ABSTRACT:

Like many countries, Brazil is currently struggling to balance economic development and environmental protection. In the Amazonian state of Acre, the state government has begun an ambitious endeavor to promote a forest-based development whereby this once remote and under-developed corner of Brazil can advance economically while valorizing the state’s vast forest resources. If Acre can in fact improve the well-being of its citizens through road paving while protecting the forest resources upon which so many of its citizens depend, this Brazilian state will serve as a model of sustainable development for other parts of Brazil and the world. Numerous past examples of road construction and paving in the Brazilian Amazon have, however, demonstrated devastating implications for both the forest ecosystem and the rural forest-dependent communities that have often been displaced by colonists who settled such areas due to the eased access.

Significant debate currently exists whether such negative consequences will accompany contemporary road projects, such as the paving of the Trans-Oceanic Highway (BR-317) in Acre. Specifically, it has been argued, that the greater presence of governance at the federal, state, municipal, and community levels may diminish the negative consequences otherwise accompanying such infrastructural projects (e.g. Nepstad, 2001, Fearnside, 2003) while other researchers (e.g. Laurance et al. 2001) remain highly skeptical of governance as a means of preventing deforestation. This paper is situated within this debate—evaluating the implications of governance for social and ecological change along the BR-317 highway corridor.

This paper first contextualizes the research topic within the broader topic of colonization, road construction and deforestation in the Brazilian Amazon. Then, drawing upon preliminary dissertation fieldwork conducted in Acre in the summer of 2003, it addresses the relationship between governance, state-sponsored highway paving, and deforestation in two adjacent field sites—a colonization project and agro-extractive reserve—in the southern part of the state. The discussion gives a qualitative analysis of the governance structures existing in the field site—what forms of governance exist, how do people participate in governance, and how do the successes and failures of governance impact local livelihoods and land use decisions. The paper furthermore illustrates the multiple layers of governance affecting deforestation trajectories in this roadside area and
also conveys preliminary findings regarding ways in which governance has both proved effective in slowing deforestation and, at times, served as a disincentive to forest conservation. The discussion concludes with an empirically-based conceptual model relating governance, property rights system, road access and deforestation that will be tested through more in-depth research scheduled for 2004 and 2005.

**Avança Brasil: A Forest-Friendly Highway Paving Program?**

A central issue in discussions about sustainable development in Brazil today involves highway paving in the Amazon Basin. While road paving carries the promise to improve access to goods and services among previously isolated rural and urban communities, it also holds the potential to bring about negative environmental and social consequences, including deforestation and the displacement of rural smallholders under pressure from external colonization and land-speculation. Currently, in academic and policy circles, a considerable debate exists regarding the capacity of governance to prevent these potential repercussions from highway paving. While much of the existing literature uses landscape-level models to predict social and environmental changes arising from highway paving and governance, to date, very little research has considered these relationships at the local level--specifically the ways in which land use governance is mediated through local-level institutions and interpreted by individuals in the Brazilian Amazon.

The Brazilian government has recently launched *Avança Brasil*—an ambitious effort to improve Amazonia’s transportation infrastructure—including the paving of many seasonal roadways. Several studies (e.g. Nepstad et al, 2001, 2002; Laurance, et al. 2001) have made widely divergent predictions regarding the social and environmental implications of *Avança Brasil*. In a series of articles, Woods Hole researcher Daniel Nepstad and co-authors discuss the role that road paving plays in promoting
unsustainable land use practices including for instance the use of fire as a technique to clear forest for cattle pasture. However, in a publication written for the Brazilian government (2001), Nepstad cautiously endorses the Brazilian government’s plans to pave existing roads while promoting sustainable land use along the newly paved roadways. Assuming a central role in this argument, Nepstad argues that Brazil’s current emphasis upon “frontier governance” may lead to less deforestation and more sustainable development along highway corridors than in past decades.

In contrast, Laurance et al (2001) see Avança Brasil as the next in a long tradition of “top-down” development programs such as POLOAMAZONIA and POLONOROESTE that consider environmental and social impacts as an afterthought. While unpaved highways tend to be accompanied by small localized deforestation, they assert that highway paving will lead to higher levels of deforestation and a broader corridor affected. Under their “optimistic scenario” (in which reserve and indigenous lands are minimally impacted by deforestation), this study predicts that 28% of the Amazon Basin will be deforested by 2020. Of the land deforested, they predict that 269,000-506,000 hectares annually will be directly attributable to Avança Brasil.

**Frontier Expansion and Brazil’s Amazonian Highway System**

For most of Brazil’s history, the Amazon Basin represented a remote extractive frontier that was at best loosely integrated with the rest of the nation. Indeed, due to prevailing wind patterns, until the advent of steamships, it was easier for ships to sail from the port city of Belém to Europe than to Rio de Janeiro (Schmink and Wood, 1992). Until the early 1960’s, when the first overland links were built between Amazonian cities and the South, the region remained isolated from the remainder of the country. While
natural resource extraction (e.g. rubber) did fuel regional economic booms, most of the surplus from these activities remained in the hands of regional elites—most of whom were based in the cities of Belém and Manaus—and little reached the coffers of the national government (Browder and Godfrey, 1997; Schmink and Wood, 1992). Prior to the 1960’s, despite the fact that the region comprises 42% of the national territory, the thinly dispersed population of Amazonia represented but a fraction of the national total (Smith, 1982:9).

While previous administrations—most notably that of President Vargas—used rhetoric about the importance of integrating Amazonia into the Brazilian mainstream, by and large, this was not converted to action until the 1960’s. In the early part of this decade, when the region’s first major highway was constructed linking Belém with the new national capital of Brasilia, Amazonia’s historic isolation began to change rapidly. During the 1960’s, and even more so in the 1970’s and 1980’s, the federal government began an enormous effort to encourage colonization of the Amazon through propaganda, road construction and massive fiscal incentives.

A number of explanations have been offered for this relatively sudden interest in the Amazon Basin on the part of the federal government. Subsequent to the military coup in 1964, the government adopted a xenophobic fear of the “internationalization of the Amazon”. Informed by scholars such as A.F. Reis (Reis, 1960), government officials feared that a sparsely populated and poorly integrated Amazonia was vulnerable to threats from neighboring and northern nations interested in the region’s vast resources. This fear was only exacerbated by reports such as a 1971 United Nations Food and
Agriculture Organization document suggesting that, if intensively farmed, the Amazon Basin could feed a global population of 36 billion (Pawley, 1971, Smith, 1982: 13).

Combined with this desire to avoid the internationalization of the Amazon was a desire on the behalf of the government to exploit what was perceived as a vast untapped source of natural resources including timber, minerals, and agricultural land. The development of this region and its resources would serve to absorb investment capital and attract surplus labor from overpopulated and impoverished areas of Brazil such as the Northeast (Schmink and Wood, 1992: 58).

Furthermore, the government’s view of the Amazon as a “safety valve” for overpopulated and impoverished regions of the nation was another important factor behind programs to colonize the area. In the Northeast, a series of droughts led to waves of out-migration from the region. Furthermore, in both the Northeast and the South, the growth of latifundas and agro-industry was forcing smallholders from their land (Smith, 1982: 13). While hindsight shows that implementation of agrarian reform would have been a much more socially just and cost effective strategy to deal with these problems (Ozorio de Almeida, 1992), doing so would have run contrary to the dictatorship’s right-wing philosophical stance and, more importantly, by angering wealthy land owners, would have under-cut a fundamental component of the dictatorship’s political base.

While transportation and settlement in the Brazilian Amazon has traditionally been reliant upon and shaped by the region’s network of waterways, the construction of highway corridors through the basin has undoubtedly been among the most fundamental infrastructural drivers behind colonization and subsequent deforestation in the Brazilian Amazon. As massive colonization is usually only viable with connectivity to the nation’s
road network, the construction of roadways was seen as key in the government’s colonization schemes. Indeed, the creation of the major colonization poles (e.g. Trans-Amazonia, BR-364) was inextricably linked to the roadways of the same name. Large-scale road construction began in Pará—with the Belém-Brasilia Highway and a subsequent network of roadways leading westward toward the Xingu River and Amazonian interior. Subsequent road construction and paving projects began connecting Rondônia and ultimately Acre with Brazil’s more populous south (Ozorio de Almeida: 1992).

Highway construction—especially in sparsely-populated areas--often led to negative social and environmental consequences including land speculation, rising land prices, population turn-over and deforestation (Schmink and Wood, 1992; Perz, 2001, Nepstad, 2001, 2002; Laurance, 2001. Many of these consequences were predicted long ago even before the government began implementation of these projects. Anthropologists and environmentalists expressed concern about the negative impacts of roads upon the region’s indigenous population and forest ecosystems. Economists expressed concern that no real cost-benefit analyses informed the projects. Many economists argued that the benefits of roadways in sparsely inhabited regions could not compensate for the massive construction and maintenance costs these projects implied (Ozorio de Almeida, 1992: 76). Unfortunately, throughout the dictatorship, these warnings went unheeded.

The negative implications of colonization in the Brazilian Amazon have been well-documented. Largely due to lack of technical assistance, colonists brought with them land use technologies that were poorly adapted to the Amazonian environment--
likely causing more deforestation than would have occurred given appropriate technologies (Ozorio de Almeida, 1992). Institutional incentives toward land conversion have encouraged land owners to deforest land holdings, even when doing so would otherwise not have been profitable. Furthermore, due to the ready availability of cheap land in many parts of the frontier, those settlers with the capital necessary to do so often found it more profitable to move on and clear new forest tracts than to sustainably manage existing fields and pastures.

Unfortunately, Brazil has suffered the loss of huge tracts of its forests while squandering the intrinsic economic wealth they contained. For example, in the Trans-Amazon region, the high costs of transport often prevented colonists from selling the timber they cut (Smith, 1982). And in Rondônia, similar transport distances and the rush to clear and claim land meant that most of the region’s valuable timber was lost. Only a few species were salvaged from the burn piles and even then, ironically, shanty-towns built of mahogany sprung up across the hinterlands of Rondônia during local and international gluts in the timber market (Browder and Godfrey, 1997).

Had these colonization projects actually improved the living conditions of Brazil’s rural poor, it would perhaps be possible to justify the environmental devastation they wrought. Unfortunately, however, this has not been the case. Existing populations—including the indigenous and rubber tappers--were displaced from their land and either forced further into the forest or into the slums of the growing frontier cities. Furthermore, the colonization of the Amazon by and large has benefited not the rural smallholder, but wealthy ranchers and urban-based land speculators. For instance, the roads which facilitated the entry of settlers also led to rapidly rising land values. The
resultant land speculation by powerful individuals and corporations (that were generally more capable of manipulating the titling system than peasant settlers) undermined the security of land tenure among initial settlers (Ozorio de Almeida, 1992, Schmink and Wood, 1992). Other factors contributed to force rural settlers off of their land, including low yields, lack of technical assistance, indebtedness, a confusing credit system, bureaucracy and disease (Smith, 1982: 170).

Several more recent developments have occurred in the Amazon Basin—largely in response to this era of colonization. In areas with large extractivist populations, such as Acre, in the 1970’s and 1980’s, local people fought to resist the usurpation of their land by outsiders. Community leaders such as Wilson Pinheiro (of Brasiléia) and Chico Mendes (of Xapuri) became spokespeople for the rubber tapper movement and helped lead their communities in organized peaceful protest against the appropriation of their land--attracting the attention of the national and international media and labor leaders including Brazil’s future president Luiz Ignacio Lula da Silva.

While both Pinheiro and Mendes were eventually assassinated by ranchers, the movement they created lived on—resulting in the late 1980’s and early 1990’s in the creation of extractive reserves. These government-administered land use units recognized traditional communal land tenure systems and the exploitation of forest resources as “productive usage” while protecting the inhabitants of these areas from displacement by outsiders (Allegretti, 1990). In many parts of Amazonia, such as Rondônia and Acre, extractive reserves stand in sharp contrast to the colonist lots and fazendas they neighbor, yet all three have historical roots in the era of government-sponsored colonization.
Case Study: PC Quixadá and PAE Santa Quitéria

The preliminary research project examines the relationship between governance and local-level land use choices by residents of two adjacent land-management areas in the Amazonian state of Acre: Colonization Project (PC) Quixadá and Agro-Extractive Reserve (PAE) Santa Quitéria, both of which are bisected by the recently paved (2002) Trans-Oceanic Highway. As both sites lie in close proximity to the highway, both areas are now much more connected with the regional economy and society and are facing increased pressures toward deforestation. However, as the two sites represent distinct populations and governance systems, the specific implications of the highway upon deforestation—as well as the role of governance in this relationship—appear to be distinctly different.

While both sites are administered by Brazil’s National Institute for Colonization and Agrarian Reform (INCRA), they have differing histories and land tenure systems. The PAE was established in the late 1980s as a response to rubber tapper demands that their traditional access to this land be legally recognized during a time of land invasions and assassinations of local leaders by ranching interests. While the land is owned by the Brazilian state, families have use rights to large areas that are defined not by firm boundaries, but by the rubber-tapping trails within them (generally three to four per family). The colonization project, on the other hand, was created as an attempt to coordinate an influx of colonists from the nation’s south who settled along the then unpaved highway. Colonists were given use rights to clearly-defined lots—the outright ownership of which is gradually being given to the residents.
In addition to representing differing government-mandated land tenure systems, the two neighboring field sites represent very different human populations—colonists and rubber tappers respectively—with largely distinct histories, systems of land use and modes of collective organization. Consequently, the research site provides a rare opportunity to evaluate the local-level mediation of land use policy by two adjacent yet culturally-distinct groups operating under differing forms of collective organization.

Methods

The research occurred during the summer of 2003. During this time, I made numerous visits ranging from one to five days to PAE Santa Quitéria and PC Quixadá. In the course of the preliminary fieldwork, due to the limited time frame and difficulty of obtaining a representative sample, I utilized snowball sampling (Bernard, 2002) to locate key informants in the field. While this precluded the possibility of robust statistical analysis, it did allow me to obtain qualitative data that has created the foundation for subsequent research scheduled to begin in the summer of 2004. The majority of the individuals interviewed were politically active in the community—either association presidents or community opinion leaders—and consequently were especially knowledgeable about the articulation of land use governance in the field sites. I utilized semi-structured interviews with these individuals—asking informants questions regarding various subjects relevant to the research topic, while allowing informants to have power in directing the conversation toward topics they felt important. When possible, these interviews were followed by farm transects—in which the informant explained specifics about their farming system—e.g. crops planted, amount of livestock, fallow period, rate of clearing, etc.
Additionally, in order to gain a better understanding of community associations in articulating governance at the local level, I attended several association meetings, both in the PAE and PC. Participation in these meetings gave me insight into the power structures present in each community (including for instance, the role of gender). Additionally, these meetings allowed the opportunity to conduct informal interviews with association members—in addition to semi-structured interviews with association presidents.

A significant amount of the research process occurred outside of the actual field sites. I met with representatives of relevant NGOs and government agencies in order to conduct interviews and to present my proposed research while gaining recommendations regarding fieldwork logistics in this particular area. Additionally, I spent considerable time in the small city of Brasiléia—the capital of the municipality in which the majority of the research site lies. While in Brasiléia, I conducted interviews with representatives of a local worker’s syndicate, agricultural cooperative and the local office of INCRA—all of which are key players in the local governance system of the research site. These meetings gave insights into the broader context of state and federal governance that ultimately affects livelihoods in the field sites. Other meetings included people working outside of the governmental and NGO communities yet who had significant role in land use in the field sites—including the owner of the timber mill which serves the entire region.

**Property Rights System and Land Use**

**PC Quixadá**
Colonization Project Quixadá lies on either side of the last 60 kilometers of the BR-317 before the road ends at the Peruvian border. As such, it bisects the PAE Santa Quitéria into two roughly equally-sized regions—one to the north and one to the south. Prior to the 1970’s, travel by boat on the Rio Acre was the primary means of long-distance transportation and the population consisted almost entirely of rubber tappers who continued to forge a living from the largely abandoned rubber estates. However, much was to change following the construction of the BR-364 connecting the neighboring state of Rondonia to Acre’s capital Rio Branco. The waves of colonists and ranchers who had followed the construction of the highway to Acre also continued along the newly constructed BR-317. In an effort to regulate settlement by colonists and to avoid their displacement by ranchers, PC Quixadá was created in the late 1980’s. INCRA carries official responsibility for overseeing the colonization project. However, families have title to their 240 hectare lots and I was informed by the local director of INCRA that the agency intends to fully privatize the project in the near future.

All colonists with whom I met had come to Acre from the south of Brazil during the late 1970’s and 1980’s and many have inter-married into the local population. Livelihoods are dominated by subsistence annual and perennial agriculture as well as some market-oriented agriculture (most notably cattle). Additionally, timber—mostly from land destined to be converted to agriculture--serves as an occasional source of supplemental income for many families. Deforestation is very advanced in this area and nearly all lots have far exceeded the 20% deforestation permitted by law. According to local INCRA estimates, some 60%-70% of the project area had been deforested as of 2003.
PAE Santa Quitéria

The Agro-Extractive Reserve Santa Quitéria was among the first to be established in Brazil (1989). The history of the reserve lies in the empates of the 1970’s and 1980’s. In collaboration with northern environmentalists (Keck, 1994), rubber tapper leaders—including Chico Mendes--lobbied the Brazilian government for the creation of a system of common property reserves in which the government would allocate long-term use rights to land to local residents while protecting against land invasions by colonists and ranchers. In the earliest extractive reserves, such as Santa Quitéria, INCRA maintained official ownership of the reserve (later reserves, such as the more famous Chico Mendes Reserve would be owned and administered by IBAMA—the federal agency charged with environmental protection). Thus, the PAE differs from the neighboring colonization project in several respects. Rather than outright ownership of specific lots, residents have use-rights to three to four *estradas da seringa* (rubber collecting trails).

Unlike PC Quixadá, the residents of the reserve practice a mixed agro-pastoral-extractivist livelihood system. While some residents have immigrated to the reserve from other areas of Acre and even Brazil, most are either former or current rubber tappers with extended family ties in the area. Many continue to tap rubber, though with falling prices and the prospect of other economic activities this practice is becoming increasingly rare and has been completely abandoned by some families. Nearly all families maintain several hectares of swidden fields near their home sites which are dedicated primarily to subsistence annuals and perennials (with beans and manioc generally being most predominant). Also, all families interviewed supplemented their household income
through cattle production (mixed dairy/beef). Most herds numbered between 10-50 head, though one unusually wealthy and well-established family boasted a herd of over 300 head. Deforestation rates stand at approximately 5-6% of the reserve’s area (INCRA estimates) and timber extraction is almost non-existent.

**Discussion:**

Preliminary evidence indicates that the more optimistic scenarios, as proposed by Nepstad et al. may prove true. In the 18 years since the return to democracy, the government has made large advances in reversing past incentives that encouraged deforestation. In most areas of the Amazon, rural landholders are legally required to maintain 80% of their land under forest cover. While violations certainly occur, mounting evidence is beginning to indicate that, with proper monitoring, institutional support, and consideration of local needs, land use laws can be effectively enforced (Fearnside, 2003). Furthermore, the Brazilian government is considering changes to the tax system which would exempt forested land from property tax (Amigos da Terra: http://www.amazonia.org.br/english/noticias/noticia.cfm?id=87631).

In the case of PC Quixadá and especially in PAE Santa Quitéria, I found evidence that in many respects, land use governance has proven effective. In both areas, (due to fear of fines), residents usually obtain permits prior to clearing land. And in the PAE, while illegal sale of land to outsiders continues, in violent confrontations between rubber tappers and outsiders today are relatively rare. Furthermore, in the reserve, where restrictions are much stricter than in the colonization project, deforestation rates are much lower (however, it is as yet unclear what the influence of intervening variables such as
distance from highway, access to credit and cultural background may have in this difference).

Additionally, many of the organizations that once collaborated in promoting unsustainable colonization policies are now collaborating to promote sustainable land use in the countryside—including colonization projects. An example can be found in ProAmbiente—a PPG-7-supported program designed to pay landowners for environmental services from their land (e.g. carbon sequestration) (Mattos, et al. n.d.). For example, in Projeto de Colonizaçao Quixadá in Acre, the federal government, BASA (The Bank of Amazonia), INCRA, and a former adversary—the Sindicato de Trabalhadores Rurais de Brasiléia (STR) are currently collaborating to educate colonists about this program. Such cases serve as preliminary evidence that, with democratic institutions and improved social and ecological awareness, the government can work hand-in-hand with former colonists to protect the nation’s environmental patrimony while promoting an economically sustainable and socially just rural development in the Brazilian Amazon.

Despite these apparent successes, conspicuous problems were noticeable in the governance systems of both the PC and PAE. For instance, in the PC, deforestation had far exceeded permitted levels, with INCRA and IBAMA poorly-equipped to halt the process. Furthermore, while under INCRA management, lots are not permitted to be sold. However, lots were nonetheless commonly sold and in some cases, for sale signs were even posted in clear view of the roadway—in blatant defiance of INCRA prohibitions against the sale of lots.
However, while land-clearing in the PC seemed to be under-regulated, sale of timber seemed to be in some senses perhaps over-regulated. Studies in other colonization projects in the Brazilian Amazon suggest that commercial timber extraction, while not a panacea for deforestation, by providing additional value to forested land, does significantly slow the process of deforestation (Vosti et al., 2003). However, in the case of PC Quixadá (and for this and other reasons in PAE Sta. Quitéria), the difficulty of obtaining a timber permit—which includes several visits to distant government offices—often prevents residents from doing so. The permitting process often does not begin until May or June—allowing little time to market timber from land destined to be cleared prior to the August-October burning season. Furthermore, even when permits are issued, they are often only for a handful of the many species present. Consequently, marketable timber often is unsold and is instead burned during field clearing. In addition to the obvious waste implied in this system, an opportunity to economically valorize a prime forest product is also lost.

Despite the area’s tumultuous legacy of land disputes, invasions and empates, I learned that out-right land invasion by colonists is currently very rare. However, despite government regulations to the contrary, land in the extractive reserve is nonetheless falling into the hands of outsiders. This commonly happens when a family decides to abandon its rural homestead (e.g. due to divorce and/or in order to seek work in the city)—a process often tied to governance and gender.

I found strong anecdotal evidence that a relationship exists between the incorporation of gender (or lack thereof) in governance systems, out-migration to cities and deforestation. While many governmental programs are directed toward men’s’
activities—including forest and pasture management, few programs and policies are tailored to the concerns of rural women. For example, in the PAE, there continues to be inadequate credit available for women’s agricultural production and in many communities children must walk several hours through the forest to attend under-funded schools. Because of such difficulties, many areas of the field site are currently experiencing female out-migration to neighboring towns as women look for better economic opportunities for themselves and better schooling and health services for their children. Without their spouses, men face increased difficulties managing their homesteads and often ultimately follow their spouses to the city—paying the cost of moving through (illegal) sale of the family’s land holding. As such sales are illegal and conducted informally, I learned that the family will generally receive inadequate compensation for their land. Furthermore, individuals with the financial resources to purchase such land often come from outside the community and bring with them an agro-pastoral culture which places a higher value on cleared than forested land. In this way, government policy and inadequate attention to local gender dynamics interact to undermine the rural economic development and forest preservation that many of these policies intend to promote.

However, perhaps the most critical weakness in the PAE is a lack of ownership of the governance project. Cardoso (2002) observes that, unlike most successful common property rights systems, in many of Brazil’s extractive reserves, there is little community-based enforcement of the local governance system. Indeed, she notes that in the creation of the early extractive reserves, few individuals wished to participate in the monitoring of community land use—preferring instead to delegate this activity to government officials.
Many rubber tappers, she found, were uncomfortable with the thought of damaging social ties by citing neighbors for land use violations. Due to this and other factors, she claims, a true common property system with local control and ownership has not yet developed in most of Brazil’s extractive reserves. My fieldwork found this to be a common problem in many parts of PAE Santa Quitéria as well. Some families with whom I visited were active in local associations, were aware of the reserve’s management plan and believed the enforcement of the common property rules (e.g. limits on deforestation, control of fires, etc) to be in the general self-interest.

However, among other families and associations, this was less true. Many individuals scarcely knew that a management plan for the reserve existed, much less what it contained. Often times, government agents—and even agents of local workers’ unions—became regarded as enforcers of externally-defined rules. For instance, a visit to one association meeting coincided with a visit from several representatives of the Brasiléia rural worker’s syndicate. When I asked association members if any homesteads had been abandoned, they responded that this is common and that several had been abandoned as their owners sought work in town. However, several hours later, when union leaders arrived and asked this same question, they received a negative response—that no lands in the area were abandoned. Contrary to my expectations, the residents had been more forthright with me than with the union leaders. While I was a foreigner who would presumably take the information with me to America, the union members might relay the information to the local INCRA office—which would in turn reallocate the use rights to the abandoned land and thus preclude the possibility for its owners to return.
The top-heavy nature of land use monitoring has other negative consequences in the reserve as well. While the burden of land use monitoring has largely fallen to state and federal agencies—primarily INCRA and IBAMA—due to under funding, these agencies are poorly equipped to effectively monitor and enforce land use regulations. In 2003, due to unreliable information about which families had and had not exceeded the permissible 10% deforestation level, the permitting process for burning and land clearing was suspended until a more accurate assessment could be obtained. Thus, due to the difficulties of monitoring, all households—including those abiding by the law—were penalized.

These problems combined with inadequate technological assistance inevitably force many families to deforest illegally and risk heavy fines. For many families, especially those with larger families practicing shifting cultivation, two acres of new land per year may not be sufficient to adequately provide for household consumption. Furthermore, extensive cattle systems in which pasture land is poorly utilized requires many households to deforest above the legal limit in order to maintain stocking rates. While many researchers have argued that intensification of cattle production (i.e. > 1 head cattle/hectare) can be much more economically and environmentally sustainable on Amazonian pasture than more extensive systems (see Faminow, 1998), few families in this area had access to the information and start-up capital necessary to maintain or improve production while staying within government-mandated deforestation limits.

**Subsequent Research**

In subsequent research, I intend to evaluate a model relating access to paved highways, property rights systems, participation in governance systems and deforestation.
The model hypothesizes that time distance to the highway will be negatively associated with deforestation. Much of the existing literature (e.g. Nepstad, 2001, Laurance 2001, Nelson and Hellersteind, 1997) and my preliminary fieldwork suggest that this is true—access to roadways both increases the susceptibility to land invasions and also facilitates the marketing of cattle and other agricultural products (though ironically, I was told by local INCRA officials that the newly paved roadway facilitates their work in monitoring deforestation). The model also contains the hypothesis that property rights system affects deforestation—preliminary evidence strongly suggests that colonists—even when controlling for distance to the roadway—tend to deforest more than residents of the PAE. Finally, initial observations suggest that participation in governance systems is negatively correlated with deforestation. However, it is as yet unclear whether interaction exists between property rights systems and participation in governance in an individual’s decision whether or not to deforest. That is, does the impact that participation in governance systems upon the decision to deforest vary based upon the property rights system in which one lives? In subsequent research, I intend to use interviews with randomly-sampled households from both PC Quixadá and PAE Santa Quitéria to statistically test these hypotheses while also controlling for potential intervening variables including cultural background of family, wealth, education and access to credit.
References


