence of overstory composition on understory colonization by native species in plantations on a degraded tropical site. *Journal of Vegetation Science* 6(5): 627-636.

Pereira, W.R.H. 1988. History of *Pinus* plantations and their potential in Sri Lanka. In H.P.M. Gunasena, S. Gunatilleke and A.H. Perera (Eds.), *Reforestation with* Pinus *in Sri Lanka: Proceedings of a symposium organized by University of Peradeniya and The British High Commission,* pp.6-9. 15-16 July.

Redondo-Brenes, A. and F. Montagnini. 2006. Growth, productivity, aboveground biomass, and carbon sequestration of pure and mixed native tree plantations in the Caribbean lowlands of Costa Rica. *Forest Ecology and Management* 232(1-3): 168-178.

Shibayama, T., M.S. Ashton, B. Singhakumara, H.P. Griscom, S. Ediriweera and B.W. Griscom 2006. Effects of fire on the recruitment of rain forest vegetation beneath *Pinus caribaea* plantations, Sri Lanka. *Forest Ecology and Management* 226(1-3): 357-363.

Tilake, H.M.Bandara. 1988. Development of pine plantations in Sri Lanka. In H.P.M. Gunasena, S. Gunatilleke and A.H. Perera (Eds.), *Reforestation with* Pinus *in Sri Lanka: Proceedings of a symposium organized by University of Peradeniya and The British High Commission,* pp.10-18. 15-16 July.

*Source: http://www.oldbookillustrations.com/index.php?lng=en*

# Impact of the Invasive Liana *Sericostachys scandens* on Forest Composition: Implications for the Recovery of Grauer's Gorilla in the Kahuzi-Biega National Park, Democratic Republic of Congo

*by Innocent Liengola, MEM 2008*

## Introduction

The eastern lowland gorilla *(Gorilla beringei graueri*) is an endangered subspecies endemic to Democratic Republic of Congo (DRC) (Schaller 1963). Currently only a few isolated populations remain in several national parks and reserves established to protect them and their habitat. Within the Kahuzi-Biega National Park (KBNP), gorillas inhabit the upland sector which is the site of greatest species diversity (Plumptre et al. 2003). But these animals are currently facing the risk of extinction as a result of increased human pressures like poaching, fire and deforestation. Habitat degradation in particular has facilitated the encroachment of invasive species that disrupt the natural habitats, causing continued forest loss.

Gorillas might be facing a particular challenge as the native but invasive liana *Sericosatchys scandens* has colonized recent forest gaps, overtopping the adjacent canopy, killing trees and bamboo and creating large mono-dominant gaps (Photograph 1). It is hypothesized that this invasion be reducing the availability of habitats that provide gorillas with their preferred food. It is therefore critical to assess the degree to which this invasive species is threatening the gorilla's survival.

This study aimed to determine the area of the gorilla's home range currently covered by *S. scandens*, and whether habitat loss to the liana is affecting the gorillas' use of the territory, making it difficult for populations to recover from anthropogenic disturbance. The study also examined the effect of *Sericostachys* invasion on forest composition by estimating the forest loss attributable to its expansion. The results of this research should help predict the future forest composition in this area and contribute to the planning of future conservation strategies.

*Innocent Liengola holds a BSc in Conservation Ecology with emphasis on Plant Ecology and Taxonomy from the University of Kisangani, Democratic Republic of Congo (DRC). He worked as a research assistant with the Wildlife Conservation Society (WCS), and was later appointed as project Director in the Kahuzi-Biega National Park to preserve and protect the lowland eastern gorillas and their habitat. At F&ES, he has focused on forest management for conservation and development. He hopes to continue working with the Congolese Wildlife Service, international NGOs, local communities and policy makers, to reduce the threats on the forests of DRC, by promoting sustainable forest management for conservation and development.*

## Gorillas and the *Sericostachys* invasion

Grauer's gorillas feed mainly on leaves, roots, stems and piths of herbaceous plants, liana and bamboo shoots. They also are seasonal frugivores, forming cohesive groups that increase their day journey length during fruiting season (Yamagiwa et al. 1992, 1996). They spend most of the day foraging and rest at noon for one to two hours (Steinhauer-Burkart 1995). When available food is uniformly distributed over the territory, gorilla groups cover about 1 km of distance under the leadership of the dominant male (Steinhauer-Burkart 1995). But goril-

**Photograph 1.** Area covered by the invasive liana, *Stericostachys scandens*.

las are territorial, and with each group requiring approximately 35 km$^2$ (Steinhauer-Burkart 1995), overlaps are inevitable (Figure 1). When groups encounter each other, dominant males usually fight while young females often switch groups and intermingle for periods of time.

*Sericostachys scandens* is a semi-woody climber that can grow 20-30 m in length. Its reproductive cycle lasts 10-20 years (Troupin 1985), when massive flowering occurs and plants die off. When a canopy opening occurs, *Sericostachy*s seedlings are capable of exploiting the full-sunlight conditions and rapidly establish, suppressing other vegetation and reaching the next stratum of the forest. It is believed that physical trampling by elephants suppresses *Sericostachys* areas along their trails creating openings for the establishment of other plant species. The recent extirpation of large herbivores like forest elephants and buffalos has reduced the grazing and trampling pressure on the liana, allowing it to become intrusive and destructive for the growth of other native flora.

Gorilla populations in KBNP have been declining as a result of hunting and poaching, habitat loss due to human. I hypothesize that proliferation of *Sericostachys* has altered the distribution of their preferred food, increasing the daily distance traveled by groups and therefore the chances of encounters between dominant males. This can lead not only to higher death rates among males but also to higher chances of infanticide, like the three recently recorded in KBNP (Yamagiwa and Kahekwa 2004).

## Research site

The KBNP is located to the east of the DRC and covers an area of 6,000 km$^2$ ranging from 600 to 3,308 meters above sea level (Fi-

**Figure 1.** Map showing the home range of 8 habituated gorilla groups.

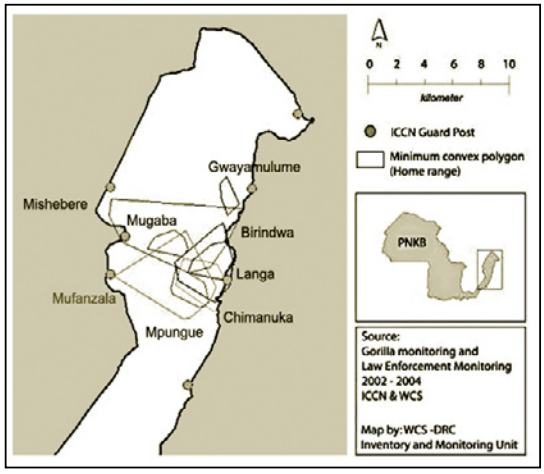
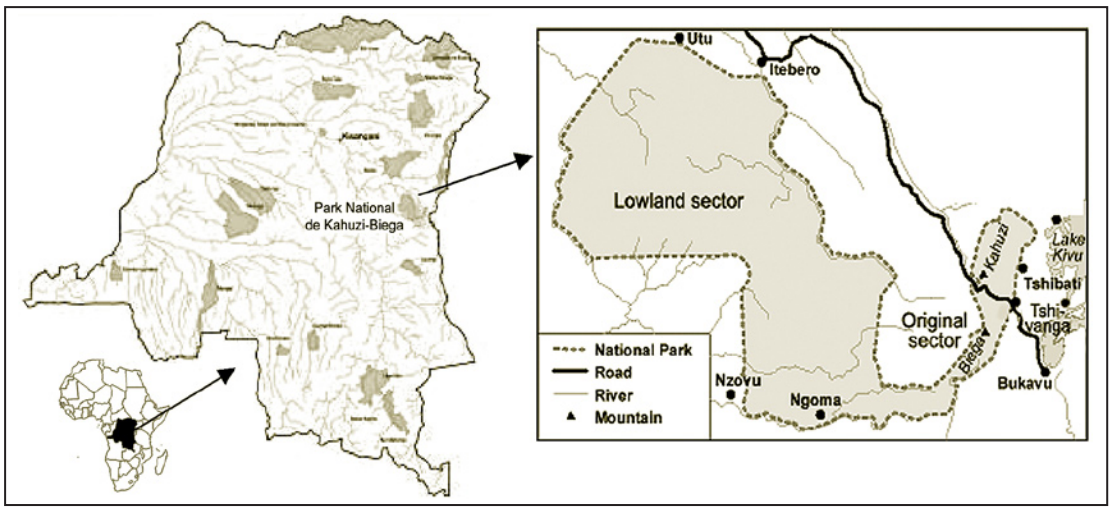


**Figure 2.** Map of the Democratic Republic of the Congo and KBNP.
*Source: WCS/ KBNP*




gure 2). The park consists of a highland and a lowland sectors interconnected by a forest corridor. This research was conducted in the highland sector of the park, originally established as Forest Reserve in 1960 and declared National Park in 1970 for the protection of the Grauer's gorilla and its habitat (Yamagiwa et al. 1992, 1996, 2003). As described by Goodall (1977) and Murnyak (1981), this area between 1,800 to 3,308 m was composed of bamboo *(Sinarundinaria alpina)* forests (37%), primary montane forests (28%), secondary montane forests (20%), *Cyperus* swamps (7%) and other vegetation (8%). Gorilla groups have been counted in the central area of this sector in 1978-79, 1990, 1994, 2000 and 2004 (Murnyak 1981, Yamagiwa et al. 1992, Hall et al.1998, Omari 2000 unpublished data, Liengola 2005 unpublished data). Their preference for this location is related to the presence of suitable habitat, composed of regenerating secondary forest with nearby bamboo stands and scattered patches of primary forest, far from human disturbance (Murnyak 1981). Since the 1990s, bamboo vegetation in the park has severely declined following the simultaneous mast flowering and die-off events. This natural phenomenon created large open areas that allowed an apparent proliferation of *Sericostachys scandens*, a native liana not eaten by gorillas or chimpanzees.

## Research methods

A combination of remote sensing and field-based surveys was used to determine the current and historical distribution of *Sericostachys* cover within the gorilla's range. Using change detection techniques, I compared 1986 (Landsat 5) and 1999 (Landsat 7) satellite images to estimate current forest coverage and evaluate habitat loss and degradation due to *Sericostachys* colonization. Since identifying invasive species in the heterogeneous landscape is difficult with multispectral imagery (Dewey et al. 1991 in Lawrence et al. 2006), and later ground truthed this data to locate *Sericostachys* in the clearing.

Between June and August 2007, I followed two gorilla groups—Chimanuka and Mankoto groups with 30 and 15 individuals respectively—and using a pedometer measured their daily foraging journey length between consecutive nest sites (Photograph 2). Every 100 m I also recorded the type of habitat and estimated the degree of *Sericostachys* invasion and canopy cover within a 10 m radius. GPS position, altitude and vegetation type were recorded at each point

**Photograph 2.** The author watches Chimanuka, the leader of a group of 30 individuals, as he rests after almost 6 hours of foraging. Gorillas travel, feed and rest together forming a cohesive group.

to help map the plots surveyed. To compare forest composition, I made four 10m x 10m plots in the different habitat types (i.e. bamboo forest, secondary forest, invaded and non-invaded areas). Smaller subplots were used to count and identify liana shoots in order to assess liana their abundance.

## Results and discussion

### *Mapping and change detection*

The land cover map classification showed 6 major cover types in the study area: primary forest, secondary forest, bamboo forest, marsh, agriculture and degraded forest, clearing and *Sericostachys* cover (Tables 1 and 2). The general pattern observed is that *Sericostachys* is encroached mostly in secondary forests, but has also invaded cleared lands (Figure 3). Fewer invasion points were found in bamboo and mixed bamboo forests, but these are also affected. Since the liana takes over the cleared lands, I combined *Sericostachys* cover and clearing for the 1999 classification.

The classification shows that land cover change occurred in all land cover types between 1986 and 1999. Tables 1 and 2 show that primary forest, secondary forest and agriculture are increasing while bamboo forest is decreasing dramatically. Large-scale disturbance by human activities may be causing this expansion of secondary forest. In the early 1990s, thousands of refugees and soldiers roamed in the forest of Kahuzi Biega during the war, hunting bushmeat and

**Table 1.** Area Summary report for 1986 supervised classification.

| Class/Region | Hectares | Sq. Km | Acres | Sq. Miles |
|---|---|---|---|---|
| Agriculture and degraded forest | 5593.32 | 55.93 | 13821.39 | 21.60 |
| Bamboo forest | 17251.62 | 172.52 | 42629.69 | 66.61 |
| Clearing | 1481.38 | 14.81 | 3660.58 | 5.72 |
| Marsh | 919.63 | 9.20 | 2272.45 | 3.55 |
| Primary Forest | 8838.50 | 88.38 | 21840.41 | 34.13 |
| Secondary forest | 3245.75 | 32.46 | 8020.43 | 12.53 |
| All | 114990.88 | 1149.91 | 284148.68 | 443.98 |

**Table 2.** Area summary report for 1999 supervised classification

| Class/Region | Hectares | Sq. Km | Acres | Sq. Miles |
|---|---|---|---|---|
| Agriculture and degraded forest | 7782.66 | 77.83 | 19231.37 | 30.05 |
| Bamboo forest | 13069.71 | 130.70 | 32295.96 | 50.46 |
| Marsh | 2189.07 | 21.89 | 5409.31 | 8.45 |
| Primary forest | 12123.63 | 121.24 | 29958.14 | 46.81 |
| Secondary forest | 9669.24 | 96.69 | 23893.21 | 37.33 |
| *Sericostachys* liana and clearing | 2178.63 | 21.79 | 5383.51 | 8.41 |
| All | 114506.64 | 1145.07 | 282952.09 | 442.11 |

cutting trees for fire wood (Yamagiwa 2003). In some areas, secondary forests were converted to agriculture and pasture. At the same time, mast flowering and die-off of bamboo forests explain the dramatic decrease in this land cover type over the past 13 years in some areas of the park. The differences in primary forest and marsh areas between the two years are possibly due to misclassification of the images rather than to real changes. Both images correspond to different seasons, and the 1986 image had excessive cloud cover which made interpretation more difficult. The use of cloud free images is recommended for the accuracy of the classification.

In the late 1980s, elephant density was high (4.5 individuals/km$^2$) (Inogwabini et al. 2000), but most elephants and about half of the gorillas were killed during the war in the early 1990s (Yamagiwa 2003). It is possible that *Sericostachys* was already present in the understory in 1986, but elephant trampling and the presence of a dense canopy cover kept it suppressed and impeded its spread. The coincidence of a dramatic reduction in elephant numbers and a bamboo mast flowering and die-off during the same period may have released the pressure on the liana, allowing it to proliferate and invade the forested areas.

### *Forest composition*

The results confirm my hypothesis that forests invaded by *Sericostachys* are less diverse than those not invaded. Despite the small size of the plots, Table 3 shows that 48 species were recorded in non-invaded secondary forests, compared to 37 in the invaded forest. Lianas make up

**Figure 3.** Presence/absence of *Sericostachys* in each vegetation type along the transects.

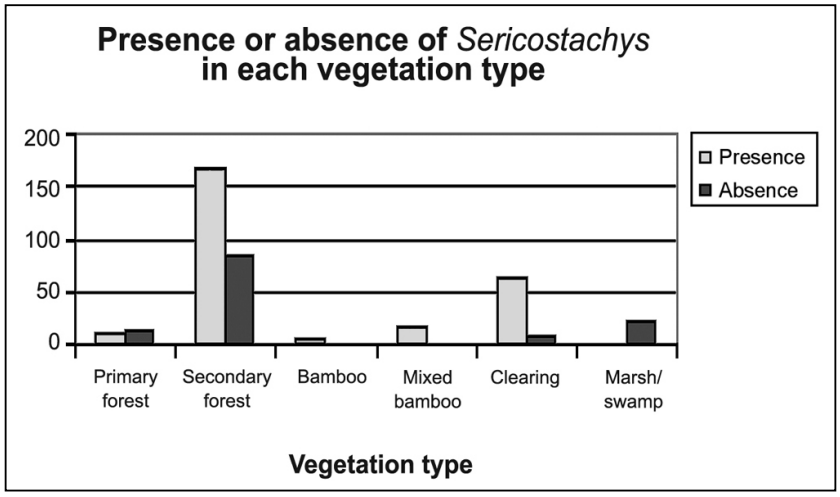


**Table 3.** Species Richness and Density of stems per plot (10mX10m).

| Plant form | Secondary forest, invaded by *Sericostachys* | Secondary forest, not invaded *Sericostachys* | Bamboo forest not invaded by *Sericostachys* | Bamboo forest invaded by *Sericostachys* |
|---|---|---|---|---|
| | | Density (stems/0.01ha) | | |
| Liana | 1522 | 229 | 384 | 1300 |
| Herb | 170 | 897 | 1439 | 1421 |
| Shrub/ Tree | 50 | 644 | 679 | 280 |
| **Total** | **1742** | **1770** | **2502** | **3001** |
| | | Richness (species/ 0.01ha) | | |
| Liana | 25 | 13 | 15 | 7 |
| Herbs | 8 | 14 | 24 | 19 |
| Shrub/ Tree | 4 | 21 | 13 | 7 |
| **Total** | **37** | **48** | **52** | **33** |

most of the density in the invaded plots, and a much smaller portion in the non-invaded ones. Invaded plots, both in the bamboo and secondary forests, have much less species diversity. In the bamboo forest for example, 52 species were recorded in non-invaded areas compared to 33 in the invaded areas. While few species were abundant, the majority of those found in *Sericostachys* zones were lianas, only a few of which are eaten by gorillas. Liana density was also differed between plots, with higher abundances in open areas and disturbed environments where light levels are higher favoring liana growth. This finding suggests that *Sericosatchys* is having a negative impact on tree regeneration. More detailed, larger scales studies are required to determine the relationship between forest structure and *Sericostachys* density.

### *Daily range*

Daily travel distance is frequently used to estimate foraging effort by primates in their natural habitats (Chapman 1990). The mean total day journey distances for the Chimanuka and Mankoto groups were 1024 m and 1496 m respectively. For 30 days, the mean length of day's journey for the gorilla in KBNP was 1260 m and the total was totalizing 37,999 m, mostly in secondary forest. Foraging focused on secondary forests because of the fruiting season, a behavior previously observed for other gorilla groups in KBNP and Gabon (Yamagiwa et al. 2003, Tutin et al. 1997).

Yamagiwa et al. (2003) measured total daily distance traveled by gorillas in KBNP between August 1994 and July 1996, and found a mean length day journey of 850.8 m. They observed a trend of increasing distance during the dry season and hypothesized that a frugivorous diet may stimulate gorillas to search for fruits in a wide area and consequently have larger travel ranges. They suggest that gorillas are selective fruit-feeders, and that they increase their day journey length with an increase in abundance and diversity of fruit available for consumption. The results of my research may provide an alternative explanation. Gorillas are in fact increasing the daily distance traveled in the areas covered by *Sericostachys.* But this may be due to food scarcity in these secondary forests affected by the liana invasion. Because food is not available in the areas covered by the liana, gorillas need to cover larger distances in find areas not yet invaded where food is available. I attribute the increase in daily travel to a decrease in gorilla food abundance which is the result of the lower plant species diversity and abundance that follows the liana invasion.

I also observed new behavioral tendencies in the KBNP groups; gorillas seem to be

shifting their range into the central sector of the park, overlapping the ranges of unfamiliar groups (Figure 1) and increasing the frequency of encounters. Longer daily travel distances seem to increase inter-group interactions, resulting in frequent transfer of females between groups following fierce fight with physical contact between Silverbacks. This in turn may be leading to unstable relationships between and within groups creating the conditions leading to infanticide. A similar change in behavior was observed in Rwanda during the 1960s, when the government decided to use part of the Virunga park for agriculture; gorillas were displaced from their usual range and some cases of infanticide were reported (Yamagiwa and Kahekwa 2004). In KBNP no infanticides had been observed since the late 1960s until the three reported in 2003 (Yamagiwa and Kahekwa 2004). Although more complete behavior studies are needed, social changes such as higher risk of infanticide can be expected in near future in this gorilla population, as a result of both human disturbance and natural phenomena.

## Conclusion

Maintaining high species diversity is important for forest conservation, and this study reveals that *Sericosatchys* is affecting the distribution and composition of vegetation in the KBNP and other mountain forests in the Albertin Rift valley. If the invasion is arresting tree species regeneration, the question is whether this is a long-term cycle in which *Sericosatchys* abundance increases in an area and then dies back allowing trees to recover and forests to remain relatively stable over time. Ultimately this will determine the survival not only of the gorillas but of several other species currently protected in the park.

### Acknowledgements

I would like to thank Ron, Larry, Jared and Nadine Laporte for the land cover change detection analysis in relation with *Sericostachys scandens*. I am greatly indebted to all gorilla guides, guards and assistants for their help in the field. The WCS/ DRC Program provided the logistic support in the field. The ICCN (Institut Congolais pour la Conservation de la nature) granted the permission to carry out research in KBNP. Funding for this research was provided by the Compton Foundation, the Tropical Resources Institute and the Council on African Studies (Lindsay Fellowship) at Yale University.

### References

Chapman, C.A. 1990. Ecological constraints on group size in three species of neotropical primates. *Folia Primatologica* 55: 1-9.

Goodall, A.G. 1977. Feeding and ranging behavior of a mountain gorilla group (*Gorilla gorilla beringei*) in Tshibinda- Kahuzi region (Zaire). In Clutton- Brock, T. H. (Ed.), *Primate Ecology,* pp. 450-479. New York Academic Press.

Hall, J.S., K. Saltonstall, B.I. Inogwabini and I. Omari. 1998. Distribution, abundance and conservation status of Grauer's gorilla. *Oryx* 32(2): 122-130.

Inogwabini B.I., J.S. Hall, A. Vedder, B. Curran, J. Yamagiwa and K. Basabose. 2000. Status of large mammals in the mountain sector of Kahuzi-Biega National Park, Democratic Republic of Congo in 1996. *African Journal of Ecology* 38: 269-276.

Lawrence, L., R.D.S. Wood and L.R. Sheley. 2006. Mapping invasive plants using hyperspectral imagery and Breiman cutler classification (RadomForest). *Remote sensing of the environment* 100(2006): 356-362.

Liengola, B.I. 2005. *Rapport d'inventaire des oiseaux, plantes, gorilles et autres grands mammifères dans le secteur de la haute altitude du Parc National de Kahuzi- Biega (PNKB), Democratic Republic of Congo: Octobre-Novembre 2004*. Wildlife Conservation Society/PNKB, unpublished report.

Murnyak, D.F. 1981. Censusing the gorillas in Kahuzi-Biega National Park. *Biological Conservation* 21: 163-176.

Omari, I. 2000. *Gorilla and large mammals census in Kahuzi-Biega National Park, Democratic Republic of Congo: June-August 2000.* Wildlife Conservation Society (WCS), unpublished report.

Plumptre, A.J., M. Behangana, T. Davenport, C. Kahindo, R. Kityo, E. Ndomba, D.N. Nkuutu, I. Owiunji, P. Ssegawa and G. Eilu. 2003. The Biodiversity of the Albertine Rift. *Albertine Rift technical reports* No. 3. World Conservation Society, New York.

Schaller, G.B. 1963. *The Mountain Gorilla: Ecology and Behavior.* Chicago, IL: University of Chicago Press.

Steinhauer-Burkhart, B., M. Muhlenberg and J. Slowik. 1995. *Kahuzi-Biega National Park.* GTZ, Germany.

Troupin, G. 1985. *Flore du Rwanda.* Institute National de Recherche Scientifique. Butare, Rwanda.

Tutin, C.E.G., R.M. Ham, L. J. T. White and M. J. S. Harrison. 1997. The primate community of the Lopé Reserve, Gabon: Diets, responses to fruit scarcity, and effects on biomass. *American Journal of Primatology* 42: 1-24.

Yamagiwa, J., N. Mwanza, A. Spangenberg, T. Maruhashi, T. Yumoto, A. Fischer, B. Steinhauer-Burkart and J. Refisch. 1992. Population density and ranging pattern of chimpanzees in Kahuzi-Biega National Park, Zaire: A comparison with a sympatric population of gorillas. *African Study Monographs*13(4): 217-230.

Yamagiwa, J., K. Kaleme, M. Milynganyo and K. Basabose. 1996. Food density and ranging patterns of gorillas and chimpanzees in the Kahuzi-Biega National Park, Zaire. *Tropics* 6 (1/2): 65-77.

Yamagiwa, J. 2003. Bushmeat poaching and the Conservation crisis in Kahuzi-Biega National Park, Democratic Republic of Congo. *Journal of Sustainable Forestry* 16: 115-135.

Yamagiwa, J., K. Basabose, K. Kaleme and T. Yumoto. 2003. Within-group feeding competition and socioecological factors influencing social organization of gorillas in the Kahuzi-Biega National park, Democratic Republic of Congo. In B.A. Taylor and L.M. Goldsmith (Eds.), *Gorilla biology: A MultidisciplinaryPerspective. pp.* 328-357. Cambridge: Cambridge University Press.

Yamagiwa, J. and J. Kahekwa. 2004. First observations of infanticides by a silverback in Kahuzi-Biega. *Gorilla Journal* 29: 6-9.

*Source: http://www.oldbookillustrations.com/index.php?lng=en*

# The Role of *Íbú ódó* Sacred Pools in Preserving Riparian Forest Structure and Diversity along the Ouèmé and Okpara Rivers of Central Benin

*by Natalie Ceperley, MESc 2008*

## Introduction

In the center of the Ouèmé River Basin that spans the Republics of Benin, Togo, and Nigeria lies the Tchabé Kingdom. The legends of the origin of this kingdom and the communities that comprise it are many, but some tell of the people emerging from the waters of the Ouèmé and Okpara rivers. Even those who say that the people arrived overland reference historical events around specific places in the river, which may be Íbú ódó. These sacred pools are subject to rules that may influence conservation practices, including the prohibition of fish poison use, over fishing pollution and the discouragement of cattle drinking from the river. Respected not only by resident populations but also by migrants to the area, they are valuable for riparian forest and water conservation. This study examines the value of Íbú ódó sacred sites for riparian forest conservation and indirectly for flood and runoff buffering.

*Natalie Ceperley completed her BA in biology with a concentration on global development studies at Grinnell College in Grinnell, Iowa before heading to the Islamic Republic of Mauritania, where she taught environmental education in the town of Jidrel Mogheun for two years with the US Peace Corps. She continued her journey south of the Sahara and spent one year as a Fulbright Student studying and researching in the Republic of Benin before returning to Yale F&ES where she is completing a MESc with a graduate certificate in African Studies. She plans to continue working in West Africa as a doctoral student studying the hydrologic consequences of land use change and the interface with local meaning and philosophy.*

Riparian vegetation, found along the borders of rivers and streams, both filters nutrients and sediment from entering waterways and slows flow, preventing flood damage. These and other ecological functions are dependent on the width of the riparian zone, forest structure and species composition (Piegay and Bravard 1997). The riparian buffer is important in runoff control, water uptake, water storage and release and filtering for water quality, influencing both the base flow and the over bank flow (Tabacchi 2000). Because of its spatial heterogeneity and position, the riparian zone houses high levels of diversity, productivity and conductivity between the up and down stream as well as between the terrestrial and aquatic ecosystems, and is thus essential in providing ecosystem services. Characteristics, such as the basal area, species composition and tree density of riparian vegetation increase the forest's capacity to resist floods, particularly in the more susceptible lower reaches (Li and Shen 1973, Piegay and Bravard 1997).

Like any forest, riparian zones are susceptible to degradation by human activities. But they have been observed to be more resilient than other forests due to their qualities of productivity, diversity and connectivity (Naiman et al. 2005). Around the world, disturbances to riparian vegetation have included logging for building, changes in flood regime, fires from pastoralists or hunters and deforestation for farmland (Damasceno et al. 2005, Goetz et al. 2006, Hughes 1988, Kellman 1993, Martin et al. 2004). The consequences of such degradation include rises in silt loads, erratic flows, decrease in river tree cover, increased temperature, river

bank erosion and deterioration of aquatic vertebrate and invertebrate biota (Allan et al. 2002, Medley 1993, Welcomme 1983). The effects of disturbance may also cascade in a riparian forest (Decamps 1993, Kinnaird 1992, Ledec 1987, O'Conner 2001, Pringle 1997). Their degradation lessens their ability to perform ecological functions, often returning full circle and affecting the communities that depend on their benefits, with serious consequences for neighboring settlements and farms.

Riparian forests have economic and social values in addition to their ecosystem services. For example, *Pentadesma butyracea* in central Beninese riparian forests produces a marketable butter similar to *Vitellaria paradoxa* (shea) (Natta 2003), while sacred forests, many of which are riparian, found throughout Benin and Nigeria reinforce community cohesion (Ojo 1967). Indigenous knowledge is often directed towards their management particularly for the sake of their high soil fertility (McClain and Cossio 2003, Muniz-Miret et al. 1996, Natta 2003, Thompson 2000). In Yoruba culture natural resource management is influenced by religious beliefs and practices, like many world cultures (Adekunle 2005). Allan et al. (1997) and also Yadav and Bhushan in India (2001) emphasized that activities of local communities play a significant role in determining local vegetation structure. Indigenous knowledge both offers a personal understanding of conservation priorities and techniques that shape resource use. But for successful management, an entire basin must be balanced to effectively steward the nutrient supply, sediments, hydrology and geomorphology. How has human use impacted riparian structure and diversity in the Ouèmé River Basin? And more precisely, do the Íbú ódó sacred pools conserve the ecological function of their riparian location?

This study assesses the ability of riparian forests to buffer floods according to their adjacent land use. It does so by examining riparian forests near three villages and adjacent to four land uses—heavily human used, agricultural,

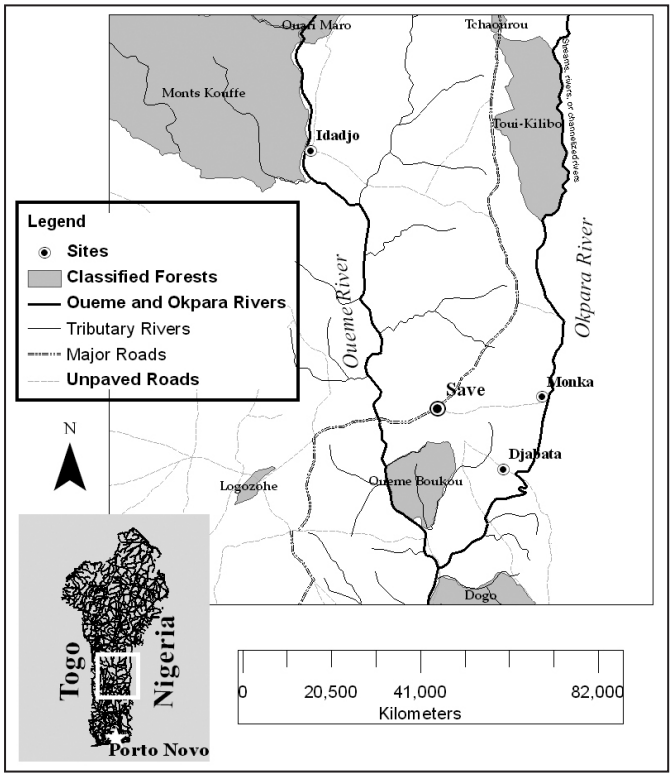



**Figure 1.** Map of study area.

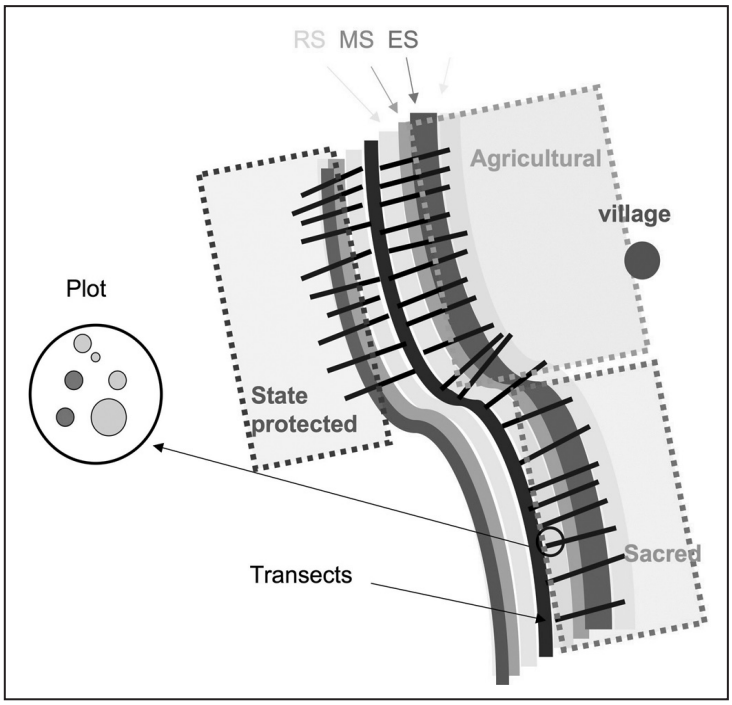



**Figure 2.** Sampling design repeated in each of 3 sites. Plot were replicated in the Riverside (RS), Middle (MS), and Edge (ES) on each transect.

sacred and state-protected—for characteristics correlating with the riparian forest's ability to reduce the kinetic energy of floods such as species composition, tree density, buffer width and tree age class. Thus it assesses the ability of these forests to buffer floods according to their adjacent land use.

Three sites in the Ouèmé Basin of Central Benin were chosen for their ecological and cultural similarity, presence of significant riparian forest and sacred sites and varying level of conservation and economic activity (Figure 1). The three sites were Idadjo, Monka and Djabata, with populations of 1918, 1128 and 692 respectively (INSAE 2004). All are located in the *Soudano-Guinean* transition zone, receive between 1100 and 1200 mm annual precipitation in two rainy seasons that peak in June and September, and speak the Yoruba dialect, Tchabé (Adamou, 2005). Idadjo is opposite *Foret des Monts Kouffe,* managed by Plan d'Aménagement des Massif Forestiers (PAMF), an internationally funded organization that has active environmental awareness programs. Monka is an easily accessible border town that benefits economically from its location where a main road to Nigeria crosses the Okpara River. Finally, Djabata is relatively isolated, reachable only by frequently flooded and overgrown paths. The variation between environmentally active Idadjo, economically accessible Monka and isolated Djabata provide interesting contrasts.

## Methods

All trees (dbh > 10 cm) in three circular plots, r=4 m, (along river, middle of riparian forest, and edge of riparian forest) on 163 transects laid perpendicular to the river, spaced semi-randomly, 50-100 m apart, were measured and identified based on Natta (2003) as shown in Figure 2. They spanned forests adjacent to three village sites, and adjacent to four land uses. Land use categories include agricultural fields which are dominated by millet or maize, classified forests maintained by the government, sacred forests identified by the village hunting chief or king, and areas that had been burned within the recent past for hunting or brush control and are heavily used for hunting and

grazing. Measurements permitted calculation of tree density, diameter at breast height distribution, in addition to riparian width and species composition, all characteristics that influence the ability of the riparian area to buffer floods. Identification of all unknown tree species was completed using herbarium samples with the help of colleagues at the National Herbarium of the Université d'Abomey-Calavi. Thirty elders, hunters, women, and men were interviewed in each site concerning the sacred sites, land management, and values of the riparian forest.

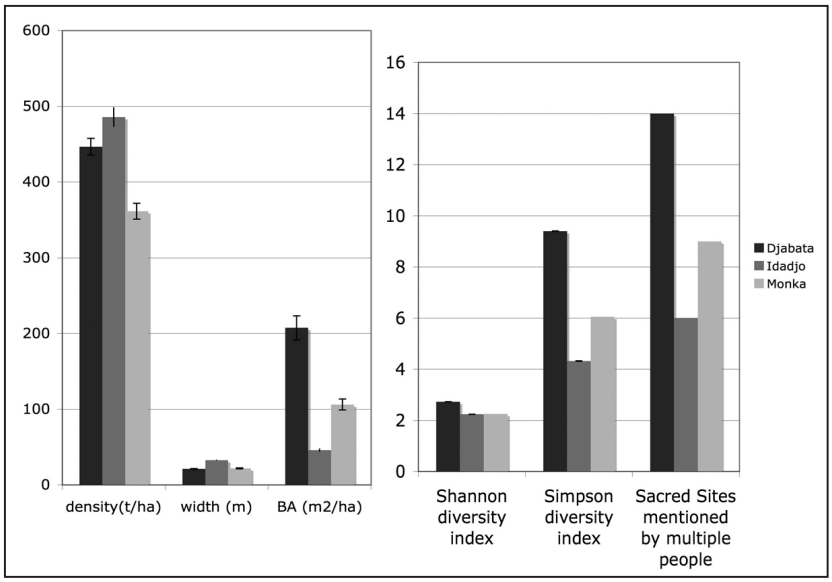
## Results

Diversity as measured by Simpson's index was highest in agricultural and sacred lands, basal area was highest in areas of heavy human use and sacred land, and density and width did not respond strongly to adjacent land use (Figure 3). Of the three sites, Idadjo contains the highest density of trees and the widest buffers. Djabata has the highest basal area, the highest level of diversity according to both Shannon and Simpson diversity indices, the greatest total basal area in riparian buffers, and is reported to have the most sacred sites. Monka has the lowest density and width and intermediate diversity and basal area (Figure 4). Djabata contains the highest species richness with 39 tree species, followed by Idadjo with 35 species and Monka with 26. The number of sacred sites and the diversity of the riparian forest in each site correlate strongly.

## Discussion

Why do agricultural and sacred lands have the highest diversity, heavily used lands and sacred land the most basal area, Idadjo the densiest and widest buffers, and Djabata the most basal area and species diversity? Monka's position on the main Nigerian transport road (Photograph 1) makes it accessible to economic exploitation. This explains its low species richness when compared to Djabata and Idadjo, much farther from the main roads and which have higher richness. Alternatively, higher species diversity could also reflect conservation due to respect for sacred pools—in the case of Djabata, where 14 pools are actively maintained compared to 9 in Monka and 5 in

**Figure 3.** Comparison of structure and diversity in riparian buffers adjacent to 4 land use classes. Error bars show standard error. Units of vertical axis indicated below.



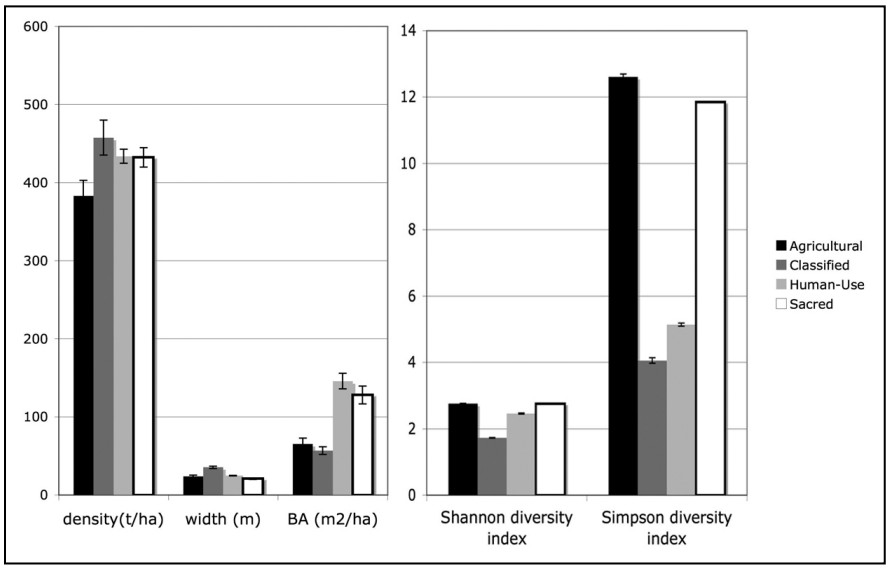



**Figure 4.** Comparison of structure and diversity in riparian buffers in the three sites. Error bars show standard error. Units of vertical axis indicated below.

Idadjo. Or, in the case of Idadjo, the higher species richness could be due to conservation work done by an internationally funded organization, PAMF, including environmental education, development of local management to enforce laws and incentives for reducing illegal cutting.

Sacred pools are located where an historical event occurred, the river is particularly deep, the water gurgles, fishing is good or where there is an interesting formation such as a suspended rock (Photograph 2). Pools are home to spirits and it is beleived that upsetting them can have dire consequences like floods, drought, disease and infertility. Taboos surrounding these pools range from the manner one must behave or dress near the site to specific rules regarding what one can or cannot do. In most cases, peo-

**Photograph 1.** Main river crossing to Nigeria at Monka.

**Photograph 2.** Sacred pool at Idadjo where the water is reportedly of immeasurable depths and no fish poisons are permitted.

ple make requests to the spirit for things such as improving business, conceiving a child or having a good harvest. Such requests can happen individually or as a collective of devotees once or twice a year and are typically accompanied by a sacrifice of livestock or food. There is usually an elder who is responsible for organizing the sacrifices and communicating with each spirit. Many uses of forest, such as heavy forest exploitation, over-gathering of plants and grazing of cattle are forbidden, which helps explain their high diversity and total basal area.

More specifically, taboos were identified that addressed to the importance of conserving these forests. But will these cultural and spiritual motivations for conservation stand up against the economic and demographic changes that are driving land use change? Major drivers of change in riparian vegetation include field expansion adjacent to riparian forest, timber harvests and cattle grazing. Migrants who come from northern Benin to farm in the central Oueme Basin are responsible for the majority of field expansion (Photograph 3). The village king designates land far from the village for their use; often it is in the riskier, more fertile floodplain. As agricultural fields encroach on the riparian buffer, savanna species begin to

**Photograph 3.** Millet field expansion adjacent to riparian forest, Idadjo.

**Photograph 4.** *Ceiba pentandra* exploitation by migrant sawyers.

penetrate it, thus artificially raising the diversity level (Figure 3).

*Ceiba pentandra*, *Diospyros mespilliformes and* the vulnerable *Albizia ferruginea* (IUCN 2007) are harvested for timber to be sold elsewhere in the region by outsiders who pay a nominal fee to the local king (Photograph 4). But perhaps the most severe threat to the landscape and water quality according to local communities, is cattle grazing which has increased in the last decade as Peulh herders have been driven into the area by the regional droughts (Photograph 5). These two land uses are captured by the designation of heavy human use, although both are present in all classifications, with the exception of sacred areas and classified (state-protected) forests.

The site with the most cultural respect for sacred sites, Djabata, appears to also have the most diverse riparian forest, the site with the most aggressive conservation program, Idadjo appears to have the most dense and widest forest, whereas Monka, more accessible to economic markets, appears to have the least dense forest. This suggests that sacred pools and conservation programs both function, although differently, to conserve riparian forest diversity in the face of economic drivers of forest change

**Photograph 5.** Cattle belonging to the Peulh people, along river bank in Monka.

in the Oueme Basin. The high diversity in sacred and agricultural sites suggests the introduction of anthropogenic species. If Íbú ódó can be incorporated into a long lasting local management strategy, they could be instrumental in conserving the riparian forest.

## Conclusion

Diversity and structure of the riparian buffer were most dramatically reduced in areas adjacent to agricultural fields or in sites more accessible to exploitation. Íbú ódó sacred pools do contribute to conservation of the ecological function of their riparian location. They conserve the structure and diversity of the buffer, which is crucial to reduce the damage of floods on adjacent areas.

Respect for riparian forests may be instrumental in preventing potential disasters caused by the changing precipitation that is the primary expression of climate change in West Africa (Ledger 1964). A dense and diverse riparian area will lessen the regional severity of related droughts and floods. Encouraging respect for sacred sites is particularly crucial among younger generations and migrants to the area. Incorporating Íbú ódó into a long lasting local conservation strategy could be instrumental in conserving the important riparian forest.

### Acknowledgements

This study would not have been possible without the blessing of the people of Monka, Idadjo, Djabata, and Save, and the support of the Tropical Resource Institute, the Yale Program in Agrarian Studies, the F&ES Summer Globalization Internships Fund, Laboratoire d'Ecologie Appliqué at the Faculté des Sciences Agronomiques of the Université d'Abomey-Calavi and the Université de Parakou. It has benefited from the guidance and help of Dr. Florencia Montagnini, Dr. Paul Draghi, Jean Didier Akpona, Dr. Armand Natta, Dr. Aristide Adamou, Adi Mama, and Dr. Brice Sinsin.

### References

Adamou, A.C. 2005. *Vegetation Patterns and Environmental Gradients in Benin.* Ph.D. Thesis. Wageningen University, the Netherlands.

Adekunle, J.O. 2005. Yoruba Culture (West Africa). In B.R. Taylor and J. Kaplan (Eds.), *Encyclopedia of Religion and Nature, Vol 1-2.* London : Thoemmes continuum.

Allan, J.D., D.L. Erikson and J. Fay. 1997. The influence of catchment land use on stream integrity across multiple spatial scales. *Freshwater Biology* 37: 140-161.

Allan, J.D., A.J. Brenner, J. Erazo, L. Fernandez, A.S. Flecker, D.L. Karwan, S. Segniniand and D.C. Taphorn. 2002. Land use in watersheds of the Venezuelan Andes: A comparative analysis. *Conservation Biology* 16(2): 527-538.

Damasceno, G.Jr., J. Semir, F.M. Dos Santos and H.d.F. Leitao-Filho. 2005. Structure, distribution of species and inundation in a riparian forest of Rio Paraguai, Pantanal, Brazil. *Flora* 200: 119-135.

Decamps, H. 1993. River margins and environmental change. *Ecological Applications* 3(3): 441-445.

Goetz, D., B. Horsch and S. Porembski. 2006. Dynamics of forest-savanna mosaics in north-eastern Ivory Coast from 1954 to 2002. *Journal of Biogeography* 33: 653-664.

Hughes, F.M.R. 1988. The ecology of African floodplain forests in semi-arid and arid zones: a review. *Journal of Biogeography* 15: 127-140.

INSAE (Institut National de la Statistique et de l'Analyse Economique). 2004. *Cahier des villages et quartiers de ville: Département des Collines.* Direction des Etudes Démographiques, Cotonou.

IUCN (International Union for the Conservation of Nature). 2007. *Red List of Threatened Species.* Retrieved October 2007 from http://www.iucnredlist.org/

Kellman, M. and R. Tackaberry. 1993. Disturbance and tree species coexistence in tropical riparian forest fragments. *Global Ecology and Biogeography Letters* 3: 1-9.

Kinnaird, M.F. 1992. Phenology of flowering and fruiting of an East African riverine forest ecosystem. *Biotropica* 24(2a): 187-194.

Ledec, G. 1987. Effects of Kenya's Bura irrigation settlement project on biological diversity and other conservation concerns. *Conservation Biology* 1(3): 247-258.

Ledger, D.C. 1964. Some Hydrological Characteristics of West African Rivers. *Transactions and Papers* (Institute of British Geographers) 35: 73-90.

Li, R.M. and H.S. Shen. 1973. Effect of tall vegetation on flow and sediment. *Journal of the Hydraulics Division, American Society of Civil Engineers* HY5: 793-814.

Martin, P.H. 2004. Forty years of tropical forest recovery from agriculture: Structure and floristics of secondary and old-growth riparian forests in the Dominican Republic. *Biotropica* 36(3): 297-317.

McClain, M.E. and R.E. Cossio. 2003. The use of riparian environments in the rural Peruvian Amazon. *Environmental Conservation* 30(3): 242-248.

Medley, K.E. 1993. Primate Conservation along the Tana River, Kenya: An Examination of the Forest Habitat. *Conservation Biology* 7(1): 109-121.

Muniz-Miret, N., R. Vamos, M. Hiraoka, F. Montagnini and R.O. Mendelsohn. 1996. The economic value of managing the acai palm (*Euterpe oleracea* Mart.) in the floodplains of the Amazon estuary, Para, Brazil. *Forest Ecology and Management* 87: 163-173.

Naiman, R.J., H. Decamps and M.E. McClain. 2005. *Riparia: Ecology, Conservation and Management of Streamside Communities.* Elsevier: Amsterdam.

Natta, A.K. 2003. *Ecological Assessment of Riparian Forests in Benin: Phytodiversity, Phytoscoiology and special distribution of tree species.* Ph.D. Thesis. Wageningen University, the Netherlands.

O'Connor, TG. 2001. Effect of small catchment dams on downstream vegetation of a seasonal river in semi-arid African savanna. *The Journal of Applied Ecology* 38(6): 1314-1325.

Ojo, A. 1967. *Yoruba Culture: a Geographic Analysis.* University of Ife and University of London Press Ltd.: London.

Piegay, H. and J.P. Bravard. 1997. Response of a Mediterranean riparian forest to a 1 in 400 year flood, Ouveze River, Drome, Vaucluse, France. *Earth Surface Processes and Landforms* 22: 31-43.

Pringle, C.M. 1997. Exploring how disturbance is transmitted upstream: going against the flow. *Journal of North American Benthological Society* 16(2): 425-438.

Tabacchi, E., L. Lambs, H. Guilloy, A.Planty-Tabacci, E. Muller and H. Descamps. 2000. Impacts of riparian vegetation on hydrological processes. *Hydrological Processes* 14: 2459-2976.

Thompson, J.R. and G. Polet. 2000. Hydrology and land use in a Sahelian floodplain wetland. *Wetlands* 20(4): 639-659.

Welcomme, R.L. 1983. River Basins. *FAO Fisheries Technical Paper* (202):60p.

Yadav, R. and L.S. Bhushan. 2002. Conservation of gullies in susceptible riparian areas of alluvial soil regions. *Land Degradation and Development* 13: 202-219.

# Market Values of the Commercial Fishery on the Madeira River:

## Calculating the Costs of the Santo Antônio and Jirau Dams to Fishermen in Rondônia, Brazil and Pando-Beni, Bolivia

*by Erin Barnes, MEM 2007*

## Problem

The Madeira River begins in the Andes, flows through the floodplain of the Bolivian Amazon, runs over forty-two waterfalls, becomes navigable at Porto Velho—the furthest inland port in Brazil—and finally meets the Amazon River near Manaus. It is the longest tributary of the Amazon River with the largest sediment load of the basin. Brazil's current hydroelectric development plan is hinged on building two dams on the Madeira River at seasonal waterfalls, Santo Antônio and Jirau (Figure 1). The dams are part of the Integration of South America's Regional Infrastructure, or IIRSA, a joint project by the Inter-American Development Bank, the Andean Development Corporation, and the UN Development Programme.

The project has an estimated construction cost of about US $8 billion. Unfortunately Brazil's overall economic analysis does not include secondary costs such as those of electricity transmission, forced relocation, increased malarial rates, land conversion from rainforest to savannah and methane gas releases in the reservoir. Nor does the Environmental Impact Assessment (EIA) (Furnas et al. 2005) by IBAMA—Brazil's environmental protection agency—enumerate the economic benefits of the project, like increased navigation and soy exports.

This study seeks to measure the market value of the Madeira River fishery between Porto Velho, Brazil, and Trinidad, Bolivia, in order to estimate one of many costs of the hydroelectric project. It relies on survey results from a small sample, so the results should be treated as trends and indications of the local market. Further studies are needed to more precisely measure the value of the commercial and non-commercial fisheries.

## Scope

The Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) defined the area impacted by the dam project based on the predicted area of inundation caused by the dams. Other studies consider the impacts of the project to be broader. Jorge Molina (2006) describes a larger stretch of flooding predicted to impact Bolivia. Dams cut off migratory fish populations from upstream communities first, but downstream populations can also be negatively impacted. Dams impact different fish species in different ways, favoring some and negatively affecting others, but it is predicted that the dams at Santo Antônio and Jirau will decrease fish populations overall and could threaten certain species with extinction (Barthem and Goulding 2006). Additionally,

*Erin Barnes completed an undergraduate degree in English and American Studies at the University of Virginia. She subsequently worked as the Public Information Officer at Save Our Wild Salmon Coalition before starting a Master's of Environmental Management at Yale. During the MEM program she co-founded SAGE Magazine and co-organized the Global Perspectives on Large Dams conference. She works for Men's Journal as assistant editor of environmental affairs.*


**Figure 1.** Location of the affected fisheries along the Madeira River.
*Source: PCE, Furnas, Odebrecht 2004*

because a significant number of the culturally important fish are migratory, fisheries biologists expect the impacts of the project to extend past the political borders (Van Damme 2006). Given the limitations in the scope of the research and in the available data, this paper focuses primarily on the area above Porto Velho and below Guajará-Mirim in Brazil. Ecosystem impacts will extend far beyond these boundaries, so the findings are likely to be conservative.

## Methods

Face-to-face surveys from May through August 2006 provided the data to estimate net incomes of fishermen. Of the surveys taken from representative communities of varying size and distance from the river, 22 samples were used. The survey measured the revenues and costs of both individuals and boats as entities. Survey participants were first asked about earnings, costs and net incomes over different periods of time and then asked to describe the average catch of typical species during typical months. The ownership and replacement of a boat and motor has been equated to an annual rent using the equation R = (p/r)/(1-e^-rt) with interest at four percent.

This equation for rent was used based on the survey responses on the average life of the boats. The rate of replacement of boats was found to be 10 years. The total costs for each fisherman were calculated according to the following equation:

$TC = R\,(boat, motor) + E + Mc + Mbm + Cf$

Where

| | |
|---|---|
| $R$ = | annual rent of boat and motor |
| $E$ = | equipment (nets, spears, lines, etc) |
| $Mc$ = | annual membership to the fishermen's association |
| $Mbm$ = | reported annual maintenance costs to the boat, motor |
| $Cf$ = | weekly costs of fishing x number of weeks fished per year OR |
| $Cf$ = | weekly costs of fishing x number of weeks fished per year |

Some of the participants in the study had invisible costs because they were employed on boats on which the owner covered all costs. The average net market values of individual boats and fishermen were calculated by estimating and summing the different costs and revenues of fishermen. Those were then used to calculate the aggregate net market value of the fishery.

## Description of the market

Porto Velho and Guajará-Mirim are the major natural ports, home to larger scale commercial fishermen. These areas are more populous and dense. In addition both ports are geographically advantageous for fishing, located either near several *cachoeiras*, or waterfalls, or at the confluence of several rivers. So, the larger scale commercial fishermen with larger boats, more fishermen per boat, and longer fishing

trip distances are at these opposite ends of the studied river stretch. As a result, these fishermen generally have larger catch and higher costs. But these fishermen have the fishermen's *colonia*, an association that assists them in the sale of their catch, setting a price per kilogram that depends on supply. They can also purchase fishing supplies at these locations.

Between the ports are many small settlements such as Cachoeira Teotônio, Jacy-Paraná, Nova Mamoré, Vila Murtinho and Jirau. These are frequently surrounded by smaller settlements of five or ten families living in wooden shacks. These groups—generally referred to as *ribeirinhos*, or river-dwellers—typically live at or above subsistence-level by fishing and farming manioc and harvesting bananas. They usually have small motor boats or canoes and their trips rarely exceed one day. Fishing is often a family activity and boats are shared casually among community members. Among *ribeirinhos* fish sale is less organized, with fishermen acting as both fisher and seller. Most fishermen own large coolers and will sell fish directly to the consumer on the street or from their homes. In many families, the father and older sons will fish and other family members will sell fish from home.

Only during peak catch will small-scale fishermen in these small settlements travel in groups, by boat or by taxi, to Porto Velho or Guajará-Mirim to sell the large supply of fish.

## Inconsistencies in historic data

First, there is a major inconsistency in the estimated number of fishermen in the impacted area. The fishermen's associations Z-1 (Porto Velho) and Z-2 (Guajará-Mirim) have paying members of commercial fishermen: Z-1 reports a total of 2,325, between registered members and estimated non-registered fishermen; Z-2 estimates 1,500 fishermen. Through personal interviews, counting, and extrapolations, I estimate 1,000 fishermen in the region between these two hubs, but there is no official data for that stretch of the river. Yet the report in the EIA (data by Doria et al. 2005) uses 230—the number of fishermen they surveyed—as the *total* number for the entire stretch of the river. The study acknowledges they underestimate the real number, but chose to do so to avoid double counting (Furnas et al. 2005: IV-894).

The second major inconsistency is in the annual fish harvest. Variations due to migration and El Niño patterns are natural, but no consistent studies have been done. The average annual fishery production for the entire stretch in question using all data is 703 tons (Figure 2).

**Figure 2.** Tons of fish produce on the impacted stretch of the river.
*Source of data: Furnas et al. 2005*

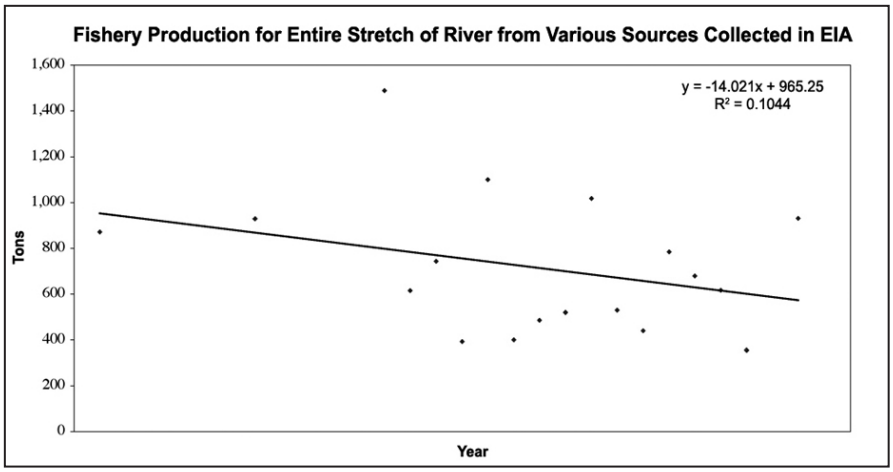
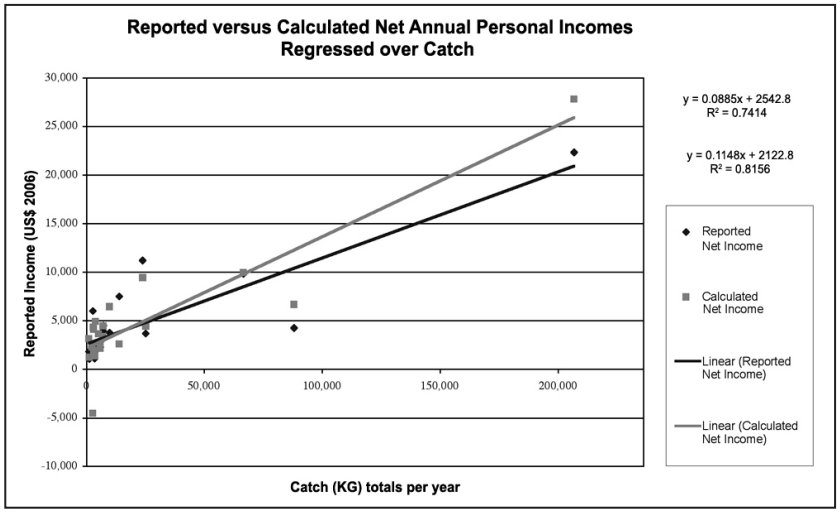


**Figure 3.** Comparison of Reported Incomes and Calculated Incomes, regressed on catch per boat (USD).




Z-1 Fishermen's Association data is consistently higher than that of the Doria et al. studies (Z-1 Colonia 2004, 2005). Higher recorded tonnage for Porto Velho than for the whole river indicates either an overestimate of the catch by the Fishermen's Association or an underestimate by the Doria et al. studies. Either way, the discrepancy highlights the need for accurate studies with standard methods for collecting samples and measuring fish production.

Third, because the sediment load of the Madeira River is so massive, there is little historic data from rivers of comparable size to predict the impacts on a river of this scale. Similarly, fish migration, feeding and spawning cycles remain unknown for many species despite the abundance of good research. As a result, the estimated percentage of fish loss used in this study is little more than a placeholder multiplier until that prediction is available.

## Results and discussion

Reported net income and net income based on reported catch differed in Bolivia where the dearth of fish was described as a natural variation in the water levels of streams connecting the mainstem rivers to the breeding lagoons. In Brazil, the small fishermen's reported and calculated incomes were fairly similar, with discrepancies increasing with the fishing scale. It is possible that the survey cannot detect some of the costs of large-scale professional fishermen with many employees, or that monthly fluctuations in catch are too wide for a survey to capture an accurate annual catch per large-scale fishermen. However, using average annual catch per large-scale fisherman from the Doria et al. (2005) study (17.655 tons/year) as a multiplier, calculated and reported incomes are much closer. The trendlines for relationships between total net income based on reported and calculated catch and between personal annual reported revenue and catch have R-squared values of 0.7414 and 0.8156 respectively (Figure 3).

The calculated best estimate for the value of the fishery is conservative, and is more an indication than an exact measurement. This report is limited in its scope, as it included only data for commercial fishermen between Porto Velho and the Bolivian border, excluding non-commercial subsistence or barter fishermen. It is also limited geographically, focusing only on the stretch of the river directly impacted by the dams and their reservoirs, and not on the indirect impact of migration.

**Table 1.** The present value of average incomes specific to certain regions, because fishermen near major cities have higher incomes than rural fishermen (USD).

| Region | Average Net Annual Personal Income (USD) | Number of Fishermen Per Region | Aggregate Annual Income per Region (USD) | Present Value (PV = A/r) |
|---|---|---|---|---|
| Brazil, Porto Velho | 11,119 | 2,325 | 25,852,215 | 646,305,368 |
| Brazil, Madeira River, Stretch Between | 2,961 | 1000 | 2,960,602 | 74,015,061 |
| Brazil, Guajará-Mirim | 4,118 | 1500 | 6,177,104 | 154,427,589 |
| | | | **Total** | **Total** |
| | | | 34,989,921 | 874,748,019 |

A discussion of total present values of fisheries by region rather than on averages across the basin is more accurate (Table 1). Because its fishermen are upstream of the dams and are likely to be cut off from migratory species first, the impacts to Bolivia's fishery should be evaluated. Based on comparisons of local fish markets, it is clear that the value of the same fish species in Bolivia and Brazil is equivalent in 2006 US dollars. Bolivia's tributaries of the Madeira are home to approximately 1,000 fishermen, so we could place a present value of approximately $126,446,000 on Bolivia's upstream tributaries of the Madeira. Similarly, we can conclude a present value of $379,338,000 downstream of the dam, using 3,000 as the approximate number of fishermen downstream of Porto Velho on the Madeira and the Lower Amazon.

Incorporating the values of the fishery beyond the directly impacted stretch of the river results in a present value ranging from an estimated low end of US$0.8 billion (Rs$1.9 billion) to a high end of $1.3 billion (Rs$2.8 billion) (Tables 2 and 3). Depending on what losses are incurred to the fishery by the hydroproject, the costs will change. The potential costs assuming a 12 percent loss to the fishery are $159 million, or $663 million assuming a 50 percent loss to the fishery (Table 4).

## Non-market values

Participants were asked to answer some willingness-to-pay, or contingent valuation, questions. Many did not understand the questions, but of the one third who answered all pos-

**Table 2.** Present value of the fishery based on averages including Bolivia and downstream regions of Brazil (USD).

| Region | | Average Net Annual Personal Income (USD) | Number of Fishermen Per Region | Aggregate Annual Income per Region (USD) | Present Value (PV = A/r) |
|---|---|---|---|---|---|
| Bolivia, Upstr. Madeira | | 5,058 | 1000 | 5,057,838 | 126,445,947 |
| Brazil, | Low End | 5,058 | 2853 | 14,430,011 | 360,750,287 |
| Upstr. Madeira | High End | 5,058 | 4825 | 24,404,068 | 610,101,694 |
| Brazil, Downstr. Madeira & Amazon | | 5,058 | 3000 | 15,173,514 | 379,337,841 |
| | | | | **Total** | **Total** |
| | | | Low | 34,661,363 | 866,534,075 |
| | | | High | 44,635,419 | 1,115,855,482 |

**Table 3 .** Present value of the fishery based on regional averages, including Bolivia and downstream regions of Brazil (USD).

| Region | Average Net Annual Personal Income (USD) | Number of Fishermen Per Region | Aggregate Annual Income per Region (USD) | Present Value (PV = A/r) |
|---|---|---|---|---|
| Bolivia, Upstr. Madeira | 2,849 | 1000 | 2,848,800 | 71,220,007 |
| Brazil, Porto Velho | 11,119 | 2,325 | 25,852,215 | 646,305,368 |
| Brazil, Madeira River, Stretch Between | 2,961 | 1000 | 2,960,602 | 74,015,061 |
| Brazil, Guajará-Mirim | 4,118 | 1500 | 6,177,104 | 154,427,589 |
| Brazil, Downstr. Madeira & Amazon | 5,058 | 3000 | 15,173,514 | 379,337,841 |
| | | | **Total** | **Total** |
| | | | 50,163,434 | 1,325,305,867 |

itively expressed they would be willing to pay to stop the dam construction. Many were unable to construct a numeric value, but those who did ranged from US$28 to "all that I have." One participant said he would pay monthly dues if a union were set up to protect the community. In fact, all fishermen currently pay monthly dues of about US$5 in membership fees to the fishermen's *colônia*, an association set up to protect their interests. This aggregate fee could be used as a metric of a trend that shows some willingness to pay. When regressed, there is some positive dependence on the following variables: location on the river, education on dam impacts and level of income based on the fishery. More contingent valuation analysis is needed to determine a firm estimate of regional willingness to pay.

## Conclusion

Although this is a conservative indication of the value of the fishery, clearly that value is large enough that it deserves further research to determine a more exact measurement. Only by correctly estimating the full costs and benefits of the hydro-project, can an economically efficient policy be made. The construction costs of the Madeira River hydroelectric project are close to US$8 billion. Yet the project puts a whole fishery worth as much as US$1.3 billion at risk, with the most commercially and culturally valuable fish, the dourada and big catfish, bound to incur the worst harm. Not only will this uncalculated economic loss cause an inefficient policy decision; but also, the loss of a fishery this size will upset the ecosystem and harm the communities that depend on them for a source of food and income. The negative impacts to these communities are disproportionately high, whereas the benefits of the project will be seen primarily outside the impacted region.

**Note**: All monetary units are expressed as US $2006.

**Table 4.** Relative costs of potential losses to the fisheries (USD).

| | | Size of Fishery Loss | | | |
|---|---|---|---|---|---|
| | | **50%** | **33%** | **20%** | **12%** |
| Averaging | 2853 | 433,267,037 | 259,960,222 | 173,306,815 | 103,984,089 |
| over the Region | 4825 | 557,942,741 | 334,765,645 | 223,177,096 | 133,906,258 |
| Averages by Specific Region | | 662,652,934 | 437,350,936 | 265,061,173 | 159,036,704 |

## Acknowledgements

Funded by the International Rivers Network, the Yale Tropical Resources Institute, the Yale F&ES Globalization Fund and the Carpenter-Sperry Fund.

## References

Barthem, R.B and M. Goulding. 2006. *Pareceres dos Consultores sobre o Estudo de Impacto Ambiental do Projeto para Aproveitamento Hidrelétrico de Santo Antônio e Jirau, Rio Madeira - RO, Parecer Técnico Sobre a Ictiofauna.*

Furnas, Odebrecht e Leme. 2005. Sumário dos Estudos de Impacto Ambiental (EIA) Tomo B. Diagnóstico Ambiental Capítulo IV. *Área de Influência Direta dos Aproveitamentos Hidrelétrico Jirau e Santo Antônio*, Part 5 of 8. IBAMA.

Doria, C. et al. Fundação Rio Madeira (RIOMAR), Instituição de Apoio à Universidade Federal de Rondônia (UNIR). 2005. *Estudo de viabilidade das AHE's Jirau e Santo Antonio, localizadas no Rio Madeira em Rondônia, no trecho entre Porto Velho e Abunã. Relatório Técnico Final, Componente: Ictiofauna e Pesca.* Porto Velho/RO. Resumo Executivo.

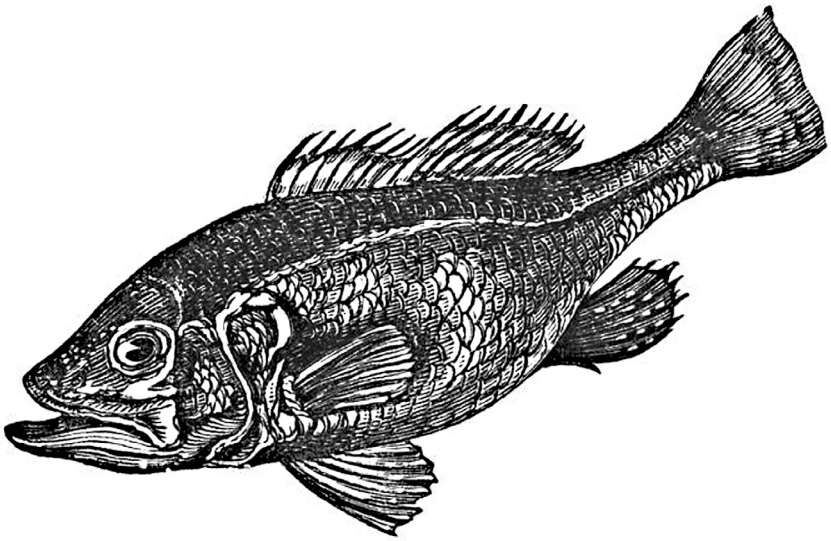
Molina, J. *Análisis de los Estudios de Impacto Ambiental del Complejo Hidroeléctrico del Rio Madera: Hidrología y Sedimentos.* La Paz, Bolivia, Abril 2006.

Paul Van Damme, Executive Director, Faunagua. Personal communication, Cochabamba, Bolivia, July 2006.

PCE, Furnas, Odebrecht. 2004. *Complexo hidroelétrico do rio Madeira, Estudos de Viabilidade do AHE Jiray.* Nov. 2004, Brasil.

PCE, Furnas, Odebrecht. 2004. *Complexo hidroelétrico do rio Madeira, Estudos de Viabilidade do AHE San Antônio.* Nov. 2004, Brasil

Z-1 Colonia de Pescadores, Porto Velho. Data for 2004 and 2005. Retrieved in person at the Colônia in Porto Velho, June 2006.



*Source: http://www.oldbookillustrations.com/index.php?lng=en*

# Negotiating Globalized Conservation:
## A Community Context of Exclusionary Discourse

*by Laura Alex Frye-Levine, MESc 2008*

Conservation-oriented community engagement strategies in developing countries, often undertaken in unfamiliar territory on a limited time scale, present a particular and easily overlooked set of challenges. This paper explores the concepts development and protected areas conservation as viewed through a globalized concept of conservation in a rural Honduran community. I take a particular focus on the broader systems and contexts that often preemptively dictate research viewpoints and conservation priorities and outcomes.

On a global scale, the imperative for conservation has never been so keen. Yet local conservation contexts are characterized by such complex stakeholder viewpoints and histories that discourses of conservation itself are often essentially contested. The seemingly universalized concept of biodiversity, as a possible common nexus of agreement, is itself not formulated well enough to provide a comprehensive or systemic measure that is quantifiable at a given scale or reconcilable with short-term priorities. The biodiversity framework enjoys no universally accepted meaning, nor are its terms translatable across local contexts (Agrawal and Redford 2006). The negotiation of a discourse of nature preservation is therefore far from an objective process. Conservation is one of a series of political discourses levied on the global south with uneven and often unintended consequences. In this paper, I show how the absence of such a unifying concept, coupled with an imperialistic legacy of development that focuses on market solutions to externally identified problems, has real consequences for both conservation and community survival.

Santo Tomás is a community of 30 households in the Merendón Mountain Range of northern Honduras, two hours from the nearest road and historically isolated from state power. This village, spread out between an altitude of 500 and 1400 meters and over an area of 300 hectares, is on the cusp of interweaving and complex outside pressures. The community faces continually increased integration into the world of the market as well as increased government enforcement of top-down conservation regulations. These policies are intended to promote compliance with international conventions, and the government has enlisted the aid of international NGOs in the development and implementation of a management scheme for a new national park. Delineation of legal boundaries for the park has undergone several iterations under a succession of different management regimes. The most recent maps designate the village of Santo Tomás as part of the buffer zone, with nearby higher altitude areas comprising a people-free core zone.

## Conservation/development?

Many scholars and conservationists argue that the often conflated goals of poverty alleviation and rural development will be of critical influence to the success of biodiversity conser-

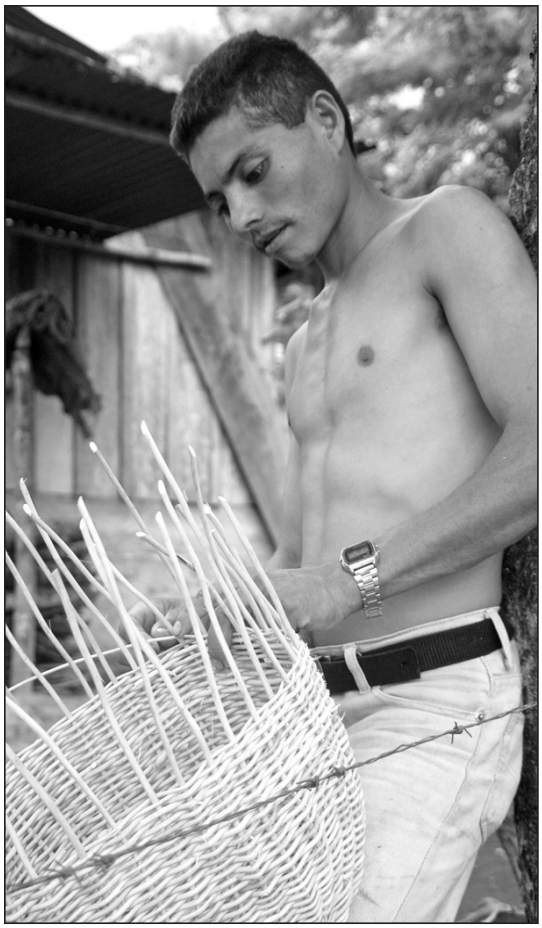
*A native of Lexington, KY, Laura Alex holds a degree in Geology from Smith College. Laura's work is in reconceptualizing broadly sourced holistic theories of sustainability, drawing on both the sciences and the arts in an intentionally interdisciplinary process. She is currently producing a film that examines the intersections between agrarian economies, systems of international trade and labor migration in the village of Santo Tomás, Honduras.*

vation in the coming decades (Sanderson 2005). The unchallenged assumptions surrounding the meaning of poverty in the third world are vast, and development goals rely almost entirely on market systems for implementation of conservation frameworks. In the context of this paper, I define development as the social and economic integration into a system of value generation that promotes consumption over subsistence and sufficiency. Invariably, conservation methods in such a system become equated with schemes of efficiency-based livelihood generation that fit into larger scale markets. Market integration in this context is the reliance on large-scale commodity pricing and the exchange of small-scale agricultural products for the values and commodities of the market. How do the imperatives of a neo-liberal view of global-scale conservation reconcile with local livelihood narratives? Santo Tomás presents a valuable study site for the examination of the imposition of a particular international scale conservation framework that fails to relate to systems of local interest. In the face of increased exposure and access to globalized markets and regulations, local attitudes towards a conservation paradigm that has set people apart from nature are further problematized.

Livelihoods in the village of Santo Tomás are primarily based on subsistence agriculture, consisting of biannual harvests of corn and beans supplemented by forest crops of wild fruits and vegetables (Photograph 1). The core zone of the park, a cloud forest, is also relied upon for lumber and, to a lesser extent, for subsistence hunting. Cattle and coffee are sold as commodities, with the coffee harvest season of November through March representing the primary source of external cash-flow into the village (Photograph 2). On the whole, villagers do not contract for wage labor outside of the village, with the notable exception of five households who currently have a head in the US as a regular source of remittances.

The villagers see their livelihoods as being firmly rooted in the surrounding landscape and in the products they obtain from the forest. Subsistence crops are grown by each household and subsidized with household labor. Such staples, if sold on the market, would go for less than the stated local value of labor. The net effective wage gained by a farmer for corn was, according to my estimates, 75¢ a day. This stands in stark comparison to the going day labor rate of $5.00 (US) in surrounding areas with a labor market. Though these customs lie outside of the con-

**Photograph 1.** Jesús Orellana López (Chungo) husks corn at the conclusion of a days work in the field. Corn and beans are grown as subsistence staple crops and are rarely supplemented with other foods from outside of the village.



**Photograph 2.** José-Lito López weaves a traditional basket in preparation for the upcoming coffee harvest season. The vine used to make the basket grows only within the core zone of the park and is thus illegal to harvest.

cept of market utility maximization; the choice not to engage the market in all sectors and at all scales is often a conscious one (Mayer 2002). However, such a situation would appear to provide a significant point of leverage for livelihood modification and disruption by external forces. Villagers currently engage the commodities market primarily through an annual coffee harvest, of which only a small amount is consumed in house. This market yields the cash reserves that support purchasing from the outside market.

Most agrarian communities, especially those situated on geographic frontiers, are characterized by a productivity focus per unit of labor rather than per unit of land. This creates a local economic system that is opened up for a slew of creative situations that do not form part of the calculus of price-centered market efficiency. Community institutions rather than class forces form the key basis for collective action in societies such as Santo Tomás. In the local economy, there is a multiplicity of measures of yield, and the spatial, seasonal and community scale of agricultural diversification can appear as counter-intuitive contrasts to conventional western ideas of economic efficiency and market-oriented production. The collective subsidization of local subsistence agriculture from the gains of market products serves as a risk-averse, sufficiency based insurance plan from the volatility of the market. This kind of economy, often misunderstood and overlooked by the development discourse, has variable fleeting notions of efficiency because its operating principles are not situated around a goal of growth and marginal profit. Instead, it relies on largely non-quantifiable and non-transmutable values of welfare. Household economic decisions are often based upon individual values and their logics are not necessarily commutable to the community regional scale (Mayer 2002). Unlike capitalist production, the household model has no explicit goal or end. Rather, it is a set of cyclical practices where any production remainders become re-integrated into the broader scenario of household activities (Gudeman and Rivera 1990). The agrarian economy is characterized by efficiency in consumption over efficiency in production and distribution. The conventional approach to conservation is to replace such an economy with one of market solutions and economic integration. This discourse is implicit in the plan of social outreach proposed by most conservation NGOs. Such plans fail to address the complexities of local rationality, and have no way of incorporating a system of local values. The irony in this conversion is one of market wastefulness in resource exploitation as consumption, which becomes a byproduct of the abandonment of the sufficiency framework.

## Regulations and contracts

Land use conversion is seen as the most significant internal threat facing the park. Villagers in Santo Tomás have successively cleared new land for agriculture up the mountain to accommodate a growing population, but park regulations now forbid the clearing of land or felling of trees for any purpose, including construction and repair of local houses. In concert with the Honduran government, a succession of international conservation NGOs have attempted to design management schemes to protect the park from such activities. The most recent of these schemes is rooted in the enforcement and accountability-based discourse of 'people-free parks', to be accomplished through further market integration. The NGO is currently proposing a contract of value-added coffee marketing ("fair trade plus") as a way to facilitate adherence to park regulations in Santo Tomás and neighboring villages. They have based this proposal on a quasi-successful conservation nut marketing scheme they pioneered in Southeast Asia. Though this NGO is interested in local livelihood in Honduras, they are unwilling to compromise to local realities on a scale that would have real significance for true buy-in to conservation through the involvement of communities in its discourse. The assumption is that the higher market prices gained from specialty coffee will be enough to justify enforced abdication of current reliance on forest products from the park, with militarized enforcement being a reasonable and effective long-term deterrent (Photograph 3). The NGO sees development, through removal of reliance on and relations to the park, as essential to park conservation and maintenance. The removal of usufruct or proto-tenure rights to lands that have now been designated as part of a protected area is not up for question. Villagers have no hold on the discourse of nature and are thus thrust into the arms of globalized conservation and therefore the values of globalized development.

## Global discourse, local consequences

Research into practical interventions in conservation and development reveals a disturbingly simplified understanding of both poverty and biodiversity (Agrawal and Redford 2006). These oversights are complicated by a decades-long 'development imperative', which has swept the contextual discourse of modern conservation towards a foregone conclusion of aban-

**Photograph 3.** The Honduran military, which enjoys significant support from the US military, patrols the park intermittently to enforce hunting and harvesting bans. The NGO has allied itself closely with the local patrol force, providing them with food, lodging, and transportation into the park during the field season.

donment of subsistence in favor of embracing integration into international markets. As a researcher working in rural conservation projects with a variety of stakeholders, one is easily 'colonized by the development discourse' (Escobar 1995). In places such as Santo Tomás, it is easy to conflate the obvious local desire for increased economic and political security with the familiar ideals of achieving this through market integration. Answers to challenges to the hegemony of the conventional conservation and development dialogue are complicated by the reality of a conjugate world. It is becoming increasingly difficult to address local diversities in a new age of globalization (Sanderson 2005).

Rather than engage Santo Tomás on a cultural level, the conservation NGO currently working in the region is attempting to adopt a 'one-size-fits-all' approach that it hopes will obviate the pursuit of a detailed understanding of local dynamics, needs and interests. Observing the forces of globalization already rapidly encroaching upon the community from other corners, the NGO has chosen to join a fray of multinational political and economic actors. They have become an additional player in a game of exclusionary conservation, offering the promise of further integration into a consumer economy in exchange for the relinquishing of the use of resources from the park.

The lack of understanding of and consideration for local community dynamics and economic systems has effectively shielded the community of Santo Tomás from the benefits of sustainable livelihood advocacy the international community perceives in such NGOs. The conservation sans community approach is thrusting them deeper into the economic and cultural volatility of increased reliance upon multinational markets, and further enables the culture of shame and secrecy that have developed around rigid monitoring of survival useage of natural resources.

In such a context, an increase in market price for coffee could easily encourage further deforestation within the core zone of the park, where the altitude is ideal for growing high yielding high quality coffee. Though labor availability is currently the limiting factor in the amount of coffee planted by the village, a higher price would allow the hiring of contract laborers from other towns, a practice already employed with some frequency when commodity coffee prices rise. Proposals by the NGO to impose a system of community policing in an effort to prevent such expansion have set up a power dynamic similar to the one already in place through resource monitoring by the Honduran military. This system not only has fostered significant resentment and unwillingness to cooperate on the part of villagers, it also is largely ineffective in achieving even its singular goals.

Participatory social science research was undertaken during the summer of 2007 in order to ascertain household and agricultural practices and attitudes towards commerce, conservation and the park. All households in Santo Tomás participated in interviews lasting four to six hours. When asked directly, no villagers were able to articulate benefits that they personally derived from the park besides clean air and clean water. The NGO has pointed to these findings as proof of lack of awareness of the inherent value of the park and used them to justify further separation of the community from the natural system. From a social science perspective, it is clear that the answers given to these questions grew out of the discourse in which they were asked. All families exhibited a detailed knowledge of agricultural cycles, and native plants and animals. Day-to-day participant observation confirmed deep as well as subtle knowledge about the natural processes that encompass the village and the land around it. Lack of awareness and integration of this knowledge by conservationists constitutes a lost opportunity at leveraging local forest knowledge in an integrated participatory system of conservation.

## Setting a new stage

Sustainability in conservation is first and foremost a place-based process, not immediately reconcilable with the trajectory of generic imperatives put forward on the international stage. Conservation NGOs have largely failed in efforts at gaining local legitimacy in Santo Tomás. Similar enterprises in other locales have been critiqued as having unclear and short-term management goals, contributing to the weakening of local leadership and patronizing local communities (Sanderson 2005).

Most global scale conservation fails in its imperatives because of lack of engagement with the questions of development and conservation beyond the socio-cultural context of neoliberalism. This operating system requires that a price be placed on the externalities of market-based environmental degradation. Such projects are explicitly set up within a zero-sum framework of poverty alleviation versus biodiversity conservation goals, perceived as fundamentally desirable yet oppositional forces. The combined problems of non-use valuation of protected areas (which requires non-use) and the subjective nature of valuation of conservation as it occurs within a market framework, fails to provide a conservation imperative on the scale that would be necessary to maintain wild nature. NGOs are saddled with picking up the pieces left behind and often unquestioningly adopt the exclusionary discourse in which they are framed, silently replacing the values of sufficiency with those of consumption.

This discourse has been used to implicitly and literally deny communities the ecosysetm services upon which they have historically relied. Many researchers take the very particular set of premises of this discourse as given truths, and propose schemes which only further an unnecessary divorce between wild lands and the communities that could serve as their most thorough and knowledgeable stewards.

One could imagine an alternative paradigm for Santo Tomás that pursues an engagement with local dynamics, values and goals, and prizes the considerable local knowledge and respect the villagers have for the park and their place within it. Such a stage for conservation would include by necessity the people of the park as significant and inextricably important stakeholders in its conservation. In the words of one villager: "We are the park, we form a direct part of it and you cannot deal with us separately."

### Acknowledgements

Many individuals helped me in the field: Juan Angel López, Tulio Hernández, Dixa Hernández, Angel Hertslet, Rheldi Purdy and the people of Santo Tomás. Alex Vallejo was invaluable at helping me navigate government and conservation organizations in San Pedro Sula. Dr Amity Doolittle has provided much inspiration and assistance both in the field and in the office. This project was funded by: The Tropical Resources Institute, The Program in Agrarian Studies, The Yale Center of International and Area Studies, and The F&ES Globalization Internship Fund.

### References

Agrawal, A. and K. Redford. 2006. *Poverty, development, and biodiversity conservation: Shooting in the dark?* Working Paper No. 26, March 2006. Wildlife Conservation Society, NY.

Escobar, A. 1995. *Encountering development.* Princeton: Princeton University Press.

Gudeman, S. and A. Rivera. 1990. *Conversations in Columbia: The domestic economy in life and text.* Cambridge: Cambridge University Press.

Mayer, E. 2002. *The articulated peasant: Household economics in the Andes.* Boulder: Westview Press.

Sanderson, S. 2005. Poverty and conservation: The new century's "peasant question". *World Development* 33(2): 323-332.

# Has Community Based Conservation Failed in Tanzania?

## Lessons from Local People's Attitudes and Practices Towards Conservation in Morogoro District

*by Baruani Mshale, MESc 2008*

### Introduction

As sustainable resource use becomes a significant aspect of wildlife conservation efforts (Hulme and Murphree 2001), the importance of involving local communities in management of wildlife resources is gaining more recognition (IUCN 1980, West and Brechin 1991, Baldus and Siege 2001). The integration of protection and utilization in conservation arose as a result of the governmental failure to sustainably conserve wildlife resources alone through a "fences-and-fines" approach (Baldus and Bigurube 1992, Songorwa 1999). In Tanzania, the clear failure of this approach led the government in the early 1990's to push for the increased involvement of local communities (Baldus and Siege 2001, Ndunguru and Hann 1998). But successful cooperation between local people and the government hinges on trust between the two parties. The need to involve local people in conservation and build this trust is the idea behind the conservation approach called community based conservation (CBC).

*Baruani Mshale holds a BS in Wildlife Science and Conservation from the University of Dar es Salaam. His undergraduate thesis examined the institutional and legal aspects of community based management of wildlife in Tanzania. At Yale he has focused on natural resources and environmental economics. Baruani plans to continue his current work on resource economics, biodiversity conservation and climate change in a doctoral program at the School of Natural Resources and Environment, University of Michigan Ann Arbor.*

The aim of CBC is "to create, through bottom up, participatory approaches, conditions whereby a maximum number of community members stand to benefit from sustainable management and utilization of wildlife resources" (Songorwa 1999). The approach intends to change rural people's behaviors and practices (Gibson and Marks 1995) and use them as vehicle for achieving conservation goals (Barrow et al. 2001, Murphree 1994). Therefore CBC can be referred to as "*conservation by the people and for the people*" (Baldus et al. 1991, IIED 1994).

In Tanzania, CBC is practiced on village lands surrounding game reserves, which are categorized as Wildlife Management Areas (WMA). Significant milestones in implementing the CBC approach in Tanzania include the establishment of early CBC projects such as the JUKUMU society in 1989 (Baldus and Bigurube 1992) and the recently enacted policy documents related to CBC namely, the Wildlife Conservation Policy of Tanzania (URT 1998) and the Wildlife Management Areas Regulations ( URT 2002). CBC is so important that three quarters of the Wildlife Policy of Tanzania objectives are about it (WPT 1998).

During summer of 2007, I conducted research to examine the JUKUMU society, a CBC organization in the northeast of the Selous Game Reserve in Tanzania. I focused on local peoples' attitudes and practices towards conservation as indicators of their interest and willingness to participate in wildlife conservation. Specifically I wanted to find out if the CBC approach had been effective in changing

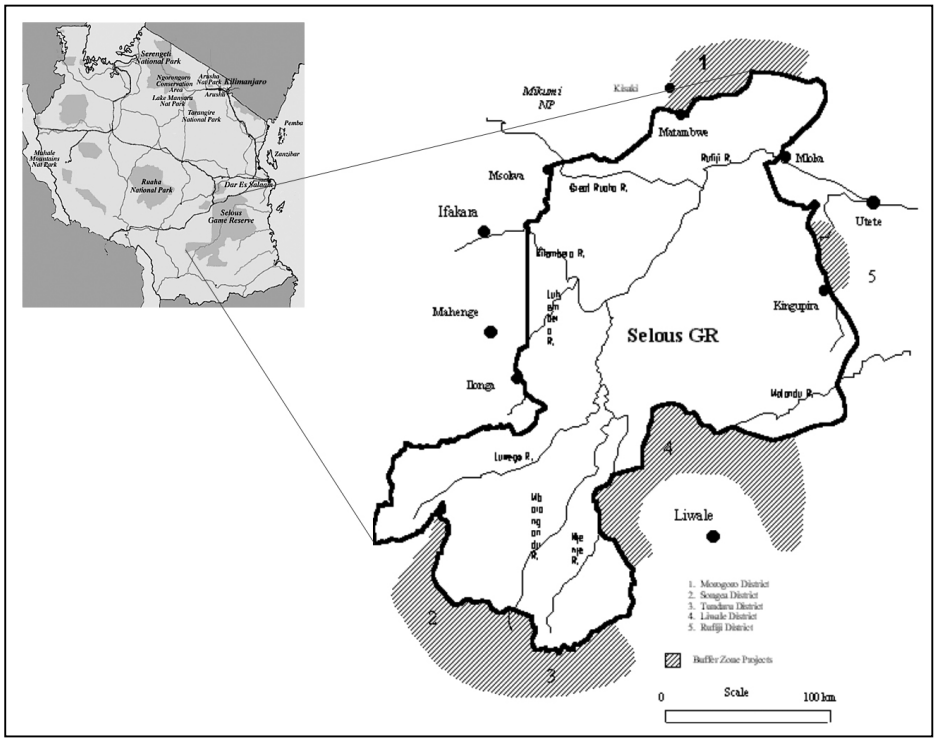



**Figure 1.** Map of the Selous Game Reserve and its location in Tanzania. Shaded area 1 is the Morogoro District Wildlife Management Area, also known as the JUKUMU Society.

rural people's behaviors and practices, and what are the underlying reasons. Understanding local attitudes and practices is important since the government has often blamed locals for the difficulties in implementing CBC in Tanzania.

## Study area and site selection

I conducted this study in the Morogoro District WMA (Figure 1), also known as the JUKUMU Society, which translated means literally "The Society for Sustainable Utilization and Conservation of Wildlife Resources in the Ukutu Valley". I selected this particular WMA because it is the oldest and largest in Tanzania in terms of member villages, area coverage and diversity and abundance of wildlife resources. I also wanted to find out why despite JUKUMU being considered a model for CBC Projects in the country and in southern Africa, it has not been granted the Authorized Association (AA) status. The AA status is the final stage in the establishment of a WMA, and it grants full management of wildlife resources and revenues to the local people, which otherwise go to the Ministry of Natural Resources and Tourism. Having conducted previous research in the area facilitated the process of gaining the villager's trust for this study.

## Research methods

I conducted over 350 semi-structured interviews with local people in six of the 22 JUKUMU Society member villages over a period of about six weeks. Information was obtained at the village, sub-village and household levels. This multilevel design allowed me to test the CBC assumption that local communities are largely homogenous. The sampling strategy and the factors included in the study were established based on a week-long pilot survey.

Village selection considered the following factors: location in relation to the Selous Game

reserve, main economic activities, amount of land contributed to the WMA and village size in terms of population and area.

At the sub-village level, two main factors were important: cluster location and economic activity. Cluster location considered the distance from the village center to the center of a cluster—a group of houses together—and was categorized as near and far. Economic activity of the sub-village was either predominantly farmers or livestock keepers.

In order to interview all groups of people, household selection was stratified first and then randomized within each stratum. Pertinent factors included household head's gender, age, education level and marital status. Household economic activity and duration of residence in the village were also significant considerations. I assessed household's income and expenditures and categorized households into poor and non-poor households.

I used questionnaires and participant observation as my primary data collection methods. I investigated local people's attitudes and practices towards conservation by examining their knowledge, behaviors, perspectives and activities in relation to conservation goals. Indicators of conservation attitudes included intensity of poaching and encroachment in protected areas, and agreement or disagreement on hypothetical situations related to conservation.

## Results and discussion

### *Attitudes and practices: General findings*

Generally, local people's attitudes and practices do not favor conservation. This is evidenced by poaching, encroachment into protected areas and 80% (n=340) of responses indicating that they would like to see JUKUMU dissolved. Poaching declined in 2002 following the start of the pilot phase but is currently increasing since the villagers' expectations of project outcomes are not being met. Local people feel they were cheated into establishing the WMA and therefore are no longer interested in participating in the Society.

### *Attitudes and practices: Differences at the household, sub-village and village levels*

There are significant differences in local people's attitudes and practices towards conservation at the sub-village and village levels, while at the household level no sharp differences based on age and gender categorization were found.

**Sub-village level.** Comparisons between sub-villages within each village showed sharp differences between cluster locations. While both near and far households exhibited negative attitudes and practices towards conservation, the far-households showed significantly more negative attitudes and practices. This may be explained by the fact that households far from the village center rarely get assistance from game scouts in the event of conflicts with wildlife. This implies that the higher the damages, the higher the negative attitude towards conservation among local people.

**Village level.** Villages differ in their levels of poaching with two villages showing notoriously high levels. Poaching and encroachment into protected areas, regardless of the reasons, are viewed by the government as indicators of negative attitudes towards conservation. In this case, however, the differences between villages should be interpreted with caution as they might indicate differences in availability of wild animals near the village land rather than in attitudes. Respondents from villages with less poaching activities repeatedly stated their willingness to engage in hunting if more wild animals were present near their villages, since they do not consider participation in wildlife protection to be rewarding.

### *Attitudes and practices: Contributing factors*

The main factors contributing to negative attitudes and practices include: increased human-wildlife conflicts in the area, the failure of the government to fulfill promises made during

CBC establishment, lack of conservation education and economic hardships.

**Human-wildlife conflicts.** Increased human-wildlife conflicts have been reported in the area. Property destruction, livestock killing, crop raiding, and injury and occasional death of villagers were at the top of the list of reasons for locals to hate wild animals. Elephants, monkeys, lions, crocodiles and hippos were the most mentioned. Interestingly buffalo incidents—mostly associated with illegal hunting—were not mentioned, although the local hospital reports more deaths by buffalos than by any other animal. Crocodile attacks were reported mainly during the rainy season, crop raiding during the harvest season when food is scarce inside the protected area, while attacks by carnivores on livestock were fairly constant throughout the year. Local people and the government argue that the higher frequency of conflict is the consequence of the achievement of conservation goals, which has resulted in increased wildlife populations. No recent data on the status of these populations are available for the area and therefore more research is needed before the argument can be supported.

An elderly Maasai pastoralist at Kisaki Station village sarcastically observed that

> *…yes, wild animals are increasing because of conservation … in the past I used to lose not more than two cows each year, but as of July this year I have lost four already and last year I lost three cows and six goats….*

Surely this old Maasai will not be impressed with conservation if it results in increased losses to him. In other words, wild animals are a threat to human survival in the area and that influences their attitudes towards wildlife conservation.

**Failure to meet economic expectations.** Because CBC is an incentive-based conservation approach, WMA regulations require that JUKUMU allocates money generated from its various sources to improving rural livelihoods and protecting wildlife resources in the area. The specific benefits agreed upon at the beginning of this project included a hunting quota of 13 animals per village for meat supply to be managed collectively by JUKUMU, the establishment of a village development fund and improvements in health, education, water and sanitation. As is evident from this study, the promised benefits are not being delivered.

***Meat from the village hunting quota.*** Despite the fact that the agreed hunting quota was not used for the past two years and no meat has been legally hunted, in 2007 the government decided to reduce the village quota from 13 to 5 animals per hunting season. In the past—between 2002 and 2005—the average number of wild animals hunted and sold in each village was 4 instead of 13. Even if all the 13 animals were hunted and sold to the village, this would not suffice to supplement the other protein sources. Consequently villagers engage in illegal hunting to satisfy meat demands. It is not clear whether the number 13 was reached by ecological or economic analysis. The low level of legal hunting is not due to villagers' lack of interest in the meat; instead it was explained by inadequate availability of ammunition and village game scouts to conduct the hunting. Thus, reducing the hunting quota instead of addressing the reasons for its insufficient utilization makes no sense.

***Improving social services.*** The WMA approach required each village to identify its development needs so that funds could be allocated to improving social services such as education, water supply, energy and health. Yet very few social services have been improved using the revenues from conservation activities. Most of the water wells I observed were not only in very poor condition and dangerous, but had not been drilled by the government as promised earlier. There has been no development as a result of local people giving up their land for conservation and therefore people are now demanding their land to use for agriculture.

## Conclusion and policy implications

Government authorities have been using findings from studies on local people's attitudes and practices towards conservation to justify the assertion that people hinder the effective implementation of the CBC approach. Such conclusions usually ignore the causes of the reported attitudes and practices. This and other studies (Songorwa 1999, Baldus and Siege 2001) have confirmed that local peoples' attitudes and practices play a significant role in implementing effective CBC projects. Attitudes and practices are largely influenced by meeting development goals while preserving wildlife resources. These goals include improving social services such as education, transportation, health and providing assistance to reduce human-wildlife conflicts. Other benefits of CBC include conservation education, game meat as a protein source to supplement dietary requirements and employment through eco-tourism. The government and other stakeholders therefore need to realize the potential of the CBC approach and promote positive attitudes and practices among local people towards conservation.

I agree with other findings including LEAT (1998) that the procedures for establishing WMAs in Tanzania are very complex and need to be reviewed and relaxed. Moreover the government must play an active role in capacity-building among the local people to run effective projects. The review should aim at putting local people in charge of the wildlife resources occurring in their area. Relaxing the procedures should go hand in hand with immediate plans to build local people's capacity to manage the wildlife resources.

### *Other general policy implications*

The Wildlife Division (WD) in the meantime should ensure equitable distribution of the benefits—funds and meat—to all the villages. The JUKUMU Society's failure to distribute the promised benefits equitably among villages makes it appear as if some villagers have more priority than others. This causes distrust and disharmony between villages and hence exacerbates the negative attitudes and practices among local people toward wildlife conservation. At the same time, WD should develop and implement immediate strategies to reduce human-wildlife impacts. Assisting local people in case of problem animals will foster positive relations between local people and conservation authorities.

Furthermore it is worth noting that CBC approach in general, if properly designed and implemented, is still relevant for bringing about a balance between conservation and sustainable utilization, despite the current situation. The claim by some authors (Berkes 2003, Holmern et al. 2002, Murombedzi 1999) that the CBC approach is failing to achieve the intended goals seems inappropriate, since none of the current projects satisfies characteristics of a fully functioning CBC project (Baldus and Siege 2001). An effective CBC project will be one that is run entirely by empowered local people within a particular community, and this is nowhere to be found in Tanzania or Southern Africa (Murphree 1994). Apart from the many projects being managed by governments on behalf of disempowered local communities, some of the projects are too big to even be called CBC in a strict sense of a community (Little 1994). Therefore the correct assertion would be that the current approach—which is not true CBC—is failing, and that a true CBC approach can achieve both conservation and rural development goals by addressing the causes of negative conservation attitudes and practices among local people.

### Acknowledgements

My sincere thanks go to Prof. Robert Mendelsohn for his guidance, from study design to write up. Further cordial appreciations are due to Amity Doolittle, William Burch, Kassim Kulindwa and Fred Strebeigh for their informative advice. I am also thankful to Compton Foundation and Yale

TRI for providing financial support for conducting this study. Many hearty thanks to my research team and everyone else who in one way or another contributed in making this study a success. I am grateful to you all.

## References

Baldus, R. D. and G. Bigurube. 1992. Community Wildlife Management in Tanzania. *Development and Cooperation* 4: 27.

Baldus, R. D. and L. Siege. 2001. Experiences with Community Based Wildlife Conservation in Tanzania. *Tanzania Wildlife Discussion Paper* No. 29. Dar es Salaam.

Baldus, R. D., G. Bigurube, D. Kaggi, H. Krischke and I.F. Ndunguru. 1991. Community Wildlife Management Around the Selous Game Reserve. *SCP Discussion Paper* No. 12. Dar es Salaam.

Barrow, E., H. Gichohi and M. Infield. 2001. The evolution of community conservation policy and practice in East Africa. In D. Hulme and M. Murphree (Eds.), *African wildlife and livelihoods: the promise and performance of community conservation* pp. 59–73. London: James Currey.

Berkes, F. 2004. Rethinking community-based conservation. *Conservation Biology* 18(3): 621-630.

Gibson, C. and S. Marks. 1995. Transforming rural hunters into conservationists: An assessment of community based wildlife management in Africa. *World Development* 23(6): 941-957.

Holmern T., E. Roskaft, J. Mbaruka, S.Y. Mkama and J. Muya 2002. Uneconomical game cropping in a community-based conservation project outside the Serengeti National Park, Tanzania. *Oryx* 36(4): 364-372.

Hulme, D. and M. Murphree. 2001. *African wildlife and livelihoods: the promise and performance of community conservation.* London: James Currey.

IIED. 1994. *Whose Eden? An overview of community approaches to wildlife management.* London: International Institute for Environment and Development.

IUCN (International Union for Conservation of Nature). 1980. World conservation strategy: Living resource conservation for sustainable development. IUCN, Gland, Switzerland

LEAT (Lawyers Environmental Action Team). 1998. *Socio-Legal Analysis of Community Based Conservation in Tanzania. Policy, Legal, Institutional and Programmatic Issues, Considerations and Options.* Tanzania National Parks and African Wildlife Fund, Arusha, Tanzania.

Little, P. D. 1994. The link between local participation and improved conservation: A review of issues and experiences. In D. Western and R.M. Wright (Eds.), *Natural Connections: Perspectives on Community Based Conservation.* Washington DC: Island Press.

Murphree, M. 1994. The role of institutions in community based conservation. In D. Western and R.M. Wright (Eds.), *Natural Connections: Perspectives on Community Based Conservation.* Washington DC: Island Press.

Murombedzi, J. C. 1999. Devolution and stewardship in Zimbabwe's CAMPFIRE Programme. *Journal of International Development* 11: 287-293.

Ndunguru, I.F. and R. Hann. 1998. *Reconciling human interests with conservation in the Selous Game Reserve (Tanzania).* International Workshop on Community Based Natural Resources Management, Washington DC, May 10–14.

Songorwa, A.N. 1999. Community based wildlife management (CWM) Tanzania: Are the communities interested? *World Development* 27(12): 2061-2079.

URT (United Republic of Tanzania). 2002. *Wildlife Management Areas Regulations.* Ministry of Natural Resources and Tourism, Dar es Salaam.

URT (United Republic of Tanzania). 1998. *The Wildlife Policy of Tanzania.* Ministry of Natural Resources and Tourism, Dar es Salaam.

West, P.C. and S. R. Brechin (Eds.). 1991. *Resident Peoples and National Parks: Social Dilemmas and Strategies in International Conservation*. Tucson: University of Arizona Press.

# Urban Growth in Peri-urban Quito, Ecuador:
## Challenges and Opportunities for Comprehensive Land Use Management

*by Brenna Vredeveld, MESc 2008*

## Introduction

Quito, Ecuador has been a cultural, economic, trading and population center for centuries. Recently, rapid urban expansion has shaped its region. Located at 2800 to 3200 meters above sea level, it now measures forty to fifty kilometers long and five to ten kilometers wide, unfolding along the trough-shaped inter-Andean valley in which it lies (Carrión 2005, Riaño 2001). From 1950 to 1990 the city grew six-fold in population and twenty-fold in area systematically incorporating minor urban areas on the periphery (Pitkin 1997, Riaño 2001) (Table 1). Unsuccessful attempts to regulate this growth have included urban growth boundaries and decentralization of management powers (Ramírez, pers. comm. July 2007). In particular, the valleys to the south and the plains to the east of Quito have experienced heightened impacts of urbanization given their greater capacity to provide livelihoods and jobs (Murray 1997). This growth has consumed fertile agricultural lands and natural areas, which in turn has prompted the agricultural frontier to expand outward into protected *páramo* (highland grassland) and native forests. The result has been an increasing strain upon disappearing natural resources (De Bievre et al. 2007a,b).

At the peri-urban interface, where land transitions from urban to rural, the composition of people and landscapes remains dynamic, metamorphosing as economies, populations and environments evolve (Adell 1999, Allen 2003, Douglas 2006). It is here that overlapping national, provincial and local land management institutions greatly influence the changing land uses of this region. And as the city grows into these areas, as infrastructure and populations solidify across municipal boundaries, opportunities for more synergistic approaches to urban growth management present themselves.

I came seeking to examine Quito's peri-urban growth management at local, provincial and national levels. Through this multi-scale approach, I found that communities, municipalities and national ministries each play a significant role in influencing urban growth in this region. Yet, there remain many collaborative opportunities that these diverse actors can take advantage of in order to comprehensively manage the associated land transition processes.

## Site description and history

I concentrated on land use management and planning in three peri-urban communities in two *cantones* (counties)—Mejía and Rumiñahui—to the south and southeast of Quito (Figure 1). These communities represent a gradient of urban development and were chosen to better understand their integration and participation in the urban growth management process. El Chaupi in Cantón Mejía is the farthest from Quito;

*Brenna Vredeveld, originally from the southeast US, holds a BA in Environmental Studies from Wellesley College. Before beginning her master's studies at Yale, she worked in both Southern California and Mexico City in issues involving management of peri-urban lands. She has lived and traveled extensively in Latin America. In her future career, she hopes to continue work with land use management around urban areas in conjunction with water resources conservation.*

**Table 1.** Population projections of Quito, Mejía and Rumiñahui and percent urban population.

| | Population (# of inhabitants) | | | Percent Urban Population (2001) | Area (km²) |
|---|---|---|---|---|---|
| | 2001 | 2007 | 2025 | | |
| Quito (urban) | 1,856,555 | 2,180,000 | 2,828,363 | 90.28% | 4,204.55 |
| Quito (rural) | 315,713 | 384,077 | 593,766 | | |
| Mejía | 61,246 | 71,862 | 116,083 | 48.38% | 1,459.23 |
| Rumiñahui | 65,882 | 79,558 | 140,307 | 88.71% | 134.15 |

*Sources: De la Torre 2004, De Bievre and Coello 2007a, Strategic Plan of Rumiñahui, Stategic Plan of Development of Mejía*

it has the slowest rate of population growth and expansion of urban infrastructure. It is the most rural in nature with an economy and population that depend on agriculture and cattle ranching. Cutuglagua, a fast-growing sector closest to Quito, is economically and infrastructurally merging with the city even though it lies within Cantón Mejía. Its population is largely composed of migrants from rural provinces who have come in search of employment, education and to benefit from its proximity to a large urban center. San Fernando, in Cantón Rumiñahui, is experiencing moderate growth due to its milder climate and lower population density, which attracts a mix of rural migrants and those wishing to leave Quito. Within each community, I focused on either a single water user group (El Chaupi and Cutuglagua) or a community association (San Fernando).These communities and *cantones* are located within important sub-watersheds, which supply water to Quito—those of the San Pedro and Pita Rivers.

**Figure 1.** The Quito region lies in the Pichincha Province of Ecuador, in the Andes Mountains. Urban expansion of the city has begun to extend into neighboring *cantones* (counties) of Mejía and Rumiñahui to the south and southeast. Specific study sites—Cutuglagua, El Chaupi and San Fernando—were chosen to represent a gradient of urban development.

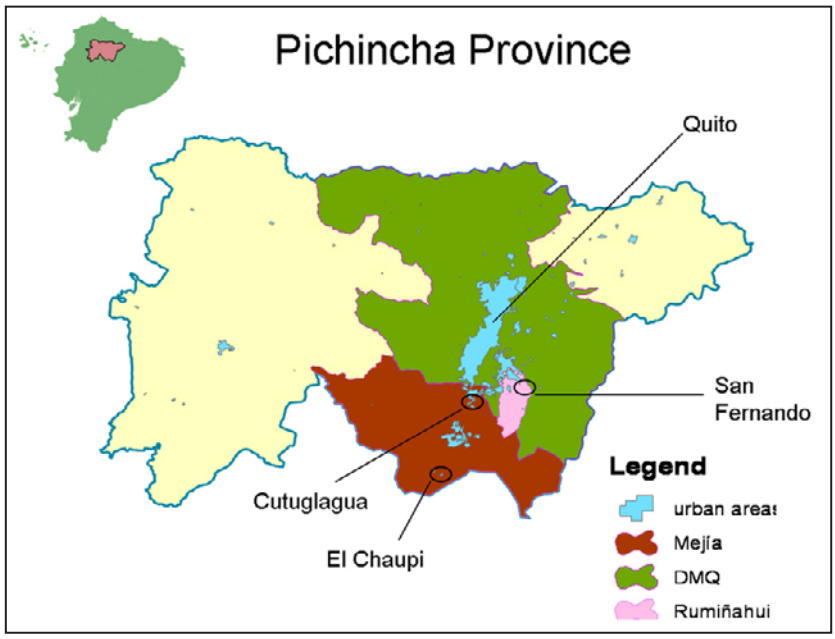
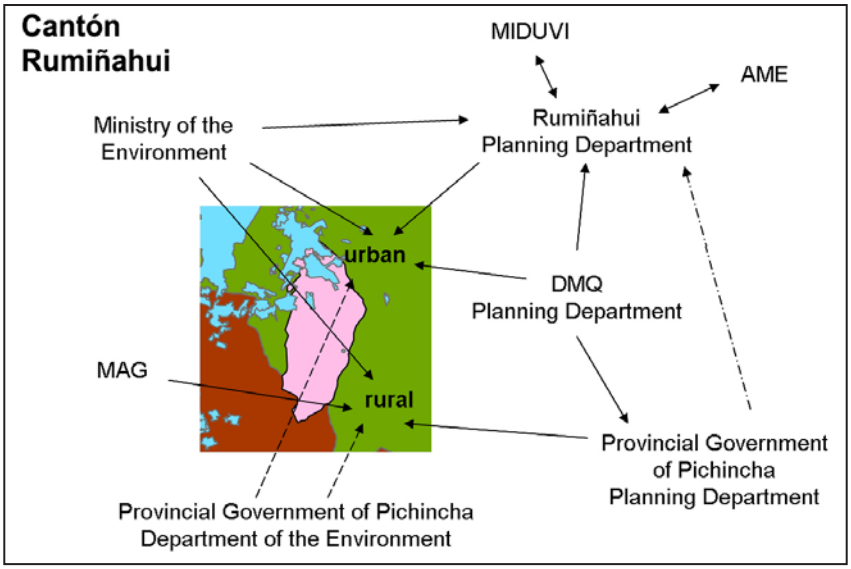


**Figure 2.** Agencies at provincial and national levels influence both urban and rural land use management in the Quito region either through direct regulation or collaboration. At a provincial or cantonal level, collaboration between agencies is often unidirectional. At the national level they do not collaborate outside of projects at provincial or cantonal levels. Arrows indicate the direction of influence in relationships between agencies and the use and development of urban or rural land. Solid lines reflect existing relationships; dotted lines reflect those that exist only on paper or are anticipated in the future.




## Methods

I conducted semi-structured interviews with organizations at three scales—local, provincial and national—to determine their roles in the land use planning process and the nature and extent of their collaboration with other institutions. At the local level I spoke with community leaders. At the provincial level, I concentrated on government agencies in charge of land use and natural resources planning and regulation such as the Departments of Planning and the Environment of the Metropolitan District of Quito (DMQ), Mejía and Rumiñahui and the Government of Pichincha. The national level included ministry programs for managing agriculture, natural resources, community development and housing. I completed a total of 23 interviews, conducted in Spanish with the help of an Ecuadorian assistant. I supplemented these with information from the Development Plans of relevant local and provincial governments and institutional documents from the ministries.

## Results and discussion

Management agencies, local governments and communities recognize that urban growth in these peri-urban regions has been occurring at an uncontrolled pace. Most describe its negative impacts on water quality and availability, the unsatisfied needs for better infrastructure that it generates, the associated increases in population and traffic congestion and the decreasing number of green and natural spaces. Among the reasons they cite for these trends are rapid migration, lack of appropriate zoning in urbanizing areas, corruption of management officials and lack of economic resources. Not mentioned very often is the lack of meaningful collaboration among land management and planning institutions (Figure 2).

### *Participatory planning at the local level*

Communities in El Chaupi, Cutuglagua and San Fernando participate in planning processes through community organizations and representative local government. They express their goals in terms of improvements in infrastructure, health, education and the economy, as opposed to specific land uses. Though, if government is slow to provide needed services, they often take the initiative themselves, regardless of the land use regulations, for which monitoring and enforcement are generally weak. Unlike El Chaupi and San Fernando, Cutuglagua's constantly changing and expanding demographic makes broad community participation in such initiatives more challenging. In all three communities, specific household land uses are allowed to continue so long as they do not create conflicts with other community members.

In addition, separation of planning responsibilities between cantonal and provincial governments occurs throughout the region. Because Cutuglagua and San Fernando are classified as "urban", their goals are incorporated into the Plans of Development of Cantón Mejía and Cantón Rumiñahui, respectively. El Chaupi, on the other hand, is considered rural and collaborates exclusively with the Provincial Government of Pichincha. This separation is reflected in Mejía's Plan of Development, which focuses on its urban areas. Rumiñahui gives a more comprehensive (though not complete) treatment to its rural and urban areas most likely because it has more resources to train planners and land managers and to prepare comprehensive planning documents.

### *Collaboration among planning institutions: DMQ, Mejía, Rumiñahui and Pichincha*

The management strategies that the DMQ adopts often dominate regional planning. Its creation in 1992 granted it more substantial legal authority to regulate its own growth and natural resources. Greater economic resources allow the District to employ a larger staff of trained personnel to use sophisticated technologies for such management. They have attempted to direct growth towards certain sectors by providing affordable housing and improved transportation corridors, but their weak enforcement of land use regulations (i.e., legalizing illegal settlements) has resulted in spontaneous growth to many areas, even onto lands designated as non-urbanizable or protected (Valdivieso 2005, Bermúdez, pers. comm. July 2007). Mejía and Rumiñahui, operating on smaller budgets and

**Photograph 1.** La minga, or "community service", is a cornerstone in rural areas of Ecuador in which communities work together to construct sanitation systems, build houses, improve community green spaces, etc. In Barrio San Fernando—adjacent to a rapidly expanding urban area southeast of Quito—the community builds trails and cleans a small stream as part of an ecotourism project in an abandoned nearby valley.

with fewer staff, have been forced into reactive planning approaches as they are subject to the side-effects of population overflow from Quito.

For Mejía and Rumiñahui, external assistance with planning initiatives has been a great help in sharing costs and saving time. They have adopted *convenios de mancomunidad* or "community agreements"—informal contracts that maintain working relationships—with other institutions and municipalities in this region to facilitate information sharing and collaboration, in this case to direct growth that spans municipal borders and lend technical assistance. Mejía's new Department of Planning has requested help from the DMQ's Planning Department to create zoning plans to regulate growth in urban and urbanizing communities (Cajiao, pers. comm. August 2007). Rumiñahui, similarly, has turned to the Association of Ecuadorian Municipalities (AME) to help structure its Plan of Development and Zoning (Ramírez, pers. comm. July 2007).

Decentralization of land management powers to local authorities allows these three *cantones* to better respond to their community's needs. While their Plans are also developed to comply with the new Plan of Development for the Pichincha Province, it has yet to be seen if they do so in practice. Collaboration among the municipalities remains on a level of lending technical assistance and resources rather than coordinating and complementing planning strategies. Integrating their planning policies could be particularly beneficial for managing watersheds and natural resources (e.g. native forests, *páramo*), which do not respect political boundaries. No mention of this kind of collaboration between Mejía and Rumiñahui was made in any of the interviews.

### *Collaboration among planning institutions and others*

National organizations such as the Ministry of Agriculture (MAG), the Ministry of Urban Development and Housing (MIDUVI), the Association of Ecuadorian Municipalities (AME) and the Ministry of the Environment provide assistance to local and provincial governments for land use management only when requested to do so. The local government defines the roles and extent of the agency's participation, which reinforces the separated treatment of urban and rural planning. Outside of providing assistance to the municipalities there is little collaboration among these national organizations to define long-term, comprehensive land use planning strategies.

Narrowly defined roles as normative regulators and "community agreement" facilitators also restrict these national agencies from participating directly in cantonal and provincial land management and urban growth plans. They are consultants rather than participants. This approach helps to maintain the integrity of projects in responding to local needs, but limits the creative planning capabilities that these agencies can apply to such projects. The combination of limited participation and resources has resulted in a lack of programs for those rural and natural areas that face increasing pressures of urbanization. The MAG, for example, has no robust programs to help farmers resist urban expansion pressures; it offers only limited technical assistance programs to small-scale agriculturalists. Its hopes for more direct participation count on only recent changes in agricultural policy (Velásquez, pers. comm. July 2007). Other than operating limited community development programs, the MIDUVI remains restricted to revising legal aspects of development projects. In the Pichincha province these Ministries work exclusively in the *cantones* outside of Quito, respecting the DMQ's special legal authority to manage its own land and public services. Many of these national agencies hope that a new Ecuadorian constitution, currently being written, will empower them to participate beyond their normative capacities in order to better contribute to land management initiatives in their respective areas of expertise.

**Photograph 2.** A view of Quito looking east from the sides of Volcano Pichincha. Unfolding along an inter-andean valley, the city measures 40-50 km long and 5-10 km wide. El Valle de los Chillos, just over the eastern ridge, is home to recent urban expansion in this region.

## Conclusion

The multi-scale, urban-gradient approach of my research identified several challenges that hinder effective urban growth management. In general, there is a lack of effective and comprehensive collaboration across institutions at all scales. "Community agreements" are limited to technical assistance programs when the real need is for coordinating and complementing development plans across administrative boundaries. Similarly, there is an absence of coordination among institutions that work on both the urban and rural sides of the expanding peri-urban interface, including within cantonal planning departments. The separated treatment of urban and rural spaces often leads to favoring urban planning in these peri-urban areas, to the detriment of rural and natural areas. This entrenched rhetoric reinforces itself by dictating the participation of national institutions in planning processes. While these national institutions may have many hopes for more direct participation, their limited scope relegates them to waiting for appropriate political changes to make it possible. In addition, the centralization of planning resources in Quito allows it to dominate regional planning policy, forcing Mejía and Rumiñahui into reactive planning approaches. Organizations across all scales suffer from an inability to effectively enforce the regulations that they create. Keeping up with the pace of city expansion spreads their time, money and staff thin.

Confronting these challenges could be captured within a long-term, comprehensive land use plan that takes into consideration the flows of people, resources and markets between urban and rural spaces at the peri-urban interface. Such a plan could integrate resources and responsibilities across institutions at the various scales, regardless of political-administrative boundaries. This process also creates opportunities to engage local actors—the land use decision-makers that are expanding the peri-urban interface on a daily basis—through the established non-governmental and community organizations with which they work. While I

did not focus on them in this study, their presence in on-the-ground land use management in this region is very real. Their ability to be a collaborative intermediary between communities and planning institutions is promising, though depends on community strength and demographic turnover. With such foundations, next steps could include resource sharing that focuses on addressing urban growth processes such as rural to urban migration, low profitability of small-scale agriculture that makes it susceptible to urbanization pressures and poor quality of life in both urban and rural areas. Using these new targets to capitalize on creative planning capacities of more participatory national ministries could then become a goal. Overall, the relationships between these diverse groups and their willingness to collaborate are as important as the projects and plans they develop. Regulating the rapid growth of this "mancha urbana" (literally the "urban stain") calls for them to take advantage of these collaborative opportunities, leaving behind the political, institutional and urban or rural biases that now separate them.

## Acknowledgements

Thanks to the Tropical Resources Institute, the Program in Agrarian Studies, the Hixon Center for Urban Ecology, and the Council on Latin American and Iberian Studies for their financial support. I am greatly indebted to el Fondo para la Protección del Agua (FONAG) for their on-the-ground support and expertise, especially Jacqueline Cisneros, Pablo Lloret and María José and Andrés. A special thanks to Alejandra Repetto who was an invaluable research assistant. Thank you to Santiago and Bárbara Vallejo who welcomed me into their home in Quito. Finally, were it not for the support of my friends and colleagues at the School of Forestry and Environmental Studies, including my advisors Bill Burch and Lisa Curran, I could not have accomplished so much.

## References

Adell, G. 1999. *Literature Review: Theories and models of the peri-urban interface: a changing conceptual landscape.* Development Planning Unit, University College London.

Allen, A. 2003. Environmental planning and management of the peri-urban interface: perspectives on an emerging field. *Environmental Planning and Management* 5: 135-148.

Bermúdez, Nury. Department of Planning of the Metropolitan District of Quito. Personal communication. July 19, 2007.

Cajiao, Augusto. Director of Department of Planning of Cantón Mejía. Personal communication. August 1, 2007.

Carrión, D. 2005. *Dealing with illicit construction in Quito.* Paper prepared for EMI Thematic Session Root Causes of vulnerability of human Settlements in Megacities, World Conference on Disaster Reduction, Kobe, Japan 20 January 2005.

De Bievre, B. and X. Coello. 2007a. *Caracterización de la Demanda Hídrica: Manejo Integrado de los Recursos Hídricos en la Hoya de Quito.* UICN-SUR, Quito, Ecuador.

De Bievre, B. and X. Coello. 2007b. *Caracterización de la Oferta Hídrica: Manejo Integrado de los Recursos Hídricos en la Hoya de Quito.* UICN-SUR, Quito, Ecuador.

De la Torre, L. 2004. *Plan Maestro Orientador del Manjeo de los Recursos Hídricos en la Hoya de Quito.* The Nature Conservancy, Quito, Ecuador.

Douglas, I. 2006. Peri-urban ecosystems and societies: Transitional zones and contrasting values. In D. McGregor, D. Simon and D. Thompson (Eds.), *The Peri-urban Interface: Approaches to Sustainable Natural and Human Resource Use,* pp.18-29. London: Earthscan.

Murray, S. 1997. The Quito context. In S. Murray, *Urban and Peri-urban Forestry in Quito, Ecuador: a Case-Study.* Rome: Forestry Department, Food and Agriculture Organization of the United Nations.

Pitkin, B. 1997. *The urban environment and participatory planning in Quito's barrios populares.* UCLA Advanced Policy Institute, School of Public Policy and Social Research, University of California Los Angeles. Presented at Association of Collegiate Schools of Planning Conference, 7 November 1997.

Ramírez, Gustavo Rubio. Director of Department of Planning of Cantón Rumiñahui. Personal communication. July 18, 2007.

Riaño, Y. 2001. *Informal land use in peripheral barrios in Quito: Planning problem, development obstacle or poverty alleviation?* Paper presented for the N-AERUS Workshop Coping with informality and illegality in human settlements in developing countries, Leuven, May 2001.

Valdivieso, J.M. 2005. *Propuesta para la gestión integral del suelo no urbanizable del Distrito Metropolitano de Quito.* Programa de Saneamiento Ambiental para El Distrito Metropolitano de Quito (PSA). Quito, Ecuador.

Velásquez, Hernán. Director of the System of Geographic Information for the Agricultural Sector, Ministry of Agriculture (SIGAGRO-MAG). Personal communication. August 7, 2007.

*Source: http://www.oldbookillustrations.com/index.php?lng=en*

# Announcing the 2008-2009 Fellows

This year again TRI Fellows have an exciting line up of research projects around the world. TRI Endowed Fellowships are designed to support Masters and Doctoral students who conduct independent research in tropical countries. This year 25 students received TRI Fellowships for summer research. The 2008 recipients and the countries where they plan to conduct research are:

| | |
|---|---|
| Meghna Agarwala | India |
| Neda Arabshahi | Mexico |
| Dwi Astiani | Indonesia |
| Ariana Bain | India |
| Jennifer Baka | India |
| Mercedes Bravo | Brazil |
| Peter Christensen | Mexico |
| Dylan Craven | Panama |
| Stephanie Day | Argentina |
| Sarah Enders | Nicaragua and Honduras |
| Mark Evidente | Philippines |
| Christopher Finney | Brazil |
| Andjar Hardiono | Indonesia |
| Tal Illany | Argentina |
| Janet Lawson | Argentina |
| David Kneas | Ecuador |
| Jordon Macknick | Nicaragua and Honduras |
| Sarah Osterhoudt | Madagascar |
| Esteban Rossi | Costa Rica |
| Stella Schons | Brazil |
| Trisha Shrum | Mexico and Bolivia |
| Meg Selby | Madagascar |
| Norio Takaki | Brazil |
| Rachel Teel | Fiji |
| Cecilia Viana | Peru and Ecuador |

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

| | |
|---|---|
| Murefu Barasa | Kenya |
| Claudia Octaviano | Mexico and India |
| Daniel Piotto | Brazil |