DYNAMICS OF LAND USE IN AN AMAZONIAN EXTRACTIVE RESERVE: THE CASE OF THE CHICO MENDES EXTRACTIVE RESERVE IN ACRE, BRAZIL

By

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To Leinha for everything

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Since the Chico Mendes Extractive Reserve (CMER) was established, different levels of land use change have taken place as a response to local and regional economic forces and prevailing social stresses. The following study addresses these changes and their drivers by analyzing key household characteristics and socio-economic factors. This study provides both a household and a rubber tapper estates (*seringal)* level approach of measuring land-use changes.

Based on remote sensing methods, four *seringais* with the highest deforestation rates were selected as the focus of analysis. The reserves' census data on all residents of the four *seringais* was analyzed for three different periods (1995/1998/2000). In addition, in-depth interviews were carried out with 66 households. The household-level analysis was based on the data gathered from the 66 families, whereas at the *seringal*-level the research explores census data. The former approach considers three groups of independent variables: background of household head (migrant status and age), labor-

force availability (sons of the household head) and location of the *seringais*. These were then measured in relation to six outcome variables per settlement: rubber and Brazil nut production, size of swidden plot, size of pasture, head of cattle and total area deforested. The *serinigal* level analysis concentrated on three main factors: population, settlement dynamic, and changes in the rubber tapper production systems.

Household level findings shows that the age of the household heads and the locations of the *seringais* have a strong association with rubber and Brazil nut production, which suggest that older household heads tend to engage in forest activities. The availability of sons of household heads exerts a strong effect on pasture and cattle raising activities, which suggests that non-forest activities tend to be carried out by the young residents. The migrant status accentuates agricultural activities, implying that non-migrant households tend to engage in forest activities. *Seringal* level findings reveal that population density have increased significantly in the four *seringais*. In addition, it shows a crucial process in occupation of space within these *seringais* is increasing the subdivision of the settlements. Moreover, rubber tapper production system has been increasingly transformed from extractive to agricultural and pastoral production activities. These increases in population density, number of settlements and change in the production systems accelerate deforestation, which will pose a serious dilemma for land use regulations in the reserve in the near future.

This work is a step toward illuminating the prevailing issues on land-use changes in the reserve. To understand which factors are driving these changes is a timely endeavor that will hopefully contribute to the strengthening of sustainable land-use management strategies in the CMER and in other extractive communities in Amazonia.

CHAPTER 1
INTRODUCTION

Amazon deforestation and its social and environmental consequences have been a major concern in the last few decades. The state of Acre in southwestern Brazilian Amazon is the birthplace of the rubber tapper movement, which was the first grass-roots movement in Brazil to advocate conservation of Amazonian forests through the establishment of extractive reserves. The creation of extractive reserves has been promoted as a major strategy for forest conservation while simultaneously providing a sustainable economic return to local peoples. A decade after the establishment of the federal extractive reserves in Amazonia, however, the extractive reserve model is still facing many challenges to put these goals into practice. The present work examines the social dynamics of smallholder deforestation in the Chico Mendes Extractive Reserve (CMER), and analyzes the socio-economic forces behind land-use change in the reserve.

The impoverishment of tropical forests through deforestation is a world-wide phenomenon. In recent decades, few if any environmental issues have received as much global attention as "tropical deforestation." Tropical deforestation will undoubtedly continue to be a central international environmental issue in coming years particularly as global issues such as climate change and the related carbon sinks and sources are discussed. Brazil, as owner of both the largest portion of the world's rainforests and the highest absolute deforestation rate, is *de facto* a leader in both conservation and destruction of these forests. There is a wide consensus that deforestation has environmental consequences, but there is considerable controversy over its social impacts and extent. In fact, the socio-economic dynamics of deforestation in the Brazilian rainforests and its implications continue to be rather poorly understood, if the widely conflicting claims about its causes, impacts and remedies can be taken as evidence.

Brazil's legal Amazon[1] region includes about 5 million square kilometers, which comprises 58% of the country's territory. The regional development policies implemented by military governments from the mid-1960s through the 1970s have engaged in programs aimed at opening up the Amazon region to development (Mahar 1978). These policies included massive highways to link these projects to the rest of the country, such as, the Transamazonica, the Belém-Brasília, and the Cuiabá-Porto Velho roads. These "development" strategies also included economic programs for mineral extraction (e.g., Grande Carajás), agricultural colonization and cattle ranching (e.g., Poloamazônia, Polonoroeste), as well as incentives to timber industries. Therefore, in recent decades massive deforestation due to large-scale cattle ranching, colonization, logging, and mining projects has significantly reduced rainforests in the Brazilian Amazon and in some cases caused violent conflicts and severe socio-economic problems for local communities (Moran 1981, Schmink and Wood 1984, Smith 1982).

Deforestation rates in the Brazilian Amazon ranged from 29,059 square kilometers in 1995 to 18,161 square kilometers in 1996; then 13,227 square kilometers in 1997, and 17,383 square kilometers in 1998, according to Brazil's National Institute for Space (INPE 2000). From August 1998 to August 1999, the mean annual rate of

[1] Two concepts are used to define the boundaries of the Brazilian Amazon region. The first and more commonly used definition is "Legal Amazônia", which was established by military government in 1966. For administrative and planning purposes it comprises nine states: Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, as well as part of Tocantins and Maranhão. The second definition, "Classical Amazon", the area covered by tropical forests, includes about 3.5 million square kilometers (40 per cent of the country). It includes the Brazilian states of Acre, Amapá, Amazonas, Pará, Rondônia, and Roraima.

deforestation was 17,259 square kilometers. The provisional estimate for the period of 1999/2000 is 19,836 square kilometers, which represents an increase of approximately 14.9% (INPE 2000).

These data clearly show that deforestation rates have not decreased in Amazonia despite efforts by the Brazilian government to slow them. Yet the Landsat TM satellite images used by INPE do not include deforestation of areas smaller than 6.25 hectares, so not even all deforestation is being counted. The impact of hundreds of thousands of small-scale farmers, including rubber tappers as well as logging activities and wild fires are not included. Logging crews alone severely damage 10,000 to 15,000 square kilometers a year of forest that are not included in deforestation mapping programs (Nepstad et al. 1999).

Despite being considered an agricultural frontier, the Amazon has most of its population concentrated in cities. In 1940, the population of Amazonia was only 1.5 million people, of whom 72% were rural dwellers (Barraclough and Ghimire 1995). According to the Demographic Census of 1970, 35.5% of the population was urban, which compares with 44.6% in 1980, 55.2% in 1991 and 61.5% in 1996. A number of explanations exist for these demographic patterns in the Amazon. The Amazon became a place of refuge for a segment of southern Brazil’s landless population that pursued the goal of obtaining its own land and building a resource base. The decade of the 1970s was a period of intense activity in the region. The highway construction projects, the colonization schemes, and the spontaneous migration into the region were among the most salient factors that altered the demographic profile of the area (Wood and Wilson

1991). Currently, almost two-thirds of Amazonia's population of almost 20 million people lives in urban areas (Browder and Godfrey 1997, Friends of the Earth 1998).

In the early 1980s, deforestation in Amazonia and its associated effects on the livelihoods of local populations became an international issue. In this scenario, the Brazilian government started to consider development alternatives that use Amazonia's diverse resources while maintaining forest cover and valuing the needs of traditional populations. Since the 1980s, recognition by Brazilian and international society of the importance of maintaining the biological and cultural diversity of Amazon ecosystems has led to the creation of numerous conservation units, including national forests, national parks, biological reserves, as well as indigenous areas and extractive reserves.

In this context, extractivism, the ancient practice of extracting economically valuable non-timber forest products (NTFPs), emerged as a possible means of reconciling economic development with forest conservation (Nepstad and Schwartzman 1992). Extractivism captured global attention in the late 1980s when a group of rubber tappers fought to protect their lands from encroaching cattle ranchers in Acre, Brazil (Allegretti 1989, 1990 and 1994, Schwartzman 1989 and 1991), culminating in the highly publicized assassination of the rubber tapper leader Francisco "Chico" Mendes in 1988. These events led to the creation of the first extractive reserves, which are "forest areas inhabited by extractive populations granted long-term usufruct rights to resources which they collectively manage" (Schwartzman 1989, MMA/IBAMA/CNPT 1995).

At that time, extractive reserves were considered necessary to act as a counter-balance to the pressures of deforestation and cattle ranching, fitting the relatively new demand for "sustainable development" and an opportunity to put into practice an explicit linkage between conservation and development. By restricting the use of forests to a defined set of products and users, extractive reserves are considered a major strategy for promoting forest conservation and local socio-economic development in Amazonia (Allegretti 1990, Anderson 1989 and 1992).

Compared to other land-use strategies, extractive reserves have been successful in maintaining relatively low deforestation rates (Mendes et al. 1996, Nepstad et al. 1992). Nonetheless, extractive reserves are not stand-alone solutions, but they complement other land use options. In the last decade, the concept of extractive reserves has evolved in the Brazilian Amazon, and extractive communities in other tropical countries have followed the example of Acre (Salafsky and Dugelby 1991).

1.1 Problem Statement

The rubber boom at the end of the nineteenth century and the brief period during World War II indelibly marked the history and cultural characteristics of Acre (Rancy 1992, Tocantins 1979). Since the 1970s, the eastern part of the state has been marked by clashes between forest dwelling people and settlement projects and cattle farms. Today, changing land-use and land-cover are the rule in Acre (153,000 km^2), the western-most state in the “Arc of Fire and Deforestation” in Brazilian Amazonia. Acre represents an interesting “threshold” site to study the dynamics of deforestation in a context where forest dwelling communities, cattle ranchers and colonists coexist.

The initial assumptions of the extractive reserve concept were that an economy based on non-timber forest products could increase the economic value of forests and rural income, offering many subsistence resources for extractivist communities, while being ecologically sustainable. However, the extractive reserve model is facing challenges in putting these objectives into practice as economic, social, political and ecological constraints have emerged (Anderson 1992, Browder 1992a, Homma 1993). Extractivist communities are faced with a current pattern of low-income generation, and the goal of economic growth is a major constraint forcing land-use changes in extractive reserves. Land-use patterns within the extractive reserves are changing from strict non-timber forest products (NTFP) economies to small-scale cash crop agricultural and pastoral activities. One of the key questions is how economic development changes land-use in extractive reserves and how these changes can be managed. Of particular importance is the management of land-use in a rapidly changing socio-economic context while protecting forest resources according to the conservation objectives of extractive reserves. To evaluate the efficiency of extractive reserves as a conservation and development model in Amazonia, it is necessary to analyze land-use change and deforestation rates within these areas.

Deforestation rates have been reported for areas along the Amazonian development frontier with colonization projects and cattle ranches that result in large-scale deforestation patterns, particularly in the state of Rondônia and Pará (Alves 1999, Fearnside 2001, Moran and Bondizio1994, Nepstad et al. 1999, Rignot et al. 1997, Skole and Tucker 1993, Skole et al. 1994, Wood and Skole 1998). Rarely, however, has forest dwelling smallholder deforestation been examined with the exception of a few studies (Brondizio et al. 1994 and in press, Peralta and Mather 2000, Sassagawa 1999).

Sassagawa (1999) conducted a remote sensing analysis of the deforestation rates in the Chico Mendes Extractive Reserve (CMER) in Acre, detecting land-use changes in the reserve during the period of 1986-1998. The analysis revealed that eight *seringais*, or rubber estates, with the highest deforestation rates within the reserve are expected to exceed the legal limit for deforestation (10% of each residents area) within 2.5 to 6 years. This thesis uses Sassagawa's work as a basis for the deforestation analysis in the CMER.

However, this study is limited to remote sensing analysis of land-cover changes and did not incorporate the human socio-economic factors driving land-use change on the CMER. That is, while this study evaluate land-use changes "top-down" looking at general patterns of deforestation in the reserve, it does not examine the on the ground socio-economic processes that lead to the patterns of land-use. In fact, socio-economic aspects of forest dwelling smallholders are still little analyzed for several parts of the Amazon. Most studies with this population have been unable to achieve an integrated perspective between land use cover and socio economic factors inducing land-use changes. Few studies have examined the way in which patterns of land cover change relate to underlying social and economic driving forces. The gaps in research in socio-economic factors on extractive reserves are important aspects to understand the land use change process that has taken place in these areas since they were established.

The analysis of land-use patterns in the CMER was not necessiry at the creation of the reserve, since the economic production at the time was primarily based on rubber and Brazil nut extraction from standing forests. In the last ten years, land-use decisions made by CMER residents have gradually changed toward a mix of extractive and non-extractive activities, in an attempt to increase household income and also in response to development incentives from projects and government initiatives. As the pressure to diversify production and to increase income grows, rubber tappers are increasingly moving toward land use activities that have more destructive impacts on forest cover.

Therefore, today, cash-crop agriculture, and small-scale cattle ranching are an important component of modern rubber tapper land-use strategies. These non-extractivist activities play a dual role as the new economic activities: not only do they increase household income, but they also increase pressure on natural resources and deforestation rates in the reserve.

1.2 Central Questions

This thesis addresses three main questions. First, what are the land-use patterns and changes occurring in the Chico Mendes extractive reserve? Specifically, this question analyzes the overall land-use patterns of the reserve in order to understand the actual land-use changes in recent years.

Second, what are the socio-economic forces behind these land-use changes? Several factors influence land-use change in the reserve, which might include population increase, development policies for extractivist communities, lack of market for non-timber forest products and development projects influencing agricultural and pastoral land-use activities.

Third and finally, what factors are contributing to deforestation in concentrated areas of the reserve? The land-use patterns in the reserve follow two separate, opposed tendencies. Some areas of the reserve have continuing and high deforestation rates, while in other parts very little deforestation has taken place in the last decade. Factors influencing deforestation in these areas could include population density, road and market access, distance to neighboring towns, as well as distinct land-use strategies bordering with the reserve.

1.3 Structure of the Study

Having here explained the importance of studying smallholders' land use patterns in the Chico Mendes Extractive Reserve, chapter 2 will provide an overview of the diverse arguments involving the concept of extractive reserves in the Amazon. This chapter is based on the literature produced in the early debate about the reserve model up through recent works based more on practical experience of the model. In Chapter 3, I will describe the procedures used to define the study site, survey setting and planning, types of primary and secondary data gathered as well as data processing, variable operationalization and definitions, and analysis.

In chapter 4, I will analyze the context in which deforestation has taken place in the reserve. I begin with a discussion of deforestation in Acre's context and how it has affected deforestation in the Reserve. I then take a look at how and why seringal level deforestation rates differs in the reserve. In chapter 5, I present a household level approach of measuring some characteristics affecting different land use activities. First I characterize the major land use activities of the rubber tapper settlements and then relate those to seasonality of land use activities throughout the years and differentiated family labor force allocation. Next, I define six major land use outcome variables that define tappers' production systems. I then, define a group of explanatory household characteristics and seringal location variables as major determinants of extractivist and non-extractivist land use activities in the study seringais.

Chapter 6 I present general trends of key socio-economic factors driving land use changes in the reserve as a whole and in the four specific seringais, based on census data of the reserve in three different periods. At the reserve level, particular attention is given to population and settlement dynamics and social organization of the residents. At a seringal level analysis, I explore factors inducing land use change, looking at population and settlement dynamics, extractivist and agricultural production, pasture expansion, and social organization. In chapter 7, I summarize some of the mean funding of the study and discuss some of the challenges that the reserve will face regarding resource regulation and future economic development of the residents. Finally, I suggest continuing steps to be taken in this research as well as in other related topics. In this regard, study in land use change in the reserve still leaves much to be explored.

CHAPTER 2
DEBATE ABOUT EXTRACTIVE RESERVES

2.1 Brief History of the Amazon Rubber Boom

Much of the economic history of Latin America has been characterized by several extractive boom-and-bust cycles. Most of these cycles have been based on the exploitation of plants of commercial value. The Amazon rubber boom, which spans the late nineteenth and early twentieth centuries, was one of Latin America's most extreme natural resource export booms.

Rubber had been known for a long time before it became an economically important commodity. The French naturalist Charles Marie De La Condamine, who traveled down the Amazon from Ecuador in 1736, is considered to be the first person to publish a study about the properties of rubber, the milky latex of the *Hevea brasiliensis* L. tree (Dean 1987). In 1839, Goodyear invented vulcanization, a process that made rubber durable, turning it into an essential product of the Industrial Age and triggering inventions that would eventually lead to massive demands.

Events such as the invention of the inflatable rubber tire by Dunlop in 1888, the bicycle craze in Europe (especially in France) in the late 1800s, and the development of the automobile industry in the early 1900s explain the world's explosive demand for rubber towards the end of the century. With the increasing world demand for rubber, the price of the product grew steadily. Amazonia, the world's sole supplier of rubber, experienced decades of economic growth in terms of exports. The wealth generated by the "black gold" rubber had fantastic proportions. Rubber exports rose sharply in quantity, and even more dramatically in value. The rubber trade became a mainstay of the Brazilian economy, providing at its height almost 40 percent of its export revenues, nearly equaling coffee in importance (Dean 1987). During these giddy decades, Brazil monopolized the world rubber trade.

After a few decades, however, the Amazon rubber fever was broken. The deterioration of Brazil's rubber economy began in 1912 with the collapse of its monopoly because of competition from Malaysia's rubber plantations. Southeast Asian plantation rubber trees grew faster and gave higher yields than the wild rubber of the Amazon, due to the skilled domestication efforts. Consequently, Asian rubber could produce higher quality rubber more cheaply, quickly, and at vastly greater quantities than its wild Amazonian rival.

The once wealthy region never fully recovered from the rubber bust, despite attempts to strengthen Amazonian rubber production. The Brazilian and North American governments heavily invested in rubber production in the Amazon during the Second World War, when American access to the Southeast Asian rubber supplies was blocked. However, after the war and with the development of synthetic rubber substitutes, the period of high rubber production in the Amazon was once again over. Despite its failure to establish long-term development of the region, the rubber-boom era indelibly marked Amazonia and caused substantial social and economic alterations in the region that can be seen and felt until today.

2.2 Evolution of the Extractivist Development Model in Amazonia

Amazonia has been indelibly marked by the rubber boom and bust (1890-1912) that brought thousands of people from the arid Northeast of Brazil to the rainforest as labor for rubber extraction (Bakx 1988, Rancy 1992). Since that time, rubber tappers have been a disenfranchised category in Brazilian history. Throughout Amazonia they have worked in the semi-slavery *aviamento* system of debt peonage, a type of social relations that persists in many regions of Amazonia until today (Weinstein 1983). However, the wealth generated for the elites by the "black gold" had fantastic proportions, bringing several decades of unparalleled prosperity and growth to the region, integrating Amazonia to the world economy, establishing extensive trading networks, constructing massive port facilities, and leaving behind large urban centers along Amazonia's rivers (Weinstein 1983).

With the end of the rubber boom, forest extractivism was generally viewed as a backward and peripheral activity of economic stagnation, and forest resources and traditional peoples considered as development obstacles in Amazonia (Barbosa 2000). This attitude characterized Brazilian government policies for many decades up through the 1980s and brought development projects to the region that included massive highway construction (e.g., Transamazônica, Belém-Brasília), dam-building (e.g., Balbina, Tucuruí), mineral extraction (e.g., Grande Carajás), agricultural colonization and cattle ranching (e.g., Polonoroeste), as well as incentives to timber industries (Hecht and Cockburn 1989, Moran 1983, Oliveira 1991, Schmink and Wood 1992). These projects brought serious social and environmental problems to rural and urban Amazonia, with deforestation reaching unprecedented rates and rural violence against traditional communities rising to alarming numbers.

As a response to the rubber boom legacies and the oppressive development projects, recurrent peasant resistance erupted in Amazonia and led to violent clashes along the development frontier. The rubber tapper movement emerged in the state of Acre in the late 1970's. Chico Mendes was the major force behind the movement.

Through collective action, Mendes and the tappers fought for the right over the land and not to leave it for the ranchers whose ownership rested more on coercion than on legality. Slowly, they began to organize against the major cases of deforestation that occurred in the area by the means of *empates*, or standoffs, blocking people and machinery with their bodies (Calaça 1993). The rubber tapper movement only received political clout after the creation of the National Council of Rubber Tappers in 1985, when it was decided that the primary demand would be agrarian reform in the form of extractive reserves (Allegretti 1994).

In the late 1980s the first powerful alliances between rubber tapper, indigenous organizations (e.g., UNI-Union of Indian Nations) and the environmental movement emerged. Common goals such as indigenous land demarcations, creation of extractive reserves and opposition to mega-projects, shaped joint strategies of civil disobedience and protests[2] (Albert 1992, Fisher 1994, Hall 1989). The onset of democracy in Brazil also politicized the national environmental and grassroots organizations and boosted the emerging NGO movement that embraced polemic rubber tappers and indigenous causes (Barbosa 2000, Viola 1988).

The Amazonian grassroots efforts also gained considerable strength when international interests in Amazonia reached high levels. The internationalization of Amazonian ecopolitics occurred twofold. First, beginning in the mid-1980s, awareness of major global environmental problems such as the greenhouse effect, the ozone hole, and biodiversity loss, sparked an international debate on the state of the global environment (Stern et al. 1992). Overnight, Brazil was in the spotlight, pressured by environmentalists,

[2] In particular the Kayapó became widely known for civil disobedience and protests in Altamira in 1989 to protest the construction of several dams along the Xingú river (Fisher 1994).

international organizations, and first-world politicians to stop the devastation taking place in the Amazon rainforest (Barbosa 1993 and 2000). Second, international development schemes were heavily attacked, resulting in international publicity around target dam and road construction projects that have caused international financial supporters to back out.[3]

At first, the international attack on Brazilian development strategies provoked strong protest against this "environmental imperialism."[4] However, President Collor's administration (1990 – 1992) changed toward a "greener" rhetoric. In the pre-UNCED (1992) arena the Brazilian government took visible steps to demonstrate to the developing world and to donor countries serious efforts to protect Amazonian forests and its people. Part of this was the creation of extractive reserves (ERs), national parks and the demarcation of indigenous territories.

This fight for ERs lasted from 1985 to1990 and encountered many difficulties. The very idea of extractive reserves was thought incongruent with the legislation of the time, since this defined property in individual terms rather than collective. Decree No. 98.897/90 was the compromise (Murrieta and Rueda 1995). It defined these areas as "property of the union or federal government" destined to be used for extractive activities (Allegretti 1994). The creation of ERs represented a novel government response to the pressure both of social movements and conservationists, and a form of legally

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[3] For example, as a result of rubber tapper lobbying the Inter-American Development Bank withdrew its financial support for the road construction of BR 364. It was a first in the bank's history that it stopped a loan on the basis of environmental concerns. Another example is the withdrawal of the World Bank from the Xingú river dam projects in response to the indigenous Kayapó protests (Barbosa 2000).

[4] In the Sarney administration (1985-1990) the development of Amazonia became a question of nationalism, of national security, and of sovereignty over encroachable lands. The demarcation of indigenous territories and protected areas was seen as a conspiracy of developed countries, to hamper competitive development in Brazil and to steal land for global (not national) carbon and biodiversity stocks (Barbosa 2000).

recognizing land tenure regimes that do not comply with the private property paradigm that characterizes most modern economic systems.[5]

In 1990, the federal ERs existed on paper, but it took several years for ERs to take shape.[6] Only by 1994 were the four federal Amazonian ERs legally and institutionally consolidated, covering an area of over 2 million hectares (ELI 1995, Murrieta and Rueda 1995). Apart from land tenure, resource utilization regulations at the community level were a principal concern in the early stages. The newly created Traditional People Department (CNPT) of the Brazilian Environmental Protection Agency (IBAMA) was made the responsible government institution for ERs. This step was followed by the development of utilization plans, jointly created in by rubber tapper associations and government representatives, where federal environmental legislation and traditional rubber tapper resource utilization were reconciled (MMA/IBAMA/CNPT 1995).

2.3 Analysis of the Extractive Reserve Literature

Despite its charisma, the basis of extractive economies is indisputably fragile and the subject of an active and sometimes polemic debate among scholars and conservation and development professionals of diverse academic backgrounds (e.g., Anderson 1992, Fearnside 1989 and 1992, Browder 1992b, Homma 1989 and 1993). Publications on ERs strategies peaked in 1992; however, since then very few works have appeared evaluating the ER debate and experience. Consequently, there is a need for a survey of the discussion. In the next section I will focus on the Extractive Reserve experience in the

[5] ERs were created by Brazilian Ministry of Agrarian Reform and Development (INCRA), also responsible for extensive colonization projects in frontier Amazonia. Approval of this form of land tenure signified a radical departure from the way in which regional development in Amazonia had been carried out in the past (Allegretti 1990).

[6] The first federal extractive reserve created was the Upper Jurua River in 1989 (Acre), followed by the Chico Mendes (Acre), Cajari River (Amapá) and Ouro Preto Riber (Rondônia).

Brazilian Amazon region in order to analyze the leading discussions about ERs, discerning the major trends of debate; and draw conclusions from current ER experiences about the prospects for ER development in Brazilian Amazonia.

2.3.1 General Patterns and Trends in the Debate

When extractive reserves were first proposed by the grassroots National Rubber Tapper Council, the cause was picked up and supported by scientists, activists, and conservation and development professionals and was considerably transformed. The late 1980s and early 1990s were characterized by a relatively “fresh” enthusiasm for environmental and social causes in the tropics (compared to the learned skepticism of today), and the debates around ERs developed into a curious mix of science, ideology and lobby. The somewhat emotional content of the debate was further enhanced by the uproar over the assassination of Chico Mendes and the violent suppression of indigenous peoples, transforming them into international environmental heroes. At the time, ERs were optimistically promoted as the panacea for most of Amazonia’s environmental problems.

Three intermeshed lines of discourse influenced, shaped and transformed the discussion about ERs. First, the international lobby saw ERs as an answer to the urgent demand for rainforest conservation as a reaction to high deforestation rates and the concern about global climate change and biodiversity loss. Second, the promotion of traditional resources management as an example of sustainable livelihoods boosted the appeal of ERs as an example of "inherently environmental" rainforest people as agents of forest conservation. Third, the proposal of ERs coincided with the promotion of non timber forest products use and marketing as a promising economic alternative for (mostly) biodiversity rich tropical regions. The different demands of these interest groups caused an inflation of the expectations on ERs. From a human rights and territorial issue that embraced forest conservation as a means of continued livelihood in the forest, the discussion spawned high economic expectations.

The main participant in the beginning debate about ERs was first a Brazilian, anthropologist Mary Allegretti (1989 and 1990) who publicized the rubber tapper's cause and later moved into important government positions. The discussion was later joined by mostly North American conservationists such as Anderson (1989, 1992 and 1994) and Fearnside (1989 and 1992), followed by development specialists like Schwartzman (1989 and 1992); regional planners such as Browder (1990a,b) as well as the Brazilian economists Alfredo Homma (1989, 1992 and 1993). From the onset it was an interdisciplinary debate, bringing formerly isolated groups together. However, no consensus existed in the vision and objectives about the nascent ERs model. The strongest proponents of the model were Allegretti (1989 and 1990) and Schwartzman (1989 and 1992), supported by Anderson and Fearnside. The strongest critiques of ERs were produced by Browder (1990a,b), and Homma (1989 and 1993).

The ER literature has been produced in a characteristic boom and bust pattern. In 1989, the year after Chico Mendes's assassination, articles mushroomed about the topic both from promoters (Allegretti 1989, Fearnside 1989, Schwartzman 1989, Hecht 1989) and skeptics (Homma 1989, Browder 1990a), in addition to the popular media coverage. From 1990-1993 a many articles were written about the topic, culminating in some edited books that discussed the non-timber forest products strategy and ERs (e.g., Nepstad and Schwartzman 1992, Anderson 1990, Redford and Padoch 1992, Plotkin and Famolare 1992, Homma 1993). However, after 1993, hardly anything was written about ERs as a development and conservation model. After that, most production has gone into gray literature reports and government policy statements.

Notable exceptions include a Brazilian edited book that refutes some of the criticism of ERs and a summary of the ER status by the government staff (Murrieta and Rueda 1995). A paper written by visionary Acre Production Secretary José do Rego points out that the new ideas of extractivist development in Amazonia, "neo-extractivism", incorporate technical improvements in cultivation, harvesting and processing, allied with a specific social environment of forest cultures – people whose lifestyle is intimately tied to the forest (Rego 1999). Also, two other papers about extractive reserves published recently discuss the institutional architecture of extractive reserve, and the political and economic empowerment of rubber tappers communities in the State of Rondônia (Brown and Rosendo 2000a,b).

Another characteristic of the ER debate is that most of the critical body of literature was written before ERs were legally and institutionally functioning on the ground (as they were to some extent after 1994, see Murrieta and Rueda 1995). This temporal gap between intellectual battle about ERs and de facto experiences of ERs suggest that the debate about ERs was a very theoretical and speculative one. This might also explain some of the arrested analysis of the model, as scholars are "waiting" for ERs to develop on the ground. Several large national and international projects were established within ERs, in great part due to the many publications and the publicity about ERs in the early stages. To understand what happened to the ER debate, one has to examine the role of different arguments in the ER literature.

2.3.2 Social Development Arguments

The rubber tappers demand for ERs was primarily a human rights battle linked to an environmental one (Schwartzman 1989). In extractivist communities, the needs of traditional lifestyles translate directly into territorial rights and the need of relatively large expanses of forests as the basis of their livelihoods. Even so, rubber tappers were also fighting to obtain modern production technology for diversification of their production and the creation of education and health systems adapted to the needs of the community (Allegretti 1995) which were, and still are, in great need. The establishment of social institutions, such as cooperatives and associations, and physical infrastructure, such as transport systems and roads, have also been determined to be crucial for the success of extractivist populations to sell their products (Schwartzman 1989).

The importance of social and political realities within the extractivist region has repeatedly been pointed out as a critical factor that can define the success or failure of ER endeavors. The behavior and incomes of rural people who extract forest products are often determined by social and economic factors over which they have little or no immediate control (Browder 1992a).[7] An additional concern about the ER model has been that it requires low population densities and therefore large forest expanses for few people (Fearnside 1989, Browder 1990a).[8] It has been argued that it is hard for land planners to justify ERs that require tens of hundreds of ha of forest to support one

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[7] For instance regional power relations and national development policies can join forces to support or to undermine ERs. In that context, it is very telling that ERs were only implemented in Amazonian states without an overwhelmingly strong large-scale landowner (latifundia) alliance (i.e., Acre and Amapá in contrast to Pará and Amazonas).

[8] Fearnside (1989) estimated that Brazil nut harvesters need 300-500ha per family, resulting in about 1-1.7 people/km, concluding that the carrying capacity for extractivist economies is low.

household in countries that have extremely high population densities.[9]

2.3.3 Economic Arguments

The most advertised promises and the most serious constraints of the ER reserve model have been identified as economic ones. The conservation community was excited about ERs as a model that could preserve biodiversity while simultaneously providing sustainable economic return to local peoples and governments (Allegretti 1990, Schwartzman 1989). This excitement was fueled by an article by Peters et al. (Peters et al. 1989) proposing that long-term financial return from the harvest of non-timber forest products found in a hectare of Amazonian rain forest far outweighed the net benefits of timber production or agricultural conversion from the same area of land (see also: Anderson and Jardim 1989, Anderson and Ioris 1992, Gomez-Pompa and Kaus 1990, Panayotou and Ashton 1992). Several authors, including Peters et al themselves, have attempted to temper this enthusiasm for income generation by pointing out that hypothetical calculations of the income streams to be derived from an average hectare of tropical forest have significant limitations (Fearnside 1989, Pinedo-Vasquez et al. 1990, Godoy and Bawa, 1993, Perez and Byron, 1999).

The fragility of extractive economies was spelled out from the onset (Anderson 1989, Fearnside 1989), as few Amazonian extractive products have augmented in production and value in the last decades. This certainly was a very fragile base for a development strategy that has as a goal the well-being of extractivist populations. The premise that NTFP extraction can produce greater financial return compared to timber or agriculture also has been challenged by many authors (e.g., Browder 1990a,b and 1992a,

[9] However, although Amazonia's population is rising and currently reaching 20 million, rural population is decreasing. In addition, many other areas of Amazonia have extremely low population density (Martine and Camargo 1998).

Homma 1992 and 1993). Particularly, Homma attacked extractive economies as inherently uneconomic, arguing that all extractive products would eventually be substituted by domesticated plantation production or synthetic replacement of the extractive good.[10] This was the case for latex, which was the main product of extraction in Amazonia and is now cultivated in plantation within and outside Brazil as well as produced synthetically. He argued that if the prices of extracted products fall, degradation is likely to follow because extractors must harvest the resources above sustainable thresholds in order to maintain their living standards. He also argued that investments should be made at the development frontier, where colonists and cattle ranchers pursued more viable economies.

However, this position has been challenged by Allegretti (Allegretti 1994 and 1995) who points out that these land-uses are only "viable" due to the massive incentives and tax benefits that the Brazilian government has used to encourage cattle ranching and colonist agriculture on the Amazonian development frontier. She argues that similar tax and credit incentives need to be established for extractive economies. Also, the inherent assumption within these critiques, that ERs have to compete with other land uses in the market economy, might be quite reductionist, as they ignore the non-market value of these areas, such as the forest conservation, subsistence value and the opportunity value of untapped resources (Allegretti 1994, Anderson and Ioris 1992, Nepstad and Schwartzman 1992).

[10] Homma delineates three phases in the extractivism of a forest product: (1) expansion; (2) stagnation and (3) decline. The decline is attributed to four main factors: (1) inelastic market for the forest products; (2) extraction levels which surpass rates of natural regeneration; (3) domestication of the product; and (4) substitution of the forest product for a similar natural or synthetic product. Extractivism is just a phase in the economic development of a region, and if a forest product is that important, it will either be domesticated (generally somewhere else) or be substituted by a cheaper synthetic product.

2.3.4 Ecological Arguments

ERs were championed for two main ecological reasons. First, ERs were proposed as a means of preserving tropical forest cover. This has been confirmed in comparison to other land-uses strategies (Mendes et al. 1996). Secondly, the early NTFP literature assumed that the harvesting of NTFPs occurrs on a sustainable basis since local people have harvested these products for hundreds of years. Particularly anthropologists (e.g., Posey and Balée 1989, Allegretti 1979) had the tendency to think so. However, studies have shown that commercialization often leads to overexploitation (Bodmer at al. 1997). In that respect very little has been published about products from ERs in Amazonia (e.g., Pinard 1991, Kainer 1995). ERs have also been criticized as areas of “open access” where extractivists were encouraged to respond to “perverse incentives of overexploitation” (Homma 1989, Salafsky and Dugelby 1991). This notion has been refuted by May (1989), and the development of Utilization Plans of the reserves demonstrates the conscious attempt at resource use regulation.

A final argument in favor of the ERs strategy has been that it supports a traditional lifestyle, increasing the subsistence value of forest resources, preserving knowledge and thus preserving biological diversity (Balick and Cox 1996). Linked to the discourse of preservation of traditional knowledge is the call for the protection of the opportunity value of protected forests within ERs as repositories of biological and genetic diversity and therefore potential sources or new products for agricultural and pharmaceutical industries (Balick and Mendelsohn 1995, Gottlieb and Kaplan 1990). However, this argument has proven problematic, as it fueled economic expectations that have not been corroborated, and triggered a highly polemic debate about access to genetic and biological diversity in Amazônia.

2.4 Achievements and Problems with Extractive Reseves

The discussion about ERs has been overly focused on their economic fragility and neglected more basic community issues that are important for the social success of the reserve and also for their eventual economic success. A number of important achievements were made. Today, rubber tappers hold communal territorial rights within federal government protected areas that explicitly state their use and management by traditional residents. A great advance is also the elaboration of Utilization Plans and an ecological monitoring program, although evaluations of ecological practices has not occurred to a great extent (Millikan and Irving 1997).

Another important achievement is, perhaps, the building of social institutions such as associations, cooperatives, affiliations with the rural workers' union and the fortification of the Rubber Tapper National Council (Ramalho 1992, Schmink 1992). Nonetheless, a continuous effort will be required in order to maintain internal cohesion and common goals within these organizations, and to acquire the administrative and organizational skills necessary to run their commercial enterprises. In terms of formal education and health services for residents, ERs are still very fragile, as access to many areas is difficult and cooperation with state and municipal agencies has been limited and fractious.

In terms of development support, Extractive Reserves have been supplied with international funds. Most significantly, they have been inserted into the international Pilot Program to Conserve the Brazilian Rain Forest (PPG-7) since 1995.[11] The focus of

[11] The PPG-7 is one of the largest conservation programs ever experienced in Amazonia. It is the joint effort on the part of the Group of Seven countries, the Government of Brazil and the European Union, with the World Bank as administrator of the financial resources. The budget of international and national support to the four federal extractive reserves in the last four years were approximately ten million dollars (CNPT 1999).

this mega-project has been 1) The consolidation of the legal status and the regulations within ERs, 2) Social organization, community participation, capacity building and education and health programs, and 3) Extractivist production organization, diversification, transportation and marketing (IBAMA/CNPT 1999).

Moreover, the Brazilian government has offered credit lines to rubber tappers settled in extractive reserves, an innovative governmental policy, as until recently credit was only accessible for agricultural and cattle production in Amazônia. The Program of Support to Extractive Development (PRODEX)'s goal is to support the development of extractives activities, providing technologies and improvement in production to the communities, and incentives for diversification of production.

However, there are many obstacles that prevent it from having a significant impact on the improvement of extractive production. First, the financial resources are administered by BASA, the Amazon Bank, which has little operational capacity and is bureaucratically too rigid to work with extractives communities, which often cannot provide the required documentation. Another weakness of the PRODEX is the quality of the technical assistance, as government technicians have little experience in working with extractives communities. Nonetheless, the program demonstrated the federal government's recognition of the needs of extractive communities.

Political changes at a federal and state level have contributed to the ER model in Amazônia. At the federal level, a team of top professionals with great commitment to Amazonian environmentalism was selected by the Brazilian minister of environment for cutting edge decision-making, such as Mary Alegretti, who greatly contributed to the definition of extractive reserve in the 1980s. At the state level, in the Amazonian states of Amapá and Acre, leftist-environmentalist governors have been elected (Capiberibe in

Amapá and Jorge Viana in Acre). In Acre where the struggle began, the government has explicitly named itself "The Government of the Forest" and sustainable development on the basis of forest resources is at the center of its mission (Schmink 1999). The best possible political conditions currently exist in these regions. The next years will show whether the structural and policy changes that are occurring can considerably improve the prospects of ERs.

The biggest difficulty at this point challenging ERs is income-generating activities (Mendes et al. 1996, Millikan and Irving 1997). An important, although late recognition has been that traditional extractive populations do not need to rely solely on extractivist production. Others land-uses activities, such as agriculture, agroforestry systems, and small-scale cattle ranching are also important (Anderson 1992 and 1994, Rego 1999). In an ideal case these other land-use practices would intensify production per area without sacrificing ecological sustainability. However, as the pressure to diversify production and increase income builds up, extractivists tend to move increasingly toward more unsustainable land use activities and thus increase deforestation in the reserves. Deforestation rate is a major indicator to evaluate the efficiency of ERs and to fulfill its conservation objectives. Chapter 4, addresses land-use changes in the state of Acre and the context of deforestation rates and trends in the Chico Mendes reserve.

CHAPTER 3
STUDY SITES AND RESEARCH METHODOLOGY

3.1 Study site selection

The field research for this project was carried out from May to August 2000 in the Chico Mendes Extractive Reserve, in Acre, Brazil. The reserve is comprised of 970,570 ha (9,705 square kilometers), and is divided into the historically important rubber tapper estates (*seringais).* For this study, I selected the four *seringais* with the highest deforestation rates based on the work of Sassagawa (1999). In addition, I selected these *seringais* according to their location and their extension across different municipalities within the reserve. The four *seringais* selected were *seringal* Filipinas (in the municipality of Xapuri), *seringais* Porongaba and Humaita (in Brasiléia) and the seringal Paraguaçu (in Assis Brasil). These *seringais* are relatively near to the closest towns and can be accessed following the highway that leads from the capital Rio Branco to the Brazilian border with Peru. *Seringal* Filipinas is closer to Xapuri. The *seringais* Porongaba and Humaitá are located three hours from the closest town, Brasiléia. *Seringal* Paraguacu is located three hours from the municipal seat of Assis Brasil. The study *seringais* differ in terms of area, population size and some economic activities practiced by the residents

Figures 3-1 and 3-2 are maps of the Chico Mendes Extractive Reserve showing the four *seringais* where fieldwork was carried out, including the households where one-time interviews were conducted. Overall, the total number of households interviewed in

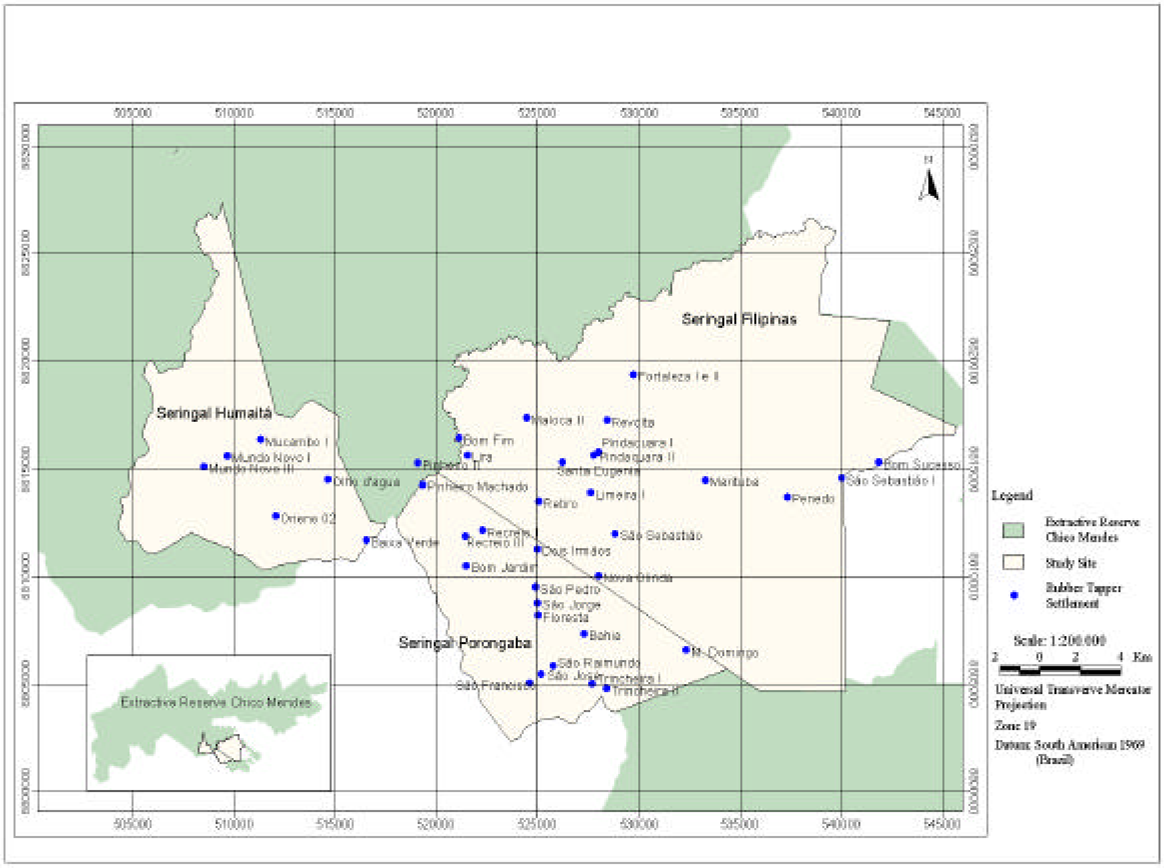

Figure 3-1 Maps of the study site showing the seringais and settlements in Xapuri and Brasiléia area

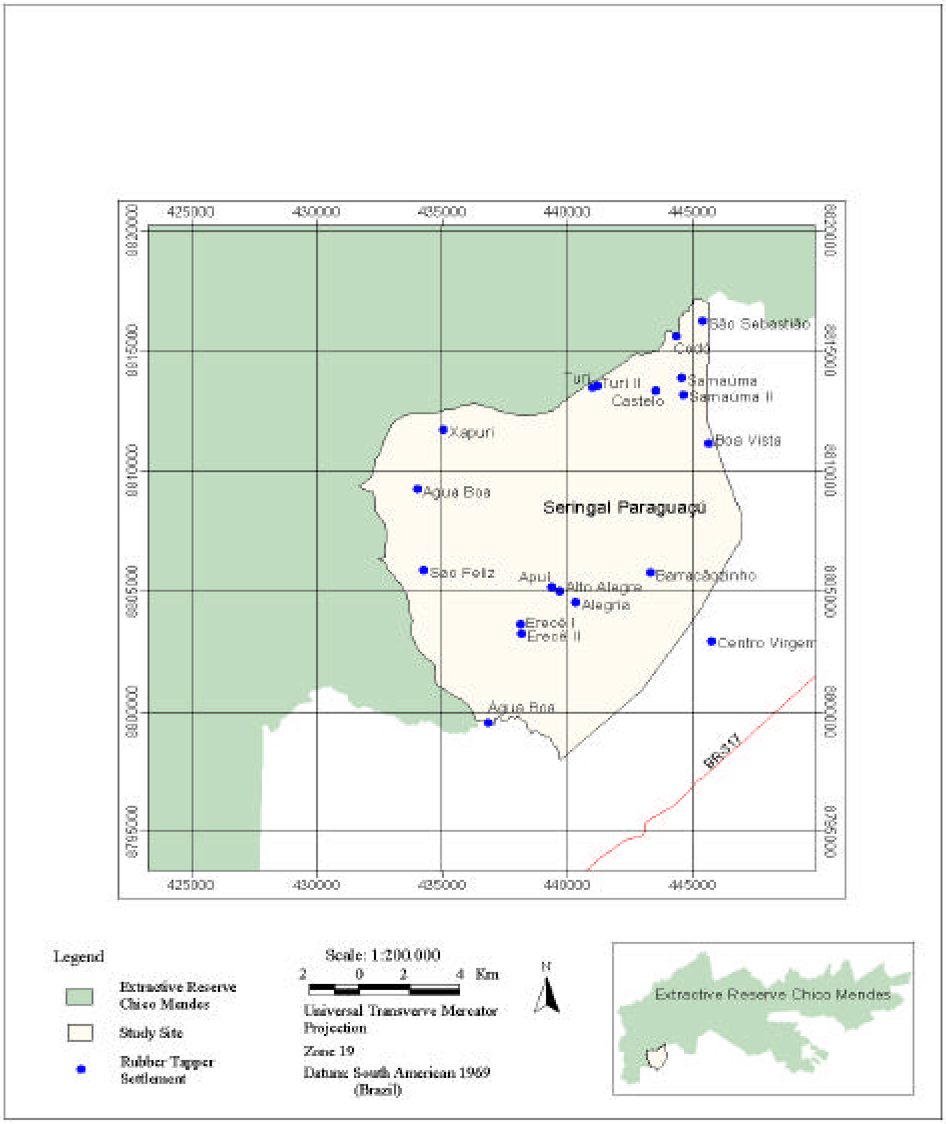

Figure 3-2 Maps of the study site showing the seringais and settlements in Assis Brasil area

the four seringais was 66. In the *seringal* Filipinas, which is the largest, nineteen interviews (28.8% of the total interviews) were carried out representing approximately 40% of the households in the seringal. In the *seringal* Porongaba, almost all the household heads were interviewed, totalling sixteen households (24.2 % of the total interviews). In the *seringal* Humaitá, a sample of eleven household heads was interviewed (16.7 % of the total interviews). In the *seringal* Paraguaçu, twenty interviews were carried out (30.3 % of the total interviews), representing approximately 70% of the total households in the seringal. It is important to stress that the interviews were mostly conducted with the male heads of household; however, in three cases women were the head of household. Interviews were limited to household-heads as these actors make the land-use decisions at a household level.

The rubber tappers' settlements in the *seringais* are located 30-120 minutes walking distance from each other. The most distant households surveyed were located at about a four hours walking distance, approximately 20 kilometers from the first household surveyed in the entrance of the *seringal*. Households were selected based on their location in the seringal, so that the sample would be evenly distributed throughout the area.

3.2 Survey setting and planning

In previous work I have gained knowledge of the rubber tappers in the Chico Mendes Extractive Reserve, which helped me set up the research in conjunction with the rubber tapper community. Before visiting the households, the research was discussed in meetings with leaders of rubber tapper social organizations in the three municipalities. In these meetings, I explained the goal of the research as well as the methodology that I was going to use. These discussions provided important feedback that helped me to make some changes in the research goal and methodology. The association leaders also helped me by announcing to the communities that I was carrying out the research, through local radio stations and the associations' amateur radios. This greatly facilitated the research, as the tappers already had an idea of the purpose of my study when I arrived at their homes, affording more time for interviews and participant observation. In addition, the associations indicated a community representative in each seringal to guide myself and a research assistant in order to safe find our way through forest trails, to select particular households, and to provide us with invaluable historical background of the community.

3.3 Survey methodology

Most of the data for this research was collected through a survey. The survey was conducted orally and carried out using structured interviews. Although the survey was applied at the household level, it targeted land-use information at the household, community, and reserve levels. The questionnaire covered a broad range of questions regarding land-use patterns, income, extractivist and agricultural production, migration dynamics, demography, transportation, social organization, and reserve wide-management efforts. I and a research assistant, an agronomy student from the Federal University of Acre who also was a certified extension worker applied the survey. The survey interviews lasted about 2-3 hours in each household. Between seven and ten days were spent surveying each seringal.

3.4 Other sources of data

The Brazilian Environmental Agency (IBAMA) conducted a census with all the residents of the reserve in 1995, 1998, and 2000. The data was collected as part of the monitoring strategies of the residents' land-use activities in the reserve. No one had analyzed the information thus far, although the censuses yield very valuable information regarding temporal changes in land-use, population and productivity. IBAMA collected the census data of the four study *seringais* in a questionnaire format, which was applied orally to the rubber tappers by extensionists and trained residents.

3.5 Data processing variables and analysis

The data collected throughout the survey were first entered into an Access database. Then, the data were entered into an excel database and a codebook was created to facilitate statistical analysis with SPSS program. In the codebook, 128 variables were defined. For the purpose of this Master's thesis, after running several tests, I selected variables that were related strictly to land-use patterns. The other variables will be used for further studies on the Chico Mendes Reserve.

To accomplish my analysis, I performed frequency distribution tests, cross-tabulation tests, and regression analyses. The frequency distribution and cross tabulation tests considered variables regarding length of residence and previous residence of the household-heads, settlement sub-divisions and the reasons for these sub-divisions, as well as residents' membership in rubber tapper social organizations. These analyses are presented in chapter 5 together with the analysis of census data of the reserve.

In addition, I performed regression tests and created an OLS model. I have defined six dependent and six independent variables. The dependent variables were divided into two categories: traditional and non-traditional land use activities among tappers.

- Traditional

- Rubber production in 1999
- Brazil nuts production in 1999

- Non-traditional

- Area deforested. Area deforested here is defined as the permanent or temporary clearing of the forest for pasture and agriculture. I combined two variables (household pasture size and agricultural plot size) into a dependent variable called “area deforested”. For a full picture of deforestation at the household level, other land covers need to be considered. Fallow areas in different stages of regeneration constitute an important component of changes in forest cover. This is problematic because I do not have data differentiating 3 year old from 20-year-old fallow.
- Total size of swidden plots in hectares per settlement
- Total size of pasture in hectares per settlement
- Total number of head of cattle per settlement

The independent variables selected point to some of the key socio-economic determinants of deforestation in the reserve and were considered as background of the household head, family labor force availability, and location of the seringais. The following independent variables were used in the analysis:

- Migrant status. The definition of who is a migrant is not straightforward and many factors can be considered to classify migrants within the reserve. For the purposes of this analysis, I classified as migrants anyone who came from outside the reserve or seringal context, be that former city-dwellers or residents that came from another land-use areas such as colonization projects or farms. Therefore, if the previous residency was outside a seringal context, the household head is considered as a migrant. In classifying migrants in the reserve as above, I am aware that I am underestimating several other forms of classification of migrants. The classification considered here is an attempt to identify residents that have engaged in different land use practices than those traditionally practiced by rubber tappers.

- Age of the household head.
- Number of sons and daughters of the household head. For this analisis, only children who were fifteen years old or older were considered, as this is the age when they start to play an important role in the family labor force availability in the settlement.
- Seringal location. I divided the four study seringais in different categories. Seringal Filipinas was considered the reference category for this analysis: as it most typically represented traditional seringal context. Seringais Humaita and Porongaba were analyzed as one unit since I observed that they have the same land use characteristics, thus not affecting the analysis, and also because they border on each other. The outcome and independent variables will be further discussed in chapter 5, where they are analyzed.

3.6 Environmental characterization of the reserve

3.6.1 Climate

The region's climate can be classified into tropical humid AM, according to Köeppen's system, and is characterized by a mean temperature between 26 e 27° C, with a short dry season a high precipitation levels. The rainy season lasts from November until April, during which precipitation averages amount to more than 110 mm/month, while during the rainy season precipitation averages are less than 93.3 mm/month, July being the driest month of the year (RADAMBRASIL 1976). The highest precipitation can be observed between the months of December to March, a period referred to as “winter” (*inverno*) in the region, while the period between June and September is referred to as “summer” (*verão*).

The average monthly temperature generally varies little between 24 a 26ºC, with a slight decrease between the months of June and August. During this period a phenomenon regionally referred to as *friagem*, results in acute drops of temperature to 4 to 6ºC, caused by an advancement of a polar front from the south (IDEAS 1993)

3.6.2 Watershed/Hydrology

The CMER’s watershed is represented by two main rivers: the Acre River and the Iaco River, both tributaries of the Purus River (Fig. 3-3). The Acre river watershed, cuts through a large part of the reserve territory and runs from west to east. The meandering river touches the reserve near Assis Brasil and runs along the frontier between Brazil and Peru as well as Bolivia. The river crosses the reserve near a community called *Itu*. The upper Acre river basin is characterized by a strong dissection of relief, forming hills located on the most elevated parts with mild slopes from 3 to 8% covered by podzólicos red-yellow soils (RADAMBRASIL 1976). The Acre River has a narrow floodplain and the peaks of the flood are observed between February and April, while July to September are characterized by a hydric deficit.

3.6.3 Geology

The geological studies of the region resulting in known descriptions of afloramentos litológicos (rocky outcrops), as well as mineral and fossil occurrences, are always based on finds on the banks of the main rivers due to the access by boat used by researchers. The CMER is totally composed of cenozoic sediments of the Solimões

Formation, lying on a base of crystalline “Craton Guaporé”, for which so far no outcrop has been detected in the reserve area. The recent alluvial with origin in the evolution of

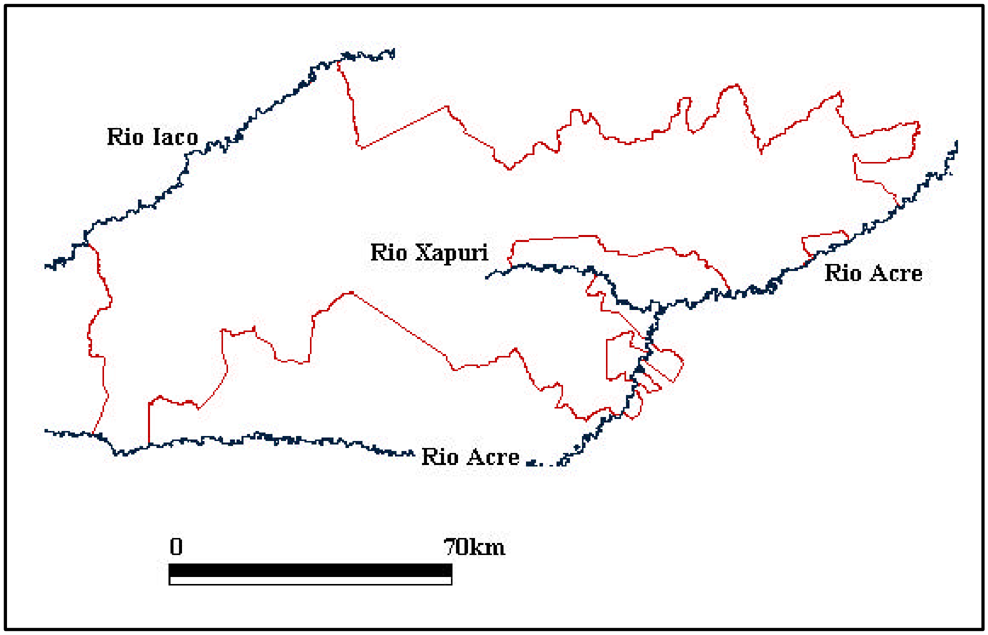

Figure 3-3 Map of the mean rivers bordering the CMER. Source: CNPT (1997)

the rivers of the actual watershed, include tertiary and quaternary sediments (IDEAS 1993).

The Solimões Formation is a result of the decomposition of “plio-pleistocenica”, which is characterized by variations of “faciológicas proeminentes”. These are typical sediments of the floodplain geology with characteristic sedimentary structures. These are part of the following geological composition: solid or stratified *argillites* (clay), with carboniferous and gypseum “concreções”; calcite and gypsies veins, occasionally with carbonized plant material; varied *argillites* with laminated structure (CNPT 1998).

3.6.4 Pedology (Soils)

Maps of the Radambrasil Project (1976), indicate that the reserve territory lies basically on eutrophic soils, which suggest good fertility due to the soil type change capacity, characterized by holding more than 50% of exchangeable bases (IDEAS 1997). Approximately 55% of the soils have clay texture and 83% have high clay activity. Such conditions are evidence that the reserve's environment has special characteristics with ample potential for production. Among the municipalities that hold territory on the reserve, the municipalities of Sena Madureira and Assis Brasil have more than 90% of its soils constituted of red-yellow podzolic eutrophic soils. In some other areas on the extreme north of the reserve, modifications of the soil profile have been detected with laminar and generalized erosion of the superficial horizon of the soils. Moreover, on other areas of the reserve, a process of slow "rastreamento" of the soil and localized laminar erosions has been identified.

3.6.5 Vegetation

The first inventory and description of the vegetation type of the state of Acre were elaborated by the Radambrasil Project (1976). In the area covering the CMER two phytoecological units were identified: the system of Dense (Closed) Tropical Forest and the system of Open Tropical Forest (IDEAS 1993). The reserve holds only 27% of dense forests, while 73% are areas covered with open forest. Figure 3-4 presents these forest distributions in the reserve.

The dense tropical forest is characterized by an understory with a dense layer of shrubs and treelets, and by closed arboreal canopy vegetation. The biggest extension of continuous dense forest is located south of the Xapuri River. Dense forest is classified into two forest types, which are differentiated according to different geological and

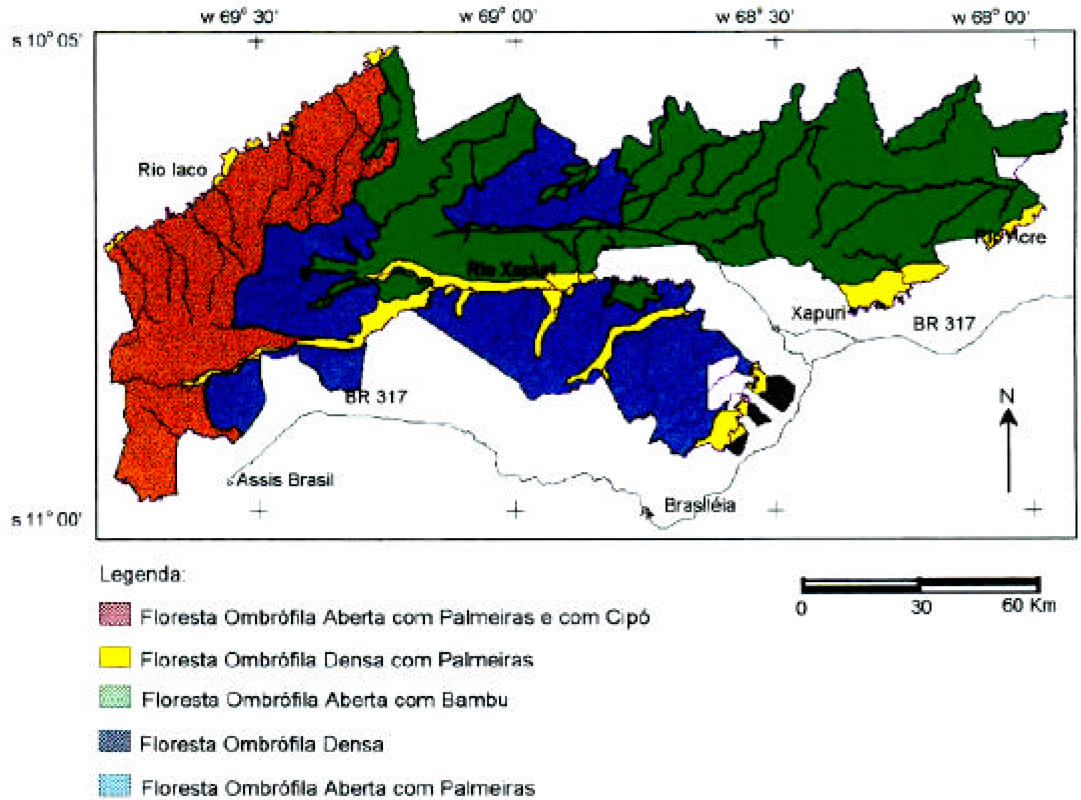

Figure 3-4 Map of forest typology occurring in the CMER, according to RADAMBRASIL (1976). Source: Sassagawa (1999)

geomorphologic properties of the sites, such as: dense forest on *terras baixas* (lowlands) with undulating relief and dense forests on dissected relief.

Dense *terra baixa* forests on undulated relief (Fdo) overlay tertiary sediments and usually reach a canopy height over 30m. In the lower areas, bordering *igarapés* (creeks), occur *seringueiras*, rubber trees (*Hevea brasiliensis* L.), the palms açaí (*Euterpe precatoria* Mart.), jaci (*Attalea butyracea*), and murumuru (*Astrocaryum murumuru*). In this forest type also occur stretches of lowland forest on dissected relief, in which the typical species is the *cerejeira* (*Amburana cearensis*) that has a high commercial value and is locally abundant.

In the dense forests on dissected reliefs on ridges and hills (Fda), compositions with smaller trees are found with frequency, in which individual trees are relatively uniform in terms of their height within their forest layer and in which the canopy reaches approximately 30m. The understory in the plateau areas is more open than those situated on the dissected relief and is increasingly dense in the direction of the “talvegues”, where shrub and palm species can be found in higher abundance (IDEAS).

These dense forests occur in three areas: In the northern part of the CMER near the headwaters of the creeks (*igarapés*) Mapinguari,; in the western part, at the headwaters of the Xapuri river, and in the southern part following the course of the Xapuri river until it reaches the Acre river. The main species found in these areas are: aquariquara (Geissospermum spp.), abiorana (Pouteria spp.), angelim (various Legumes), breu (Tetragastris and Protium), cariperana, castanheira (Bertholettia), cedrorana, copaiba (*Copaifera* spp), louro (Aniba, Ocotea), parapara, pau-mulato (*Calycophyllum spruceanum*) e ucuúba (*Virola* spp.).

Open Forest is caracterized by a distribution over lowland covering sandy tertiary geology and in the alluvial terrasses of quaternary sediments as well as the submontane relatively high areas on pre-cambian ground material. In this forest typology three main types of evergreen open forest types with palms and lianas occur.

The first evergreen open forest types with palms and lianas *(*Fac) is the forest on alluvial terraces on quarternary geology, covering 7% of the reserve. It occurs on the margin of all the major water flows in the region, however in variable “width” along the banks of the rivers. The forests in that environment can have very large trees. The most characteristic species of this environment are the abiorana seca (*Pouteria* sp.), aquariquara (*Geissospermum* sp.), andirobarana, mamorana, munguba, seringueira and ucuúba. Common palms also are: açaí, bacaba (*Oenocarpus mapora*) and graminoid species such as the bamboo (*Guadua* spp.).

The second *Open Evergreen Forest with Palms and Lianas* (Faa), is the forest of lowland and dissected relief. It occupies 22% of the reserve area and is located in the margin/edges of residual interflúvials. This forest is encountered throughout almost all of the western part of the reserve, limited by a band of Open Forest on Alluvial Terrases and the Iaco River. Its understory is rich in small palms. In dryer areas and on the margins of residual interfluvials lianas dominate what is called liana forests. In the depression and valleys there is a higher abundance of palms. Among the most characteristic species are the palms açaí, inajá (Attalea maripa), jarina (Phytelephas macrocarpa), mumbaca, murumuru, patauá (Oenocarpus bataua), paxiubão (Iriartea deltoidea) and paxiubinha (Socratea exorrhiza). Others commons species also include açacu (Hura crepitans), amarelão (Aspidosperma parviflorum), fava de espinho, ingás (Inga spp.), matamatás (Eschweilera spp), muratinga, seringueira, tauari (Couratari sp.) and ucuúba (Virola sp.).

The third *Open Evergreen Forest with Bamboo* on the lowland areas with undulated relief (Fao), covers 44% of the reserve, situated mostly in the area of lowland plateaus and variable drainage. This forest is by far more common than the other types covering most of the central-eastern part of the reserve. Three forest communities are part of this forest type: 1) *Open forest with lianas 2) Open forest with palms* and *3) Open forest with bamboo.*

CHAPTER 4
DEFORESTATION TRENDS IN THE EXTRACTIVE RESERVE

4.1 Introduction

This chapter introduces land use changes in the Southwestern Amazonian state of Acre and in the Chico Mendes Extractive Reserve. In particular, deforestation rates outside the reserve and within the reserve will be examined and discussed focusing on the state, municipal, reserve, and *seringal* levels. In addition, the chapter provides the necessary land-use change background on which the following chapters 5 and 6 base their discussion of household determinants of land use activities and keys socio-economic drivers of this change in the CMER.

The eastern part of Acre, particularly the Acre River Basin, lies at the westernmost limit of the development frontier that experienced massive changes in land use since the 1970s. The Chico Mendes Extractive Reserve lies just at this limit of the frontier (figure 4-1). To understand deforestation patterns within the Extractive Reserves, one also has to look at land use and deforestation rates in the surrounding areas of the state. First, land conversion and encroachment into rubber tapper areas were one of the reasons for the mobilization of the rubber tapper movement and the creation of the reserves. Second, until this day, land uses surrounding the reserve influence land uses in the reserve to a certain extent, as there is a lot of social interaction along the boundaries. Third, by comparing deforestation rates and patterns in the reserve with deforestation outside the reserve can one assess the effectiveness of the extractive reserve in maintaining forest cover.

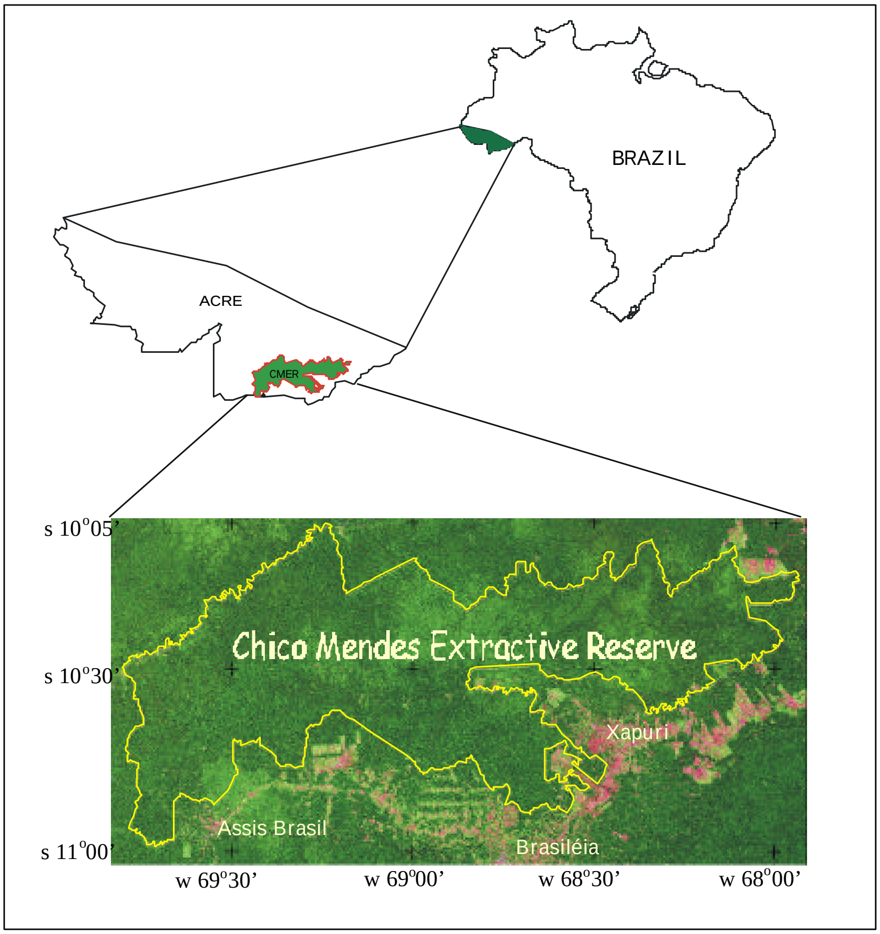

Figure 4-1 Location of the Chico Mendes Extractive Reserve in Acre

4.2 Deforestation and Land Use Trends in the state of Acre

Acre was almost totally covered by dense tropical forest before the 1970s when most of its economy was based on rubber and Brazil nut extraction. According to the Landsat satellite data, in 1978 Acre had only 2,500 square kilometers of deforested land. By 1988, after the onset of larger development efforts, deforestation reached a total area of 8,900 square kilometers (INPE 2000). This relatively low figure, compared to other Amazonian states, does not seem to give cause for alarm. What is significant, however, is that the area cleared down between 1978 and 1988 tripled in just ten years.

According to FUNTAC (1996), which analyzed deforestation at the state level, the increase in deforestation in Acre has been greater in the upper and lower Acre basin, the eastern part of the state, which comprises approximately 86% of the deforestation in the entire state. In fact, half of this deforestation until 1996 occurred in the six eastern municipalities of the state: Rio Branco, Senador Guiomard, Brasiléia, Bujari, Placido de Castro, and Xapuri (in decreasing magnitudes), with between 51% and 17% of these municipalities deforested.

While this region experienced most of the cattle ranching expansions it also concentrates a large portion of the extractive population. Deforestation from forest conversion for agriculture and cattle pasture generated sometimes violent social conflicts as the completely diverse social and cultural standards of production and organization clashed. As extractive activities, mostly rubber and Brazil nut extraction, were almost abandoned, the living conditions of the rubber tappers, who relied more heavily on forest resources, were severely compromised. Therefore, this conversion caused a significant rural exodus by the landless poor, many of them rubber tappers. As a result of the clashes between, particularly, cattle ranchers and resisting *seringueiros*, the rubber tapper movement was born, struggling for land, traditional livelihoods, and socio-economic development. Thus today, Eastern Acre's extractive reserves, the major achievement of this movement, are "islands" nested within and along the development frontier on otherwise "prime" development land.

The greater rate of deforestation in the upper and lower Acre River region is directly related to the transition from traditional non-timber forest production to ranching and farming. Since the 1970s, deforestation rates have increased at quite high rates, threatening the vegetation cover and forest of the state already compromised by about

15,000 squares kilometers of clearings in 1999 (See Figure 4-2)[12]. Concurrently, Acre's rubber production, which was the basis of the state's economy, has decreased drastically. This occurred not only as a result of the deforestation in this region, but also as a result of national and regional development policies that favored cattle ranching and large scale agriculture over extractivism, and the declining wild rubber market. Figure 4-2 demonstrates that there is a direct inverse relationship between deforestation and rubber production in the state of Acre, illustrating how extractive activities (rubber) gradually lost importance and large-scale land-use activities were prioritized. This inverse relationship tends to continue until today, although rubber production has increased a little in the last two years due to a new local government subsidy intended not only to provide rubber tapper communities with better income, but to decrease deforestation rates as well.[13]

The regional and local socio-economic factors that have affected land-use change in Eastern Acre also have directly and indirectly influenced land use change within extractive reserves. The Chico Mendes Extractive Reserve in particular is rooted in the history of the grassroots movement for forested land but also in the history of land-use change in the region.

4.3 Deforestation rates in the CMER

The CMER, with nearly one million hectares, borders the highway BR 317 leading to the Pacific through Peru. Although the CMER has served to impede large-scale

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[12] The deforestation rates between 1979 and 1988 were estimated by averaging due to the lack of data

[13] The "Lei Chico Mendes" or "subsídio da borraha" was the first effort of the "government of the Forest" elected in 1998 to strengthen extractivist communities by boosting rubber production. It provided an additional 0,20 US $ for every kg of rubber for every rubber tapper in a production association. In addition to making it worthwhile for many *seringueiros* to tap rubber again, it was intended to strengthen and encourage the rubber tapper social organization (Governo do Acre 1999).

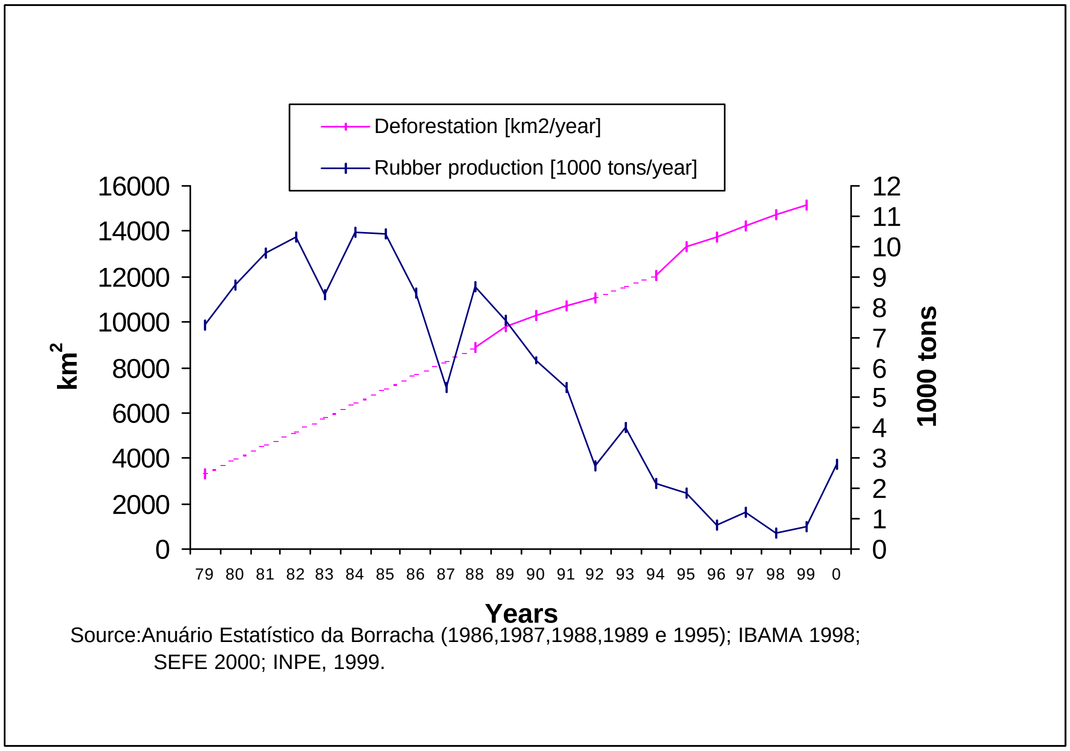
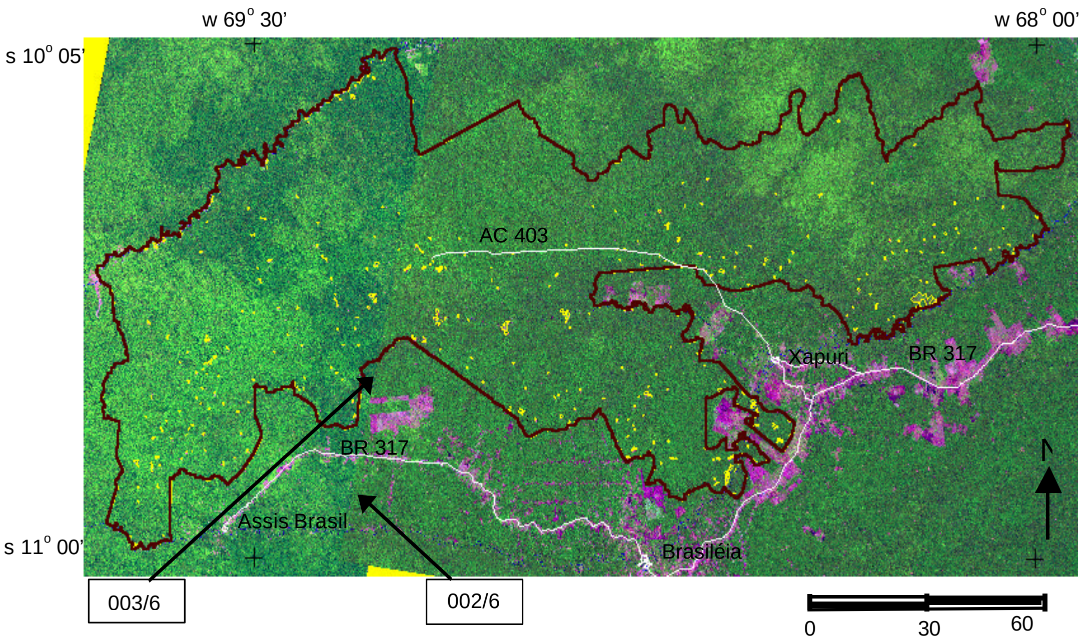


Figure 4-2 Deforestation and rubber production in Acre (1979-2000)

deforestation along this highway, it has experienced accelerating small-scale deforestation since it was established (Figure 4-3 and 4-4). It is predicted that within a decade about 12% of the reserve area will exceed the legal limit for deforestation of 10%, as determined by the Utilization Plan[14] (Brown 2001). In addition, the higher occupation of some parts of the reserve, mostly the southwest part, may cause land clearing to exceed the 10% limit for those areas in a few years. Nonetheless, despite increasing deforestation within the reserve areas, compared to levels of deforestation outside the

[14] The Plan sets forth an upper limit of 10% of deforested area per household (of an estimated 300-400 hectares), including residential clearings, backyards, pastures, agricultural and abandoned fields, as well as agroforestry plots. The plan also includes strict regulations of the extraction of rubber and Brazil nuts and the development of management plans for new forest products. Timber extraction and hunting is restricted to the resident's subsistence use. The Plan defines as "common use areas", rivers, lakes, main paths, and beaches, although residents close to these environments tend to dominate their access. The resident associations have authority to participate in the monitoring process of the plan and a team of resident woodsmen were trained and given the legal status of environmental inspection agents.



Legend: Border of the Chico Mendes Reserve

Road

Desforestation1986

Figure 4-3 Satellite image mosaic of the CMER illustrating deforestation in and out of the reserve. Source: Sassawaga 1999.

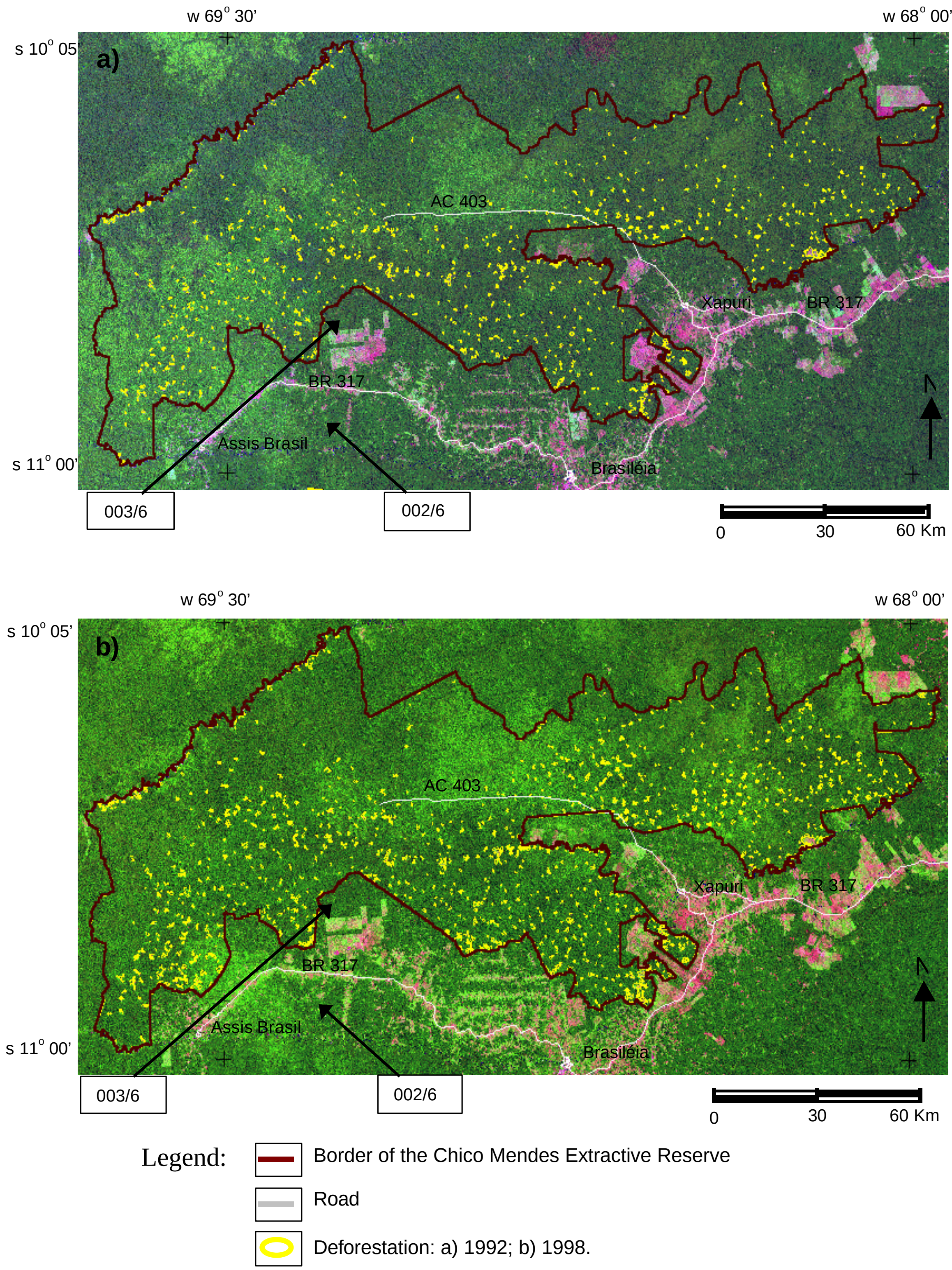


Figure 4-4 Satellite image mosaic of the CMER illustrating deforestation in and out of the reserve. Source: Sassawaga 1999.

reserve these are relatively small, particularly compared to areas along the BR-317 highway, which is dominated by large-scale cattle ranching activities. Figure 4-5 shows the percent of overall deforestation in three periods of time that Sassagawa (1999) determined for the CMER. The mean annual deforestation rates within the reserve were 0,137% a year for the 1986-1992 period and 0,227% a year for the 1992-1998 period. This shows that deforestation rates of the second period nearly doubled compared to the first one.

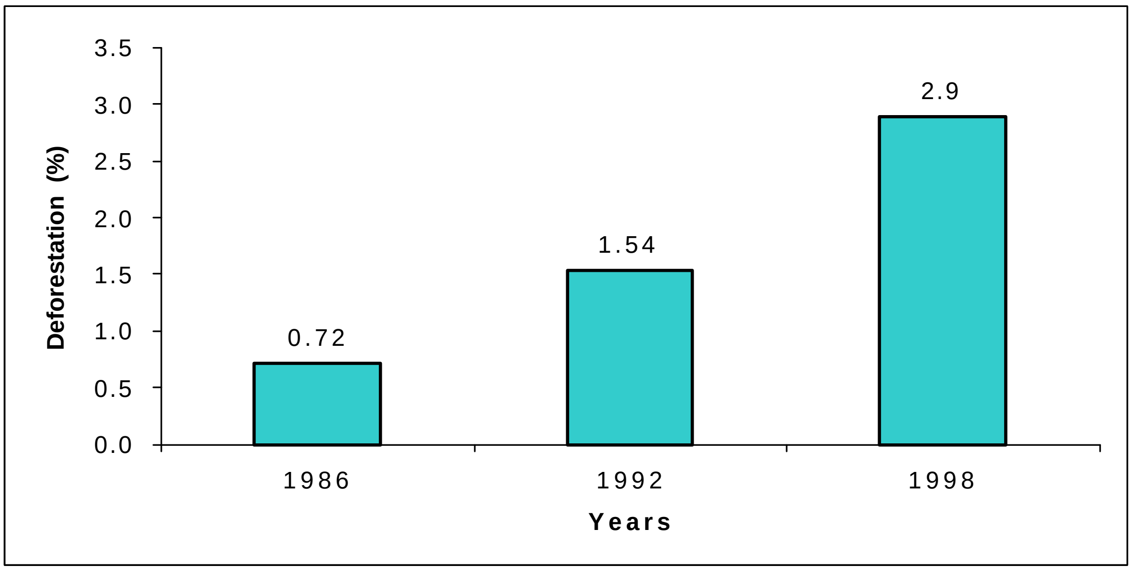


Figure 4-5 Percent of deforestation in the CMER (1986, 1992 and 1998) Source: Sassagawa (1999)

4.4 Deforestation at the seringal level

Within the extremely large CMER Reserve there is great variability in deforestation levels. Some areas have levels as low as 0.02 % (1998) while others are approaching 8% (1998) almost reaching the legal limit of 10%. Table 4-1 shows the different rubber tapper estates or *seringais* of the reserve, the area that they cover and the proportion of that area that was deforested in 1986, 1992 and 1998, respectively.

As noted before, there is a great variability within the reserve as can be seen by the very different deforestation rates that the seringais have experienced. Some, mostly more remote areas such as the Seringal Arari, and Seringal Petrópolis have extremely low levels of deforestation, whereas Fazenda Carmen has surpassed the legal limit of 10%.

Table 4-1 Total area and percentage deforestation in each seringal of the reserve within the three associations of the municipalities

Seringal	Área (Km^2) in CMER	Deforestation/Seringal (%)		
		1986	1992	1998
Assis Brasil (AMOREAB)				
Seringal Guanabara	707,69	0,61	1,67	2,75
Seringal Icuriã	644,05	0,54	1,38	2,27
Seringal Paraguassú	195,11	0,62	1,62	6,70
Seringal Petrópolis	121,68	0,02	0,02	0,02
Seringal São Francisco	299,33	1,12	2,12	3,27
Brasiléia (AMOREB)				
Fazenda Carmem	70,04	2,43	4,31	12,81
Fazenda Porvir	46,80	0,62	0,85	3,63
Seringal Nazaré	128,22	0,26	0,92	2,32
Seringal Amapá	513,85	0,79	1,54	2,50
Seringal Apodi	191,17	0,47	1,54	2,43
Seringal Canamari	69,70	0,88	0,92	1,25
Seringal Humaitá	144,87	1,13	2,93	7,95
Seringal Nova Olinda	358,32	0,06	0,14	0,47
Seringal Pacuara	69,59	0,89	2,04	2,56
Seringal Pindamonhangaba	99,05	1,71	2,46	3,63
Seringal Porongaba	89,57	2,27	4,04	7,15
Seringal São Cristóvão	165,81	0,55	1,26	2,98
Seringal São Salvador	62,83	1,40	2,34	3,42
Seringal Tabatinga	759,88	0,24	0,49	0,56
Seringal Triunfo	103,17	1,40	3,57	5,08
Seringal Vale Quem Tem	25,14	0,00	2,31	3,50
Seringal Várzea Alegre	83,43	1,17	3,03	4,44
Xapuri (AMOREX)				
Fazenda Bonfim	329,40	0,15	0,53	1,38
Fazenda Ana Cláudia	46,83	0,23	0,81	0,96
Fazenda Filipinas	442,21	1,96	3,62	7,55
Seringal Arari	104,67	0,00	0,00	0,06
Seringal Curitiba	120,75	0,03	0,07	0,07
Seringal Fronteira	339,89	0,37	0,64	1,05
Seringal Remanso	54,05	0,02	0,44	0,91
Seringal São José	95,65	0,26	1,08	2,05

Table 4-1 Continued

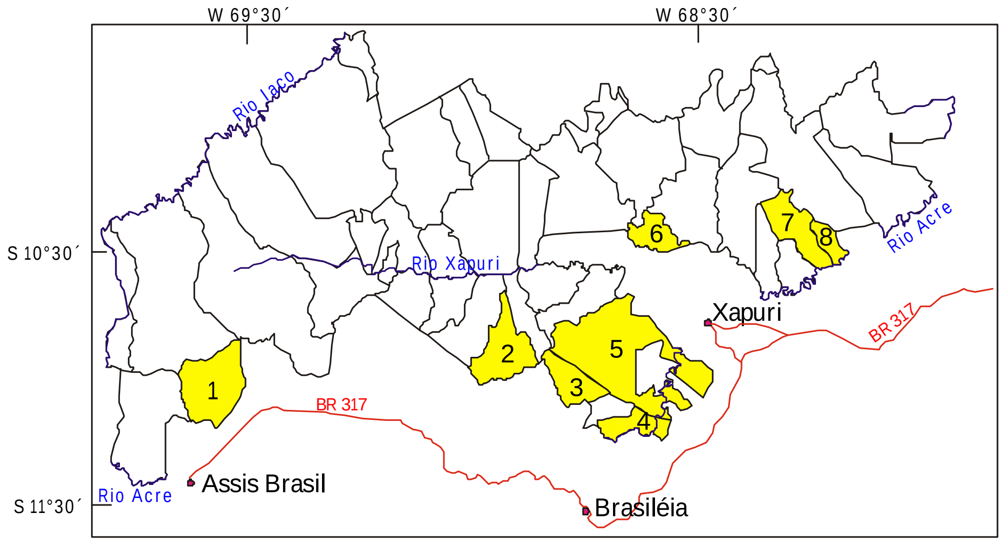
Seringal Sai Cinza	63,38	1,47	2,46	2,86
Seringal Venezuela	115,41	0,55	2,97	4,80
Seringal Albrácia	255,00	0,25	1,04	2,68
Seringal Barra	183,44	0,18	0,39	0,92
Seringal Boa Vista	315,69	0,29	0,86	2,46
Seringal Dois Irmãos	68,88	0,99	1,09	3,91
Seringal Floresta	70,09	1,63	4,58	7,35
Seringal Independência	120,43	5,20	6,02	8,1
Seringal Lua Cheia	54,03	1,11	3,09	3,83
Seringal Nazaré	273,06	0,71	1,24	2,50
Seringal Palmarizinho	87,29	1,13	2,26	4,83
Seringal S. F^{co}. do Iracema	456,78	0,37	1,09	2,23
Seringal S. João do Iracema	41,27	5,38	7,87	7,87
Seringal São Pedro	143,99	0,22	0,76	2,06
Seringal Sibéria	227,54	0,50	1,29	2,48
Seringal Vila Nova	248,76	0,82	2,09	4,30

Source: Sassagawa (1999)

Generally, the *seringais* with higher deforestation rates are situated at the boundaries of the reserve and in relatively close proximity to Xapuri or Brasiléia and the highway (See Figure 4-6). Another area of increased deforestation is in the municipality of Assis Brasil, where there is more agricultural activity and Brazil nut tree density is extremely low, limiting the extractivist potential of the area. In contrast, many seringais toward the “middle” or “back” of the reserve are very little impacted.

It is important to note that these numbers represent overall deforestation per *seringal* and do not always reflect similarities across these areas. Some seringais with very high levels of deforestation may have largely forested land in one portion of the area whereas some *seringais* can have large deforested areas although the seringal as a whole is still forested. Therefore, a certain caution needs to be exercised when evaluating these numbers.

Another important point of consideration is that prior to the creation of the reserve, some *seringais* of the current extractive reserve had already experienced a small



Legend: 1 - Paraguaçu, 2 - Humaitá, 3 - Porongaba, 4 - Carmem, 5 - Filipinas, 6 - Floresta, 7 - Independência, 8 - São João do Iracema

Figure 4-6 Map of the eight seringais with the highest deforestation rates in the CMER

percentage of deforestation, as evidenced by the 1986 rates. This is particularly true for the areas close to the highway and towns, such as the *Fazeda Carmen*, *Seringal Floresta* and *Seringal São João do Iracema*, thus setting a different trend for later land-use in these areas.

Table 4-2 shows only the *seringais* that have reached the highest deforestation rates since 1986, which are the areas of particular interest to this study. The four seringais highlighted in yellow are the ones selected as study seringais. All of them are similar in the level of deforestation and by 1998 they were all reaching the legal deforestation limits of 10% per settlement in the reserve. If the same deforestation rates continue, these four seringais will reach their legal limitation of deforestation in the next few years. The *Fazenda Carmen*, which has even surpassed this limit, is currently even in discussion with authorities about being turned into a traditional colonization project (personal communication with Josémar A. Caminha, CNPT-IBAMA 2001).

Table 4-2 *Seringais* within the CMER with the highest deforestation rates

Seringal (with over 6% of deforestation)	Deforestation/Seringal (%)					Prediction for 10% (Years)
	1986	Rate in 86 - 92	1992	Rate in 92 - 98	1998	
Seringal Paraguassú	0,62	0,17	1,62	0,85	6,70	4
Fazenda Carmem	2,43	0,31	4,34	1,42	12,81	*
Seringal Humaitá	1,13	0,30	2,93	0,84	7,95	2,5
Seringal Porongaba	2,27	0,30	4,04	0,52	7,15	5,5
Seringal Filipinas	1,96	0,28	3,62	0,66	7,55	4
Seringal Floresta	1,63	0,49	4,58	0,46	7,35	6
Seringal Independência	5,20	0,14	6,02	0,35	8,10	6
Seringal S.João Iracema	5,38	0,43	7,87	0,00	7,87	**

* Exceeded the 10% allowed;
** Presented a 0% deforestation rate in the 92 to 98 period.
Source: Sassagawa (1999).

Particularly in recent years, the communities of the seringais with higher deforestation no longer have the historical close relationship with forest resources, and have developed their agricultural and pastoral activities more intensely. The 1992-1998 figures demonstrate this increasing change in attitudes towards land-use, mirroring the trends outside the reserve, though on a smaller scale. The increased adoption of these new land uses; however, might become a potential source of conflict between these practices and the Utilization Plan regulations.

Apart from deforestation levels, the four study *seringais* also have other characteristics in common which might be determining factors in the increased deforestation levels. All of them, excluding Filipinas, are accessible via roads and are located near cities. In addition, the outer limits of the reserve in these areas border on or are close to cattle ranches and colonization projects. However, they differ in area and population size, as well as some land use activities. By more closely examining these *seringais,* this thesis hopes to elucidate some of the factors that have led to this increased deforestation in parts of the reserve. Chapter 6 will consider what factors at the household level might affect land-use patterns in the four seringais. These characteristics include head-of-household traits, family composition, and rubber estate location as determinants of land use activities measured in six outcome variables.

CHAPTER 5
HOUSEHOLD DETERMINANTS OF FOREST AND NONFOREST ACTIVITIES

5.1 Introduction

Recently, studies of land use processes at the household level have emerged as an important component in understanding social deforestation dynamics in Amazônia (Brondizio and Siqueira 1997, Perz 2001a,b). This chapter provides a household level approach, measuring some characteristics as determinants of land use activities in four seringais of the Chico Mendes reserve. The central question of this chapter concerns how the origin and age of the household head, family composition, and location of a household affect land-use choices in the four study seringais. If this question is answered we will understand much more about these diversified land use activities in these seringais and their implication for forest conservation. The results might also delineate future trends of land use in these more impacted areas of the reserve as well as other areas that can follow this trend. Thus, this is important for basic policymaking regarding land use regulation and economic development for these rubber tapper's communities.

5.2 Characterization of Rubber Tappers' Settlements in the CMER

In the Chico Mendes reserve there are 46 *seringais*, which are historically determined rubber tapper estates. Each *seringal* is composed of approximately 10-25 or more household units, the *colocação*[15] or family settlement. Before the creation of the

[15] This term comes from the verb *colocar*, meaning to place or to put. The colocação or placement refers to the area where a rubber tapper was placed or *colocado* in the forest by the boss during the rubber boom.

reserve, these units were not formally managed for multiple uses, but rubber tapper families have managed them for rubber and Brazil nut extraction for generations. Today, with the diversification of rubber tapper production systems, it is exactly at this landscape level that most of the new land-use decisions are made and carried out.

Figure 5-1 shows a typical modern settlement in the CMER. The settlements comprise a residential clearing associated with backyards and small open fields; one or more agricultural plots at some distance in the forest; extractive rubber tapping trails radiating in loops from the residential clearing; a gathering and hunting territory delimited by trails; and a pasture area, mostly resulting from old agricultural areas that were not left to fallow. The size of these settlements ranges from 300 to 800 hectares and is informally determined by the number of rubber tapping trails that historically defined the productive unit of the settlement. In other words, settlement territories have no physical boundaries that can be mapped precisely. Instead, the attention is concentrated on the natural resources they contain, measured by the rubber trails and the rubber and Brazil nut trees in that area. As noted, rubber tapper settlements cover a variety of land use activities that are distributed seasonally throughout the years and require differentiated family labor force allocation. The next section will present the allocation of the rubber tapper' major land use activities.

5.3 Seasonality – The Rubber Tapper's Year

A good way to understand factors affecting rubber tappers production is to learn about their main land use activities throughout the year. Although production systems shared by rubber tappers are similar, there are differences. How much time a family spends on rubber tapping, on Brazil nut collecting, agriculture, livestock raising, and hunting varies greatly between families and by season. In addition, the patterns of

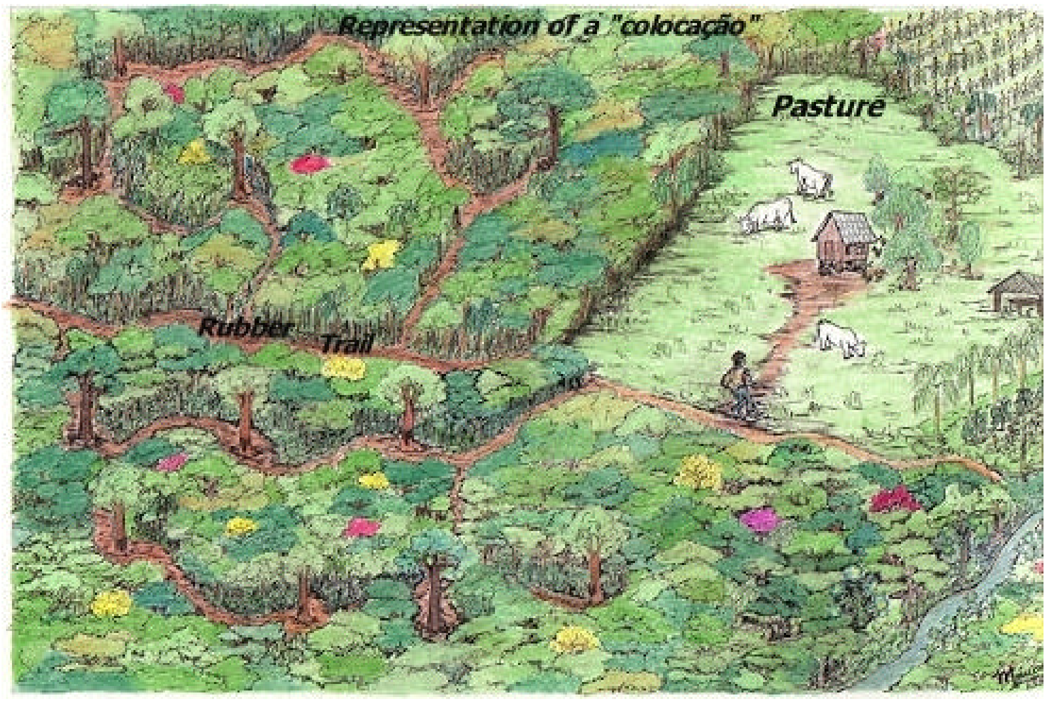


Figure 5-1 Representation of the settlement in the CMER

work spent in each activity cannot be studied in isolation. The outcome from one activity can only be analyzed in the context of another activity in order to understand how each operation influences each other. Also, understanding household members' multiple roles and responsibilities is crucial to the study of land use activities.

Figure 5-2 presents a seasonal calendar of rubber tapper activities throughout the year. The principal seasonal influence on land use activities is that of the rainy and dry seasons. Forest production activities complement one another seasonally. Rubber is harvested in the dry season (April to August) while Brazil nuts are collected in the "winter" (December to March). Since labor is an important limiting factor in the tapper's production system, the fact that rubber and Brazil nuts do not compete for labor is very beneficial and important to tapper families.

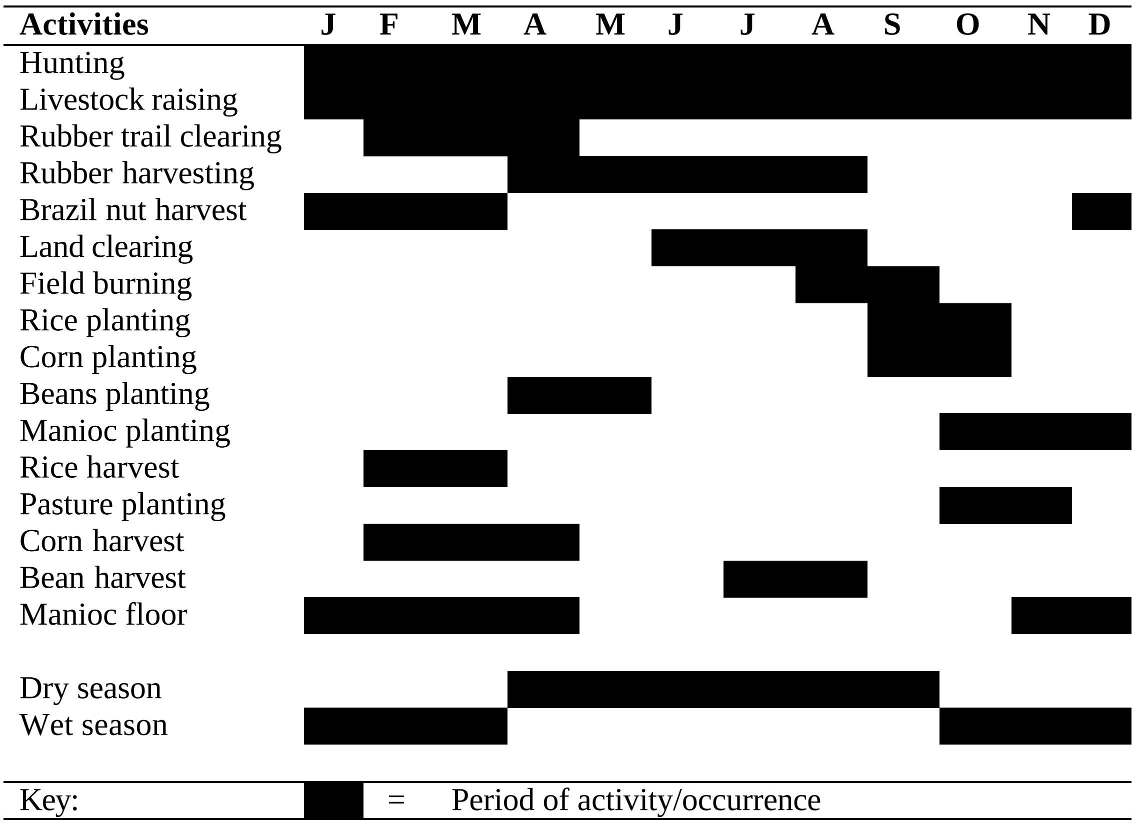


Figure 5-2 Seasonality in the rubber tapper’s year

Land clearing for crop production is performed from July to August. Tappers choose an area close to the house that is free of Brazil nut and rubber trees. Trees and understory must be cut on the land to be cleared. This referred to as the *broca* and *derrubada.* Broca refers to cutting vines and other small brush. After this is done, the tappers performs the *derrubada* which is to cut the larger trees with an ax or a chainsaw usually provided by the Association. After that, the vegetation is on the ground, drying for at least three weeks so that it will dry well enough to burn well, which generally is carried out in September. The land clearing process and rubber tapping need to be done in the dry season and are carried out by the adult males. These concomitant high labor activities cause a constraint in the family's labor force availability.

Corn and rice are then planted intercropped at the beginning of the rainy season (September and October). These crops are harvested in February and March. Beans are planted in April or May, at start of the dry season, and harvested in July and August. Manioc is planted from October to December. Manioc is used to produce flour (farinha), and is harvested as necessary. Following this planting period there is much weeding of these crops to be done in the wet season. Following the second year, the plot will be left in fallow and then used in cultivation again after a few years, will be transformed into pasture or left to regenerate into forest. Usually all adult family members plant, weed and harvest. Women help in planting and harvesting. Besides planting and harvesting, young sons and daughters are involved in the weeding.

Livestock raising is carried out throughout the year. This includes chickens, pigs, goats, sheep and cattle. Women usually take care of most of the livestock, excluding cattle, which is often the responsibility of the sons or heads of households. Hunting continues throughout the year for most rubber tappers. The head of household usually undertakes this activity, but in the busiest times of the year tappers often have no time to hunt and thus send their oldest sons instead.

In general, rubber tappers' activities are very well distributed throughout the year. However, the period that requires the most family labor is between June and October. During this period the family members are harvesting rubber, planting and weeding crops, clearing new agricultural land and taking care of livestock. This period of labor stress limits how much a family can dedicate to any one activity, and ultimately decisions need to be made as whether to invest more into rubber tapping, agriculture, or pasture creation. In the following section I will statistically compare the different forms of land use with some household determinants, an important one of which is labor availability.

5.4 Conceptualization and Operationalization of Outcome and Independent Variables

Rubber tapper activities throughout the year involve a series of complementary activities. Four main activities can be defined for rubber tapper production systems: rubber tapping, Brazil nut collection, livestock raising, and crop production. Since these activities have different influences on deforestation, the ones with low impact on the forest were conceptualized as traditional forest activities, and the ones with high forest impact were conceptualized as non-traditional forest activities. I consider six land use outcome variables and a set of other independent variables that influence rubber tapper land use activities. Table 5-1 presents outcome and independent variables names, their operational definition and their descriptive statistics.

5.4.1 Outcome Variables

The first two outcome variables, rubber and Brazil nut production were conceptualized as the basis of the traditional forest activities because they have low forest impacts and represent the traditional forest based economy practiced by rubber tappers. I operationalized rubber production in terms of kilos and Brazil nut in terms of *latas.*[16] The average finding for rubber production per household is 268 kilos per year. It represents a very low rubber production per household, but the distribution is skewed, as indicated by

[16] Rubber tappers usually measure Brazil nut by "latas," or eighteen to twenty-liter cans of cooking oil. One lata of Brazil nut is equal to 13 kilos.

Table 5-1 Variable names, operational definition, and descriptive statistics, CMER

Variable Name	Operational definition	Mean	Standard Deviation
Outcome variables			
Forest and nonforest activities			
Rubber	Total rubber production in 1999 measured in kilos	268.6061	418.3590
Brazil nut	Total brazil nut production in 1999 measured in *latas*	227.2424	284.9748
Area deforested	Total size of pasture and swidden combined in hectares	9.3788	10.9492
Swidden size	Total size of swidden plots in hectares per settlement	2.2803	1.5863
Pasture size	Total size of pasture in hectares per settlement	7.0985	10.0641
Heads of cattle	Total number of head of cattle per settlement	8.3485	10.3247
Independent variables			
Household Background			
Migrant	Residents that came from the city or other locations outside the reserve, such as colonization projects and ranches	.3333	.4750
Age	Age of the head of household	42.3788	12.9398
Labor force availability			
Sons	Number of sons in the household aged 15 years or older	2.0308	1.9683
Daughter	Number of daughters in the household aged 15 years or older	1.6154	1.6554
Seringal location (reference category seringal Filipinas)			
Seringal Paraguaçu		.3030	.4631
Seringais Humaita/Porongaba	Seringais Humaita and Porongaba were tied together since they present the same land use characteristics	.4091	.4953
n = 66			

the large standard deviation. It reflects that some households do not tap any rubber, while other households still have a considerable rubber production. Brazil nut production averages 227 *latas* per household per year. In general, these traditional forest activities findings show that rubber tapping activities have limited importance for many households, although they are living in an extractive reserve where rubber is still supposed to be a key part of the economy.

The other four outcome variables, area deforested, swidden size,[17] pasture size and number of cattle heads, I classified as non-traditional forest activities among rubber tappers. All these variables represent important activities increasingly developed by rubber tappers in the study seringais and are important indicators of the impact on forest cover and deforestation in the reserve. In addition, the way these variables behave has important development and political implications for rubber tapper communities settled in extractive reserves.

The area deforested variable is an important measurement of household forest impact, which has several implications in terms of land use regulation in the reserve, such as the one defined in the utilization plan that sets forth an upper limit of 10% of deforested area per household. In addition, the area-deforested variable is further implicated in terms of the cultural identity of tappers as an extractive population. I conceptualized area deforested as the permanent or temporary clearing of the forest for pasture and agriculture.[18] I operationalized this variable combining household pasture

[17] Note that swidden agriculture to some extent is also a traditional activity for rubber tappers, mostly for family subsistence.

[18] I considered these two variables as a mean of measuring area deforested in the settlement. However, they have different ecological impact on forest cover. Swidden might be left to fallow and thus have less ecological effect on forest cover than pasture, which usually has greater impact, and is more permanent forest clearing.

size and agricultural plot size. The mean household area deforested area was 9 hectares per household.

Swidden agriculture is relatively traditional among rubber tapper because it was practiced as a subsistence activity. This has a relatively small forest impact because small areas of forest are cleared annually. In addition, the impact is low because a rotation system is practiced by tappers whereby the same plots are used for two or three years and then left in fallow to be used again after a few years. This rotation, if conducted properly, may guarantee sustainability. However, I conceptualized swidden agriculture as non-traditional forest activities because, more recently, swidden agriculture has increasingly had greater forest impact in the study's seringais.[19] Since agriculture has become an important source of family income, many families have increased the size of swidden agricultural annually, and swidden areas that before were left as fallow are increasingly turned into pasture. I operationalized the swidden agriculture in terms of the size of the swidden plot in hectares per household. The descriptive statistics show that the mean swidden size was 2.2 hectares per household each year.

The pasture outcome variable represents the newest land use among rubber tappers. An accelerated increase in pasture areas has taken place within the study seringais and, thus, pasture represents the land use with the greatest impact on forest cover. A recent perception among rubber tappers in these seringais is that the conversion of land into pasture will increase the value of their settlement. This indicates their plans for future land use choices and has a series of implications in terms of the future economic and ecological viability of their reserve as well as in terms of their very identity

[19] Traditionally, a tapper family usually has a hectare of agricultural land that is used for family consumption throughout the years. In the studied seringais, I observed that many families have increased their swidden plot at least with another hectare for cash crop agriculture. Though I did not distinguish these families in the analysis, I recognize that it would have been important to look at the families separately.

as rubber tappers. I operationalized the pasture variable in terms of the size of the pasture area in hectares per household. The mean pasture area was 7 hectares per household.

Likewise, the cattle outcome variable is another important indicator of new economic activities for the rubber tappers. It was agreed upon in the utilization plan of the reserve that families could have a small number of cattle, just to improve their daily diets and transport their products. However, in the study seringais, cattle raising is the activity showing the greatest increase recently. Some households in the study seringais have no cattle, while others have over 30 heads. It seems that most of the tappers' profits in the studied seringais are invested in cattle raising. These cattle raising expansion phenomenon has been perceived as a "savings account", an investment that can be easily changed into cash. Again, the increase of this economic activity among rubber tappers has implications in terms of the their concept of economic development and the conservation goal of their extractive reserve. I operationalized the cattle outcome variable in terms of the number of cattle heads per household. The mean number of cattle heads per household was 8.

5.4.2 Independent Variables

The production system developed and managed by the rubber tappers can be, to a great extent, characterized in socioeconomic (e.g., age, family, labor force availability, price) and biophysical terms (e.g., location of the household, distance to market, resource availability). The independent variables consider three groups of two variables each that affect the production systems: household head background (migrant status and age), labor force availability (sons and daughters of the household head) and location of the study seringais.

In addition to these characteristics, a series of other variables[20] were considered, but the ones discussed here were noted to be most significant to the model discussed later in this chapter. Moreover, the limited number of cases in my sample (66), lowered the likelihood for statistical significance of these other independent variables.

The household background involves two indicators: migrant status and age of the household head. I operationalized the migrant variable according to previous place of residence of the household head, which might allow for the assessment of difference in land use practices. Migrant household heads might be more engaged in non-traditional forest activities than non-migratory household heads. The age of the household-head might also be an important indicator of the economic activities they have engaged in throughout their life cycle. Older household-heads might be more concentrated on traditional forest activities (e.g., rubber tapping), while younger household head may be more engaged on non-traditional forest activities (e.g., agricultural crops). The descriptive statistics reveal that 33% of the head of the household were migrants. The mean age of household heads was 42 years old.

The rubber tappers' extractive system varies, depending upon how large the family is and upon how dependent the family is on income producing activities. The family itself provides most of the labor on the landholding of a tapper family. Thus, I conceptualized labor force availability in terms of the number of sons and daughters, and operationalized it in terms of their age. The sons and daughthers considered for this

[20] Among these are: length of the residence; the total number of the residents in the settlement; how old the settlement is and how many tappers have occupied it. Also, I considered household membership in rubber tapper associations, rural workers union and cooperatives. Moreover, I considered household head access to government credit. In terms of location, I considered the distance to market measures and different transportation means (walking time, animal time and truck time) and types of access to the market (trail, ramal and road). Some of the variables that were theoretically important, but did not show stronger statistical significance were excluded. Others, that were less theoretically important, but presented a much stronger significance, were kept in the model.

analysis are the ones who are fifteen years old or older. I considered that sons/daughters over this age start to make an important contribution to the family labor force and thus influence productive land use actitivities. Besides the household-head, the most important factor for labor force is the number of sons of age fifteen and older to tap rubber or to help clear land. This is because the availability of this manpower influences the area of land the family can exploit for rubber or put into pasture or field crops. For example, rubber and Brazil nut activities require less labor input, while agriculture activities require more labor input. As noted in table 5-1, the household head had on average 2.03 sons of age fifteen years old or older, and 1.62 daughters of age fifteen years old or older.

There are structural forces outside the household level caracteristics that are important in determining land use activities. The location of the household itself in each seringal might present some degree of influece in land use activities. However, the location of the seringal as a whole is a more poweful structural factor. Therefore, I conceptualized location at a seringal level. The core aspect here is that the location of the seringal influences land use activities since it involves aspects of market-distance and transportation costs that may reduce some land use activities and stimulate others. A tapper settled in a seringal closer to towns often presents different activities from the tappers who live farther. For example, more distant seringais tend to influence tappers to emphasize rubber and Brazil nut activities with high value relative to weight and bulk over less easily transported agricultural products.

The four study seringais present different characteristics in terms of location. Seringais Paraguaçu, Humaita and Porongaba are road-accessed seringais, while seringal Filipinas is far way from the road and is easier accessed by river in the Xapuri region. It is important to analyze land use activities in the seringal Filipinas compared to the other three seringais. I classified the seringal Filipinas as the reference category, as it represents most closely the scenario of the traditional seringal, being farther from the road, and having the bigger rubber production. In addition, I operationalized Seringais Humaita and Porongaba as a unit due to the fact that they border each other and I observed that they have the same land use characteristics, thus not affecting the analysis. The descriptive statistics show that of the 66 households in my sample, 30% were located in seringal Paraguaçu, 40% in the seringais Humaita and Porongaba and 30% in the seringal Filipinas.

5.5 Correlations Between Outcome and Independent Variables

Table 5-2 presents correlation coefficients between each land use outcome variable and every independent variable. Traditional forest activities variables have a strong correlation with each other. That is to say that households that tap rubber also tend to collect Brazil nuts. However, they differ when correlated with nonforest activities. Pasture and cattle have a strong negative relationship with rubber production, but this is less true for Brazil nuts, and these coefficients are not statistically significant. Also, Brazil nuts have a positive association with swidden agriculture and thus households that collect Brazil nuts tend to have swidden plots, but do not necessarily have pastures or cattle. In general, the traditional and non-traditional forest activities outcome variables exhibit the expected correlations.

As anticipated, the non-traditional activities have strong positive correlations with area deforested. It is not surprising that area deforested has a strong correlation with swidden and pastures as the area-deforested variable is equal to swidden plus pasture area. Similarly, area deforested is strongly associated with cattle. Since most of the area

Table 5-2 Correlations between traditional and non-traditional outcomes variables and household background, labor force availability and seringal location variables, CMER.

	Variables name					
	Rubber	Brazil nut	Area deforested	Swidden	Pasture	Cattle
Outcome variables						
Rubber	1.00					
Brazil nut	.303*	1.00				
Area deforested	-.190	.131	1.00			
Swidden	.104	.324**	.598**	1.00		
Pasture	-.254*	.018	.915**	.338**	1.00	
Cattle	-.247*	-.127	.540**	.105	.613**	1.00
Independent variables						
Household Background						
Migrant	-.287*	.186	.131	.268*	.099	.079
Age	.208+	.261*	.284*	.246*	.269*	.186
Labor force						
Sons	.026	-.053	.345**	.147	.355**	.339**
Daughter	.077	-.089	.103	.149	.047	-.063
Seringal location						
Humaita/Porongaba	-.331**	.392**	.205+	.267*	.176	.107
Paraguaçu	-.312*	-.782**	.022	-.242*	.121	.234+

+ $p < .10$; * $p < .05$; ** $p < .01$.

deforested is for pasture making purposes, it has a positive relationship with cattle. Also, swidden agriculture has a strong positive relationship with pasture, but not with cattle. This implies that households have increasingly transformed swidden plots into pasture, even when they do not have cattle. In general, the non-traditional forest activities correlations are all highly significant, except for swidden and cattle.

The forest activities variables (rubber and Brazil nut) have distinct correlations with the three groups of explanatory variables. Rubber production is negatively associated with migrants and also a weaker correlation with age, but still suggests that the older the head of household, the more rubber tapping activities are performed. In terms of location variables, rubber production tends not to be done by households that live in the seringais Humaita, Porongaba and Paraguaçu. In other words, the household head more engaged in rubber production tends to live in the seringal Filipinas. This reflects Filipinas's involvement with traditional forest-based economy. With Brazil nut activities, there is little correlation with migrant status, but it shows a stronger association with age, where the older head of the household tends to collect more Brazil nuts. In terms of location, seringais Humaita and Porongaba have a strong correlation with Brazil nuts, while seringal Paraguaçu exhibits a negative correlation. That is, households that collect Brazil nuts tend to be located in Seringais Humaita and Porongaba. In general, seringal Filipinas has lots of rubber tapping and less Brazil nut collectors.[21] Seringais Humaita

[21] Note that although seringal Filipinas is considered the more traditional seringal, it has less Brazil nuts production than seringais Humaita and Porongaba. It might be related to market distance factors. Distance to town is an important factor determinant of how many Brazil nut a family will collect. If there is no such nearby market, it is usually uneconomical to transport Brazil nuts because they are heavy and require more transportation structure. Seringal Filipinas is far from the road. Households in seringal Filipinas might be not as attracted by Brazil nut collection as the households in seringais Humaita and Paraguaçu. Having road access, households in seringais Humaita and Porongaba have more transportation facilities for Brazil nut activities. Also, it would be important to analyze other variables that consider ecological factors such as distribution and density, affecting the availabilities of Brazil nut trees in the reserve.

and Porongaba have less rubber tapping and more Brazil nut collectors. Seringal Paraguaçu, on the other hand, has less of both rubber tapping and Brazil nuts collecting.

Area deforested is strongly correlated with age of the household head and number of sons. That is, older households and households with sons tend to have larger area deforested. In terms of location, area deforested has a small effect in the seringais Humaita and Porongaba. This means that households deforest slightly more in these seringais than in seringal Filipinas. In general, area deforested is related to the age of the household head and male labor force availability.

Swidden agriculture has a strong association with the two-househod background indicators: migrant status and older households tend to have more swidden agriculture. In terms of the location, households located in the seringais Humaita, Porongaba and Paraguaçu tend to have much more swidden agriculture area than households in Filipinas.

Both pasture and cattle have a strong positive correlation with sons in the household, which demonstrates their role in terms of family labor force allocation. However, these variables differ in terms of age of household-head and location of the seringais. Pasture is positively associated with the age of the household-head, with older household-heads having more land into pasture. Cattle, on the other hand, are correlated with the location of the seringais. Only seringal Paraguaçu shows a correlation with cattle and thus in this seringal there are relatively more cattle raising activities than in the other seringais.

5.6 Analysis of Multivariable Regression Models

Table 5-3 presents the results of Ordinary Least Squares (OLS) models of rubber, Brazil nut, area deforested, swidden, pasture and cattle regressed on indicators of household background, labor force availability and seringal location. As noted earlier, I

Table 5-3 Multivariable regression models at rubber extraction, Brazil nut extraction, area deforested, swidden size, pasture size and head of cattle, CMER.

Independent variables	Model					
	Rubber (1)	Brazil nut (2)	Area deforested (3)	Swidden (4)	Pasture (5)	Cattle (6)
Constant	3.858*	2.146*	.563	-9.832	-.507	-1.528
Household Background						
Migrant	-.1.439	.795	.203	.294+	.222	.344
Age	6.035+	6.180**	1.248	1.012+	1.647	1.289
Labor force						
Sons	-.213	7.598	.138*	5.147	.200*	.367*
Daughter	.196	9.571	6.515	8.238+	4.163	-.110
Seringal location						
Humaita/Porongaba	-5.417**	-.409	.587*	.216	.937**	1.525*
Paraguaçu	-6.088**	-5.870**	.247	-.226	678+	1.676*
(Reference Filipinas)						
Adjusted R^2	.452	.638	.199	.191	.201	.185
F ratio	9.781**	19.775**	3.656**	3.519**	3.690**	3.421**

+ p < .10; * p < .05; ** p < .01.

considered several other explanatory variables. The problem with the multivariable model is that, due to the small sample size, I was only able to set six independent variables. These six variables were selected out of several potential variables that I introduced into the model. They were chosen because they proved to be statistically significant for at least one or two outcome variables and had theoretical importance. Other variables that are considered theoretically important but did not prove significant were not included in this model. Also, I used the same set of variables for all outcomes to facilitate comparisons among the models. In this way, I tried to develop a single set of variables that represented a stronger model overall. After this procedure, it became clear that I had a small number of explanatory variables that were stronger predictors of all the outcome variables.

The primary determinants of rubber production (model 1) involved the age of the household heads and location of the seringais. The model for Brazil nut (model 2) had similar significant variables, but differences are evident. Brazil nut has a stronger age effect, even bigger than that for rubber. The stronger age effect for Brazil nut is because it not only has a more stable market than rubber, but also requires less intensive labor force

The location variable is less important for Brazil nut than for rubber production. That is to say that rubber has a stronger negative effect with seringais Humaita, Porongaba and Paraguaçu, while Brazil nut has a negative effect only with seringal Paraguaçu. This seringal is located in the Assis Brazil region, where Brazil nut trees have lower density, leaving fewer options for residents to increment their forest production economy. None of the labor force availability variables show significant net effects on rubber tapping and Brazil nuts activities, which suggests that regardless of household background and location of the seringais, young residents are not engaged in traditional forest activities.

The area-deforested model (model 3) reveals a limited array of significant factors. The determinants of having area deforested emphasize the labor force factor and the location variable. Sons of the household head exert a strong and positive effect on area deforested. Therefore, the availability of sons of household head is important to having area deforested, a reflection of the high male labor demands in forest clearing, harvesting cash crop and processing land into pasture. The location factor has important effect in seringais Humaita and Porongaba and thus there are more non-traditional land use activities (swidden and pasture) driving deforestation in these two seringais.

In contrast, the determinants of agricultural production (model 4) accentuate the household background variables. Ages of the household head and migrant status are determinants of agricultural production. This basically indicates that older household-heads imply having a bigger family and they have tended to expand their agricultural production for family consumption. In addition, this demonstrates that migrant households have been more exposed to agricultural activities, while non-migrant households tend to engage in traditional forest activities. Moreover, model 4 presents two important factors. It is the only model in which daughters show effects on swidden agriculture, and location of the seringais present no significant effect on swidden activities. This demonstrates that daughters of household head give important contributions to swidden agriculture activities such as planting and harvesting crops. It also shows that agricultural production is practiced in all these seringais, which demonstrate its fundamental role as a subsistence activity.

The models for pasture and cattle (model 5 and 6) are stronger and have the same significant variables. Sons of the household heads exert a strong and positive effect on pasture size and number of cattle. This demonstrates that the availability of sons for labor is crucial to having pasture and cattle and suggests that expansion of nonforest activities will continue in these seringais, which tend to be carried out by the young residents. As conceptually proposed, pasture area and cattle raising activities are greater on the non-traditional seringais (seringal Filipinas was considered the closest one to the traditional seringal). Thus, it demonstrates that households settled in seringais with better road access and closer to the towns have been more involved in non-traditional forest activities. In general, the land under pasture and cattle raising activities depends on the availability of labor and the location of the seringais. In this model, household background variables were unimportant to pasture and cattle, implying that non-migrant households are as involved in pasture expansion and cattle raising as migrants.

5.7 Discussion

This chapter examines how some of the household characteristics and rubber estate location determine land use activities among rubber tappers in four seringais of the Chico Mendes reserve. The findings from these empirical models that account for household background, labor force availability and seringal location show that these factors exert a significant effect on land use activities. Household background variables have effect on rubber and Brazil nut extraction, as well as swidden agriculture. Labor force availability variables have significant effects on area deforested, pasture and cattle. Finally, location of the seringais has important effects on almost all outcome land use variables, excluding the swidden model.

The findings of age of household head and labor availability call attention to the age structure of the rubber tapper families, showcasing differences in labor allocation at the household level. It may be that heads of household are more involved in forest activities (rubber and Brazil nut) and the sons with pasture and cattle. Older household heads might have worked with rubber activities throughout their life cycle, and thus, although rubber production no longer has market stimulation like before, they continue tapping rubber because it is the practice of which they have the greatest knowledge and with which they identify themselves. If this interpretation is correct, older household heads will insist on continuing this activity if at all possible, even if they are not maximizing their income. However, it must be stated that this effect of older household heads with rubber activities might be because rubber activities requires heavy labor and more specialized skills so that the younger residents are not as apt to develop this activity. Due to their skills with rubber, older household heads might have more profit from rubber activities than non-traditional activities.

By contrast, the younger residents (sons of household heads) probably are relying less and less on a purely extractive strategy and more on farming systems. If the younger residents continue to go through their life with the same land use practices, their future trajectory as “rubber tappers” will be very different from that of their parents, and we might see increases in the extent of land under pasture in these seringais. The distribution of different activities among members of the rubber tapper families shows that people have to make choices, which may favor one component of production at the expense of the others. The land use strategies chosen reflect the families’ judgments of the available options, taking into account immediate necessities, market criteria, food security as well as personal preferences.

The location of the seringais is an important factor differentiating diverse livelihood activities. I assume that the seringais, with the exception of Filipinas, have better market integration, which might lead to better prices for cash crops and livestock. This in turn should increase forest clearance. Of course, the forest clearance decision is based on the expected increase in family income, although I did not analyze data about prices and income. Market integration in the long run may foster even more forest clearance in these seringais, if such integration does not result in increased levels of land use regulation enforcement. While market integration and increasing household income may increase forest clearance, the rate at which that occurs could dramatically change rubber tappers' relations with forest resource.

Given the extremely large territory of the Chico Mendes reserve, there are contrasted interests among rubber tapper communities living in different part of the reserve. Development programs in the reserve tend to benefit these communities that live in seringais located closer to the towns. It seems that the rubber tappers settled in these seringais not only have more development benefits, but also will not be able to enforce the reserve's land use regulation, as shown by the increasing deforestation rates. In this case, reserve development programs and land use regulation might need to be approached as a way to benefit a particular tapper community without affecting negatively the interests of others that also deserve attention. I suggest two strategies that might indicate a role for development activities and land use regulation.

Development initiatives for rubber tappers should first consider the different zones in the reserve. Rubber tapper communities settled in seringais closest to the cities should receive development incentives to stimulate traditional forest activities. Tappers focused on agriculture and livestock raising should be stimulated to occupy more distant seringais, with the stimulus of having more land for deforestation. If these approaches do not have any repercussions on the deforestation scenario of today, at least deforestation levels would be more dispersed, which would have some ecological benefits, and rubber tapper communities would be more equally distributed in the reserve's territory, resulting in less pressure on forest resources. Both are unrealistic suggestions.

The deforestation situation in these seringais will pose a serious dilemma for land use regulation in the reserve. The forest reserve quota legally required on private property in Amazônia currently is 80%, although it is in a huge debate for changes in the Brazilian congress. Due to extractive reserves' importance as forest conservation tools, rubber tappers are allowed to deforest only 10% of their settlement. Some seringais are increasingly deforested areas and will reach the limit quota in few years. In this context, rubber tappers who are supposed to be forest conservationists might reach the same level of deforestation as other non-traditional rural workers on private property in Amazônia, such as the colonists. The difference is that tappers have the privilege of holding hundreds of hectares of land. In this context, it will become increasingly hard to justify the extractive reserve model, if rubber tapper communities cannot keep low deforestation rates. If these study seringais exceed their deforestation legal limit, they might have to be taken out of the reserve territory and transformed into another land use strategy, and thus more people would have access to land.

Cattle and pasture expansion in these seringais will pose a difficult problem for rubber tapper communities in the near future, and one that will call for political decisions. The initial concept of the reserve, which advocates finding ways to alleviate poverty without degrading the environment, could be a guide to understanding the new decisions that rubber tapper communities are making in terms of land use and to formulate development policies that regard tappers' modified socio-economic development perspective and still guarantee forest cover. So far, there are no major concerns from the Brazilian Environmental Agency (IBAMA) and rubber tapper organizations about the pasture and cattle expansion in the reserve.

Some principal factors that fall outside of this analysis that influence the tappers' production system are the improvement of state's transportation networks, and the emergence of autonomous tappers who are more socially and politically organized, and less dependent on the traditional *aviamento* system. Experiencing less of the inhibiting effects of the greater isolation and the strict traditional marketing system as in past decades, many tappers now have growing opportunities and incentives to maximize their production. Additionally, extractive lands now have more pressure from alternative land-uses such as ranching and agricultural colonization than ever before.

Different combinations of land use patterns and diverse social relations are part of the rubber tapper communities of today. A broad range of social and environmental factors determines their diversified production systems. The household characteristics and seringal location factors discussed in this chapter offer important insight into land-use strategies at the family level, representing an integral fraction of these determinants. Socio-economic criteria, such as access to markets, development initiatives and policies, population dynamic, land use regulation, and so on, need to be broken down into smaller units so that a complete but detailed view of the actual dynamic of land use is obtained for these seringais and the reserve as a whole. In chapter 6 I will discuss some key land use changes taking place in these seringais in a long-term perspective, and their role in deforestation levels in the reserve and in the study seringais.

CHAPTER 6
DRIVERS OF LAND USE CHANGE IN THE CMER: Population and Settlement Dynamics, Changes in the Production System, and Social Organization

6.1 Introduction

In the previous chapter, small-scale changes in land use at the household level were assessed in order to identify household factors that drive these land use changes. In this chapter I will explore primarily socio-economic factors that drive land use change at a *seringal* and reserve level.

Socio-economic drivers of land-use in small forest dwelling communities are still little understood for large parts of the Amazon Basin, compared to studies of large-scale development projects. In most cases, studies with forest dwelling small-holders have been unable to incorporate an integrated perspective of changes in land use cover and particular socio-economic factors. In the case of the C MER, although a study has established deforestation rates and patterns (Sassagawa 1999), the underlying reasons for changes in land-use and land-use decisions have not been examined. As the establishment of Extractive Reserves reaches 10 years, it is important to breach this gap and determine what is driving land-use change in extractivist communities at the threshold of the development frontier. This is of particular importance because the appeal and an often-cited justification of extractive reserves lies in low deforestation levels and the conservation of forest resources. Thus, understanding what drives deforestation in those areas that have experienced higher deforestation is a timely and fundamental endeavor, that will hopefully aid in the prediction and planning of land-use in the extractive reserve.

The reasons for increased deforestation rates in concentrated areas of the CMER most likely lie in a variety of factors. A broad range of factors influences land-use choices and the rubber tappers' quality of life to some extent or another. First, with the demarcation of the extractive reserve, more families may have moved into the area searching for secure land tenure. This secured land tenure has also led people to invest more into long-term forms of land-use which include increased agricultural activity and cattle holdings and as well as a stronger investment into structural elements of their settlements, such as fences, houses and storage facilities.

Second, recent development projects and credit programs have encouraged residents to diversify their land use activities toward agroforestry and cash crop agriculture as well as small scale cattle raising, activities that result in a increased cleared areas in the *colocações*. Changes in the production systems are also a result of decreased investment into the extraction of forest products. As discussed in the previous chapter, the price for rubber has decreased significantly in the last decades and many people have abandoned rubber tapping in favor of non-extractivist forms of land use. Brazil Nut extraction, though more profitable than rubber, also has decreased. Third, the influence of the rubber tapper social movement and its organization for productive activities needs to be stressed, as many new opportunities and contacts are accessed through the various organizations, which increasingly mobilize production processes and link individual residents to larger development and other government projects. Fourth, more localized variables that can affect land-use choices are the relative proximity to towns, means of transportation, access to markets, and exposure to cattle ranches and colonization projects, as is the case for the four study seringais.

The present land-use patterns and decisions are also embedded in the particular history of each seringal and its role on the development frontier and the rubber tapper resistance. Seringais at the periphery of the reserve that had part of their land transformed into cattle ranches or adjacent to those are more vulnerable to fast land use changes. Overall, deforestation in these areas occurs as a combination of many factors, which influence each other. It is impossible to pin down increased deforestation levels as the result of a single factor.

All of these variables cannot be studied simultaneously; therefore, I will concentrate the analysis on three main factors that influence land use changes in these seringais. First, I will analyze the population and settlement dynamics in the reserve as a whole and the study seringais, which may lead to an understanding of why these four *seringais* not only have the highest population growth but also have experienced the most drastic land-use changes. Second, I will discuss the changes in the rubber tapper production systems in order to explore the economic factors that are leading to land use changes. Finally, I will analyze the social organization model in the reserve and how it may influence land use change through different levels of organization of the communities, political influence of the rubber tapper leaders, and the Residents' Associations in these *seringais*. This chapter will mostly focus on an analysis of the IBAMA census data of the reserve in three different periods (1995-1998-2000).

6.2 Population Dynamics in the CMER

According to data from the census carried out by the Brazilian Environmental Agency (IBAMA) in 1998, the total number of residents in the reserve is approximately seven thousand people, of which 44.8% are female and 55.2% are male. 63.3% of the population is under twenty-one years of age, which demonstrates that the reserve has a very young population. Although the reserve has territory in six municipalities of the state, the majority of the reserve population is located in three municipalities along the BR-317 highway: Xapuri, Brasiléia and Assis Brasil.

Figure 6-1 presents the population dynamic of the reserve in these three municipalities from 1995 to 1998. Xapuri, which comprises an area of 3,208.91 km^2 in the reserve, concentrates most of the residents of the reserve. In 1995, Xapuri had 3,660 residents (58.5% of the total reserve), decreasing to 2,612 (43.3%) in 1998, which represent a decrease of 28.6%. Despite this decline, it still holds most of the population of the reserve. On the other hand, Brasiléia, which comprises 1,330.30 square kilometers, had an increment in its reserve residents from 1,338 (21.4%) in 1995 to 2,120 (35.2%) in 1998, representing an increment of 36.8%. Although this data suggests that there are significant changes in population levels in the two municipalities, this is in part an artifact of an administrative change of 2 seringais from Xapuri to Brasiléia between 1995 and 1998 (personal communication Josémar C. CNPT/IBAMA 2001), demonstrating the difficulties of conducting an analysis at the municipal level. Assis Brasil, comprising 2,158.30 square kilometers of the reserve territory, maintained approximately the same population size of 1,300 (21.5%) residents in the two periods. Overall, population levels in the reserve have stayed approximately the same in the period 1995-1998.

Nonetheless, this very general data does not reveal more subtle changes in immigration and exodus in the reserve, as well as internal migration from one seringal into the other or from one colocação to the other. A true understanding of this dynamic can only be gained by examining the records of all the settlements in the reserve over time, or at least looking at particular seringais, as does this study.

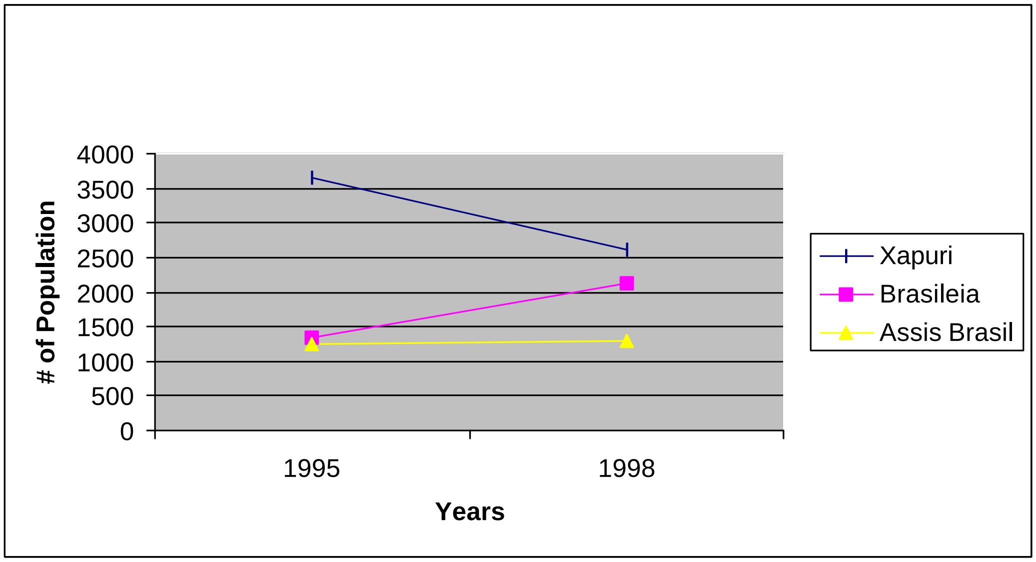


Figure 6-1 Total population of the CMER in three municipalities

Traditionally, rubber tappers have always moved around because their *patrão* determined this in the old *seringal* times or later on by their own volition. Mobility has always been an important element in rubber tapper existence be it due to the old rubber system or the more recent insecurity in land tenure. Also, in recent decades with the uncertainty of the extractivist economy, many people have moved within the region and from forested areas to urban areas. Different fluxes of migration characterize the area: exodus from the *seringal* into the urban centers, immigration into the CMER from urban areas, and migrations at a local level from one seringal to another.

Particularly, Xapuri and Brasiléia are towns that have increasingly accommodated rubber tappers. It seems that the population in the Xapuri area of the reserve has decreased more than Brasiléia has increased, indicating some kind of out-migration from the area into urban centers. Xapuri might be particularly vulnerable to exodus because it is closer to the state capital Rio Branco than the other municipalities, and rubber tappers have better transportation access to the area. In addition to out-migration, many families in the nearby *seringais* (e.g., Dois Irmãos) have close relatives in Xapuri and thus spend time in town, resulting in almost double residency in and outside the reserve. These people often alternate time spent in the city and the *seringal*.

While some people have moved out of the area others have moved into or returned to the reserve for lack of quality of life on the urban periphery, and unemployment in the cities. Before the establishment of the reserve many families had to leave their settlements in this region due to encroaching cattle ranching in the boundary of today's reserve. With the establishment of the reserve, many of these families that had moved to the cities gained right to the land and thus some slowly started returning to the *seringal*, or if they opted for staying in the cities, passed the settlement rights to relatives. The families that returned to the forest realized that living in the reserve areas granted them not only the rights to the land, but also to several benefits from the government agency, responsible for the reserve management.

Assis Brasil, the most remote of the three municipalities, might have maintained its relatively low population size in these two periods due to its further isolation. In the *seringais* of this region, the influence of urban lifestyle on the reserve residents is less prevalent. This is because Assis Brasil is a very small and remote town that does not offer much better social services than those that are offered in the reserve, with the exception of health care. In addition to the distance, the road access to Assis Brasil from Brasiléia and Rio Branco, is very precarious and during the rainy season becomes muddy and practically impassable. However, this road currently is being paved and should be completed in 2002.

In terms of internal migration, Brasiléia and Xapuri do not differ significantly to influence households to move to one or another territory in the reserve. Both cities are close to each other, and many tappers that live in the Brasiléia region may interact and travel to Xapuri and vice verse depending the distance inside the reserve and the means of transportation available. While Brasiléia is slightly larger, basically, these cities have the same market options. (i.e., cooperatives to sell their production) and also offer the same goods that they need in their household. However, factors inside the reserve might influence a household more to migrate to another settlement, independently of the municipality area. One of the factors might have to do with household consumption, such as game and hunting areas. If game resource become scarce a household is likely to move to another settlement. In addition, rubber tapper families tend to live closer to their relatives. If the decision of the household head is to leave, the son/daughter that live closer to them might decide to move as well. Thus, as overall population in the reserve has remained approximately the same, migration occurs both into and out of the reserve, and people move within the reserve, it is hard to determine particular migration patterns and population dynamics at a reserve scale and municipality.

When considering deforestation in these municipalities, it is also important to look at population density per area and the link of population to deforestation rates. Both population density and deforestation rates vary greatly across these three municipalities. In 1998, Assis Brasil had the lowest population density with 0.60 persons per square kilometer, followed by Xapuri with 0.81 persons per kilometer square. Brasiléia, on the contrary, has a population density of 1.60 person per kilometer square, almost double that of Xapuri. According to Sassagawa (1999), the Xapuri area presents the highest deforestation percentage in 1998, although it has shown a decrease in population, resulting in a higher per capita deforestation level. Thus, even though the population has decreased, or rather a smaller number of seringais belong to this municipality, the deforestation rates continued to increase the region.

Overall, the relationship between population growth and deforestation rates is low at the scale of municipalities. This is probably due to the large extent of each of these areas and the very distinct population density in different parts of the municipalities. The northernmost and remote areas in the Brasiléia, along the Iaco river has few households and immense areas that are uninhabited, while the southern part holds a high population density, with *seringais* linked to roads and closer to the city. Similarly, higher levels of deforestation are concentrated in particular zones of the reserve. Deforestation at this level appears to be driven by the increases of population in concentrated areas of the reserve, which would require different scale of analysis. Thus, to understand it, we need to look at different scale processes operating deforestation in the reserve. In the next section I will present a *seringal* level analysis of population grown and deforestation rates, for those seringais with particularly high deforestation rates in the reserve.

6.3 Population Dynamics in the Study *Seringais*

Figure 6-2 demonstrates the changes in rubber tapper populations in the four study seringais from 1995 to 2000, as obtained from the IBAMA census records. In general, the number of residents by seringais has increased constantly from 1995 to 1998 irrespective of the municipalities where they are located. In the seringal Paraguaçu the total number of residents was relatively high, with 221 people in 1995 rising to 290 residents in 1998, presenting an increase of about 31% in the population growth. Similar population growth has taken place in the seringal Filipinas, the most populated of the four study seringais. In 1995, it had a population of 295 people and in 1998 it reached a total of 378 residents, demonstrating an increase of 28%. Seringal Humaitá had a population of only 53 residents in 1995, reaching a total of 96 residents in 1998, representing in an impressive increase of about 81% in the population size.

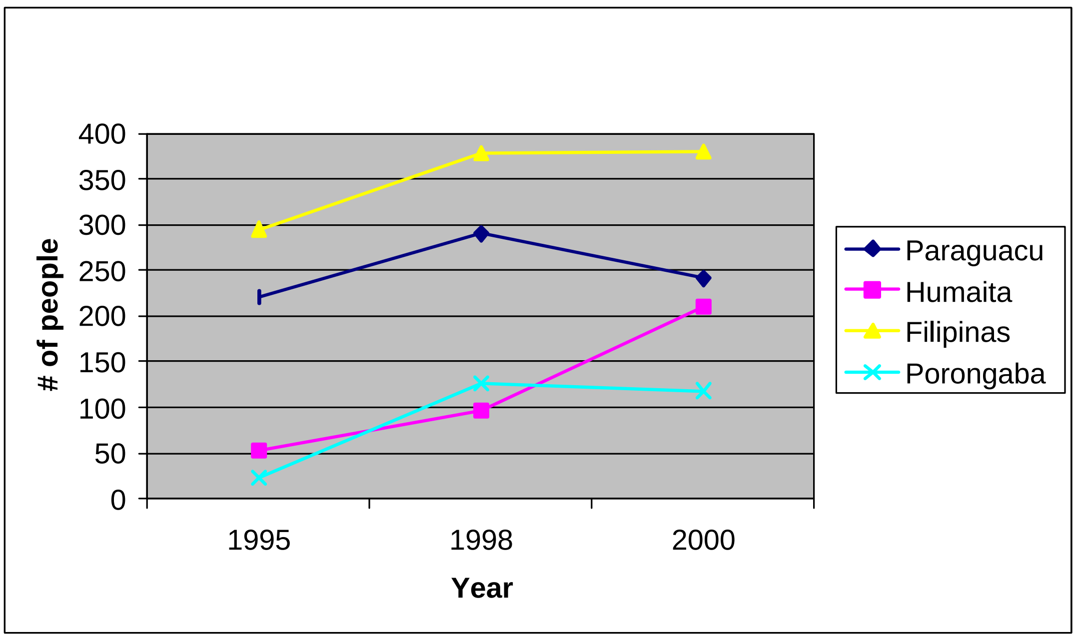


Figure 6-2 Total population in the four study *seringais*

The highest rate of growth occurred in the seringal Porongaba, which in 1995 had only 23 residents, growing to 126 in 1998, an increme nt of about 447%, although overall population density is lower compared to the other study seringais. It is clear that the period of largest population growth was from 1995 to 1998, with the exception of seringal Humaitá. Here, population growth continued through 2000, reaching a total of

210 residents, which represents an increment of about 118% compared to 1998 and 296% in relation to 1995. While both Porongaba and Filipinas *seringais* maintained approximately equal population levels from 1998 to 2000, population levels decreased significantly in the *seringal* Paraguaçu, by about 17%.

Various factors contribute to this increase in population in these four seringais. Immigration of former and new residents from urban areas as well as rural areas close by, play a important role in increasing rubber tapper population levels. More significant, the move of CMER residents from remote areas to more accessible areas such as the four study seringais is an important factor. It can be argued that rubber tappers who live in more isolated areas may be more likely to migrate to areas near cities, in part because they may have lower income levels. In the these four seringais the increase of population occurs partly because many families left isolated deep forest seringais of the reserve and settled in more accessible. Table 6-1, which presents data from my own sample in these seringais, shows that the largest proportion of the household heads (39.4%) have migrated from other seringais in the reserve. These household heads had frequently migrated from the more isolated, deep forest *seringais*. For instance, the seringais Amapá and Guanabara in Brasiléia, despite being the biggest seringais in the reserve and the ones with the largest rubber production, experienced severe out migration as rubber tappers faced great economic difficulties due to the decline of the rubber price. With the falling price of rubber, these families had little to sell. Moreover, there were fewer *marreteiros* or traveling middlemen from whom they could buy dry goods and sell their production, forcing them to move into other areas with more services closer to the cities, such as the four study seringais.

Table 6-1 Previous residences of the households in four seringais in the CMER

Locations	Seringais				Total	
	Filipinas	Humaitá	Porongaba	Paraguaçu		
	N°	N°	N°	N°	N°	%
Different seringal	7	3	4	12	26	39.4
Other location*	1	6	7	2	16	24.2
Other settlement in the same seringal	7	2	1	4	14	21.2
City	2	--	2	2	6	9.1
Always lived in the same settlement	2	--	2	--	4	6.1
Total	19	11	16	20	66	100

* Households have lived in one of the following: colonization projects, ranches, and Bolivia

In addition, as showed in table 6-1, a large part of these residents (24.2%) came from other locations outside the reserve, basically from colonization projects, and cattle ranching areas. To some extent, colonists that hold land in the settlement projects along the road also have a settlement in the reserve, in the seringais bordering the settlement projects, which may be occupied by a family member. This is the case of the seringal Humaitá, where sons of colonists leaving the settlement project bordering the reserve, have moved into the reserve. Although the resident's association has the role of monitoring the entrance of new residents into the reserve, it is very limited in controlling these residents.[22] These new "rubber tappers" although aware that they have moved into the reserve, continue the same land use patterns as practiced by their parents in the

[22] The reserve residents Associations are legally responsible for the entrance of new residents into the reserve, according to the Utilization Plan. However, they are very limited in monitoring it, because the residents who want to leave can sell their settlements to anyone. The entrance of new residents is supposed to be first approved by the communities in each seringal and then be approved by the Association. Rarely is this process followed in the seringais because of political interests of the leaders, family ties, and lack of Association capacity to monitor the reserve.

colonization projects. Therefore, these new kind of neo-*seringueiro* residents might have influenced land use change in this *seringal* in particular as well as others in this region.

Another important factor influencing population increase in these four *seringais* is the return migration of families that had to leave their settlements in the late 1980s, mostly in the Brasiléia region. For example, in the seringal Porongaba, out of about 20 families that lived in this seringal in the late 1980s, only two families refused to leave their home when they were faced with encroaching ranching in the region. With secured land tenure through the establishment of the reserve many families retuned to their settlements after living in another seringal or in the nearby city.

Another aspect that needs to be taken into consideration is the time of residence of households in the study seringais. Table 6-2 shows that most residents in these four *seringais* are relatively new in their settlements; 63.6% have lived in their *colocação* for ten years or less. This demonstrates the constant population dynamic of rubber tappers families in these seringais and in the reserve as a whole since these data follow the same trends of socio-economic data of the entire reserve. For example, a study in 1998 determined that when the reserve was established only 35.4% of the current households were already living the Xapuri’s area of the reserve, while 40.3% and 50.4% of the households where already settled in Brasiléia and Assis Brasil, respectively (ISPN 1998). The same study determined that approximately 23.9% of the reserve residents had worked or lived in the cities. In Xapuri and Brasiléia 27.1% and 26% respectively of the population had done so, while in Assis Brasil only 7.9% had spent time in urban areas.

Table 6-2 Time of residence of households in the study seringais, CMER

Years	Seringais				Total	
	Filipinas	Humaitá	Porongaba	Paraguaçu		
	N°	N°	N°	N°	N°	%
1-10	13	8	9	12	42	63.6
11-20	3	1	3	6	13	19.7
21-30	1	2	--	2	5	7.6
31-40	2	--	3	--	5	7.6
41-50	--	--	1	--	1	1.5
Total	19	11	16	20	66	100

6.4 Population Density and Deforestation in the Study Seringais

The four study *seringais* are similar to each other in terms of population increase and are not representative for general trends within each municipality. Within the reserve and within each municipality they represent seringais with relatively high population density. Some *seringais* in these municipalities, although being bigger in size than these discussed here, have lower population density. Therefore, population density seems to be a matter of location. The four study *seringais* are located in the southern boundary of the reserve, with relatively easy access to roads and transportation. Generally, the further the *seringais* are from roads and urban centers, the lower the population. This trend seems to be strongly related to deforestation levels.

Table 6-3 represents deforestation levels and rates in the four study *seringais*. Although their area is quite different, the rates at which they were deforested are quite similar. *Seringal* Paraguaçu, in the municipality of Assis Brasil, has the lowest deforestation level of them all, although the rate of deforestation has increased tremendously in the 92-98 periods. The *seringal* Humaitá starts with relatively low deforestation levels in 1986, increases in 1992 and surpasses other seringais in terms of deforestation levels in 1998, mirroring the steep increase in population size it experienced. *Seringal* Porongaba had a relatively high deforestation rate from 1986 to 1992 compared to the other study seringais, but from 1992 to 1998 its deforestation rate was lower than the other seringais. Seringal Filipinas, with the largest population but little increase since 1998, experienced relatively high increases in deforestation rates until 1998, resulting in the second highest deforestation level among the study seringais.

Table 6-3 Deforestation levels and rates in the four study seringais

Seringal (over 6% of deforestation)	Deforestation/Seringal (%)				
	1986	Rate in 86 - 92	1992	Rate in 92 - 98	1998
Ser. Paraguaçú	0,62	0,17	1,62	0,85	6,70
Ser. Humaitá	1,13	0,30	2,93	0,84	7,95
Ser. Porongaba	2,27	0,30	4,04	0,52	7,15
Ser. Filipinas	1,96	0,28	3,62	0,66	7,55

Source: Sassagawa, 1999.

These data seem to suggest that there is a correlation between rising population levels and deforestation rates in these four seringais. However, this relationship is not a 100% clear one. In figure 6-3 one can detect a positive correlation, although a weak one. Compared to the municipal level though, the relationship between deforestation rates and population density is stronger. Possibly, to demonstrate this relationship more clearly the sample size needs to be larger and various types of seringais might need to be compared to be able to associate low deforestation rates with low population densities and high deforestation rates with high population densities. In addition, even at the seringal level a lot of heterogeneity exists between different *colocações*. Possibly, a comparison of different areas within seringais or at the colocação level might be more appropriate to irrefutably establish this relationship.

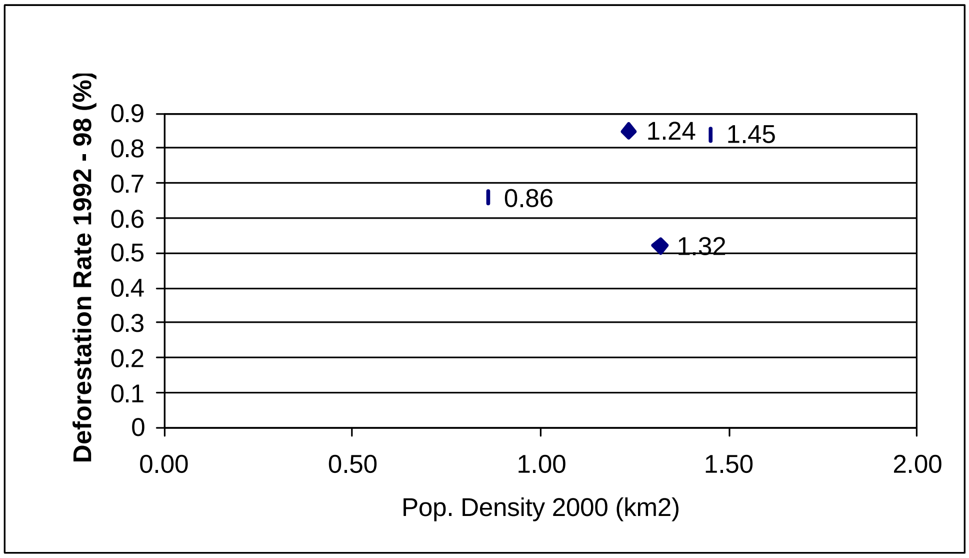


Figure 6-3 Relationship of deforestation rates vs. population density in the four seringais.

Land use changes in these seringais, then, is very likely to have been influenced by rising population levels in the area, although in combination with other factors. These *seringais* are attractive to new residents because they are closer to the cities and can be accessed by road, possibilities that do not exist in more remote areas. This proximity allows income generation with products other than rubber. These new forms of income generation are likely to involve those that change forest cover more significantly. Nonetheless, while the analysis of the population growth presented here suggests that it has affected land use changes in the seringais, other socioeconomic and ecological characteristics of the area need to be taken into account for a more complete understanding of their land use dynamics in recent years.

6.5 Settlement Dynamics in the Study *Seringais*

Not only have population levels changed within the reserve and particular *seringais*, but also the settlement dynamics and distribution have changed in recent years. Today, with the diversification of land-use activities, it is exactly at the landscape level of individual settlements that most of the new land-use decisions are made and carried out. Therefore, apart from looking at population levels per se it is important to examine increases in settlement numbers within the reserve and the study areas.

Figure 6-4 shows the number of settlements in the Reserve. In the 1995-1998 period the total number of the rubber tapper settlements in the Xapuri area was 681 (62% of the total reserve) in 1995 and 507 (45.9%) in 1998, followed by Brasiléia, which had a total of 219 (20%) in 1995 and 369 (33.4%) in 1998. However, similarly to the population data, the colocações in the *seringais* that were changed from Xapuri to Brasiléia between 1995 and 1998, also changed. Thus, the decline and increase for Xapuri and Brasiléia respectively are less significant than they seem according to this data. As for Assis Brasil, it had a total of 197 (18%) in 1995 and 228 (20.7%) in 1998, which shows an increase of 13.5% in the number of settlement. As noted early, Assis Brasil had presented the same population size in the period 1995-1998; however, this area has had an increase of 13.5% in the number of settlements within the reserve.

Settlement expansion follows the same trends with the population when it is looked at a municipalities level. That is to say that in these three municipalities settlement number has a direct relation with the population trends. But a few new questions arise. Are brand new settlements being opened? That might be the case if new residents are migrating to the reserve. Or are the oldest settlements being subdivided due to family size? In this latter case, settlement dynamic is not related to migrant population in these

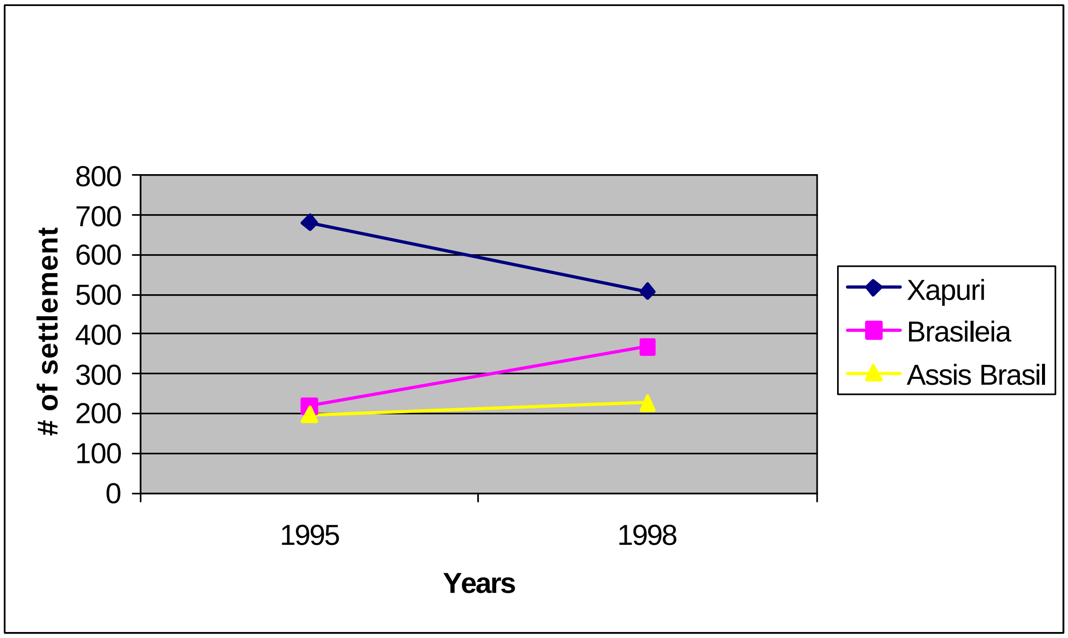


Figure 6-4 Total number of settlements in three municipalities of the CMER

areas. In the following we will look at settlement expansion at a *seringal* level and try to examine the implications that these factors conducing the increase in settlement number may have for deforestation in these *seringais*.

Figure 6-5 shows the number of settlements in the four study seringais. Overall, the number of settlements in these seringais has increased continuously, with the exception of Paraguaçu, which decreased from 1998 to 2000, and Porongaba that remained constant from 1998 to 2000. Overall, all four areas experienced the greatest increase in settlement from 1995 to 1998. The seringal Paraguaçu in 1995 had 33 settlements, increasing to 52 in 1998, which represents an increase of 57.6%. In the same way, seringal Humaitá went from 10 settlements in 1995 to 23 in 1998, showing an increment of 130%, and seringal Filipinas, with 52 settlements in 1995, reached 63 in 1998 increasing by 21.15%. Only seringal Humaitá and Filipinas continued increasing the number of settlements in the entire period analyzed (1995-2000). The former reached a total number of 32 settlements in 2000, a total increase of 220%. The latter reached a total of 72 settlements, a total increase of 38.5%.

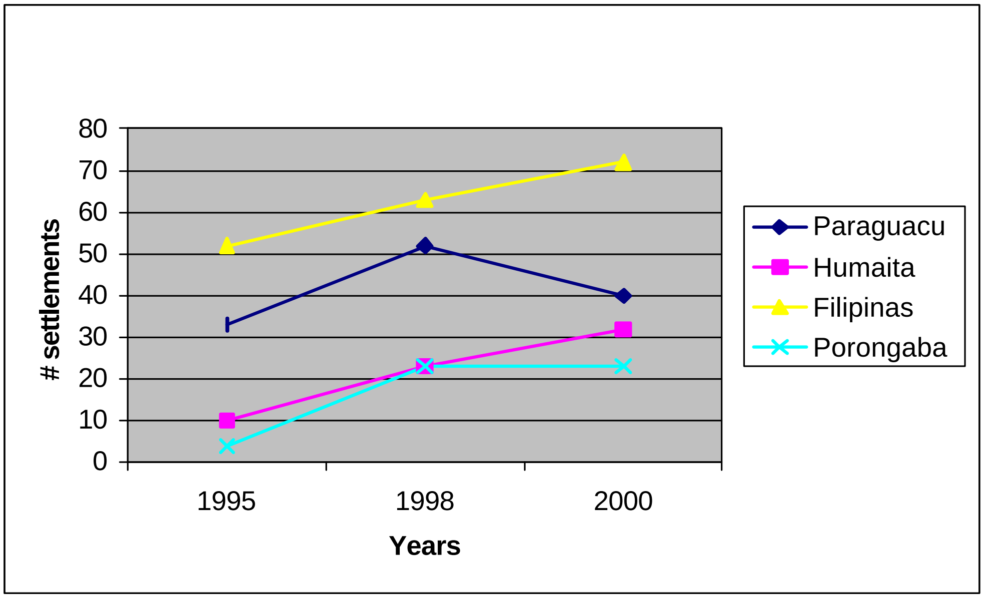


Figure 6-5 Total numbers of settlements in the four study seringais

As noted before, 39.4% (Table 6-1) of the residents in these seringais came from different seringais within the reserve. This speaks for the arguments that the increase in the number of settlements in these seringais is strongly due to migration from other areas. In addition to migration, which implies opening new settlements, settlement subdivision is another important factor responsible for settlement increase. Table 6-4 shows the number of settlement subdivisions in these seringais. Overall, it shows that 65.2% of the settlements have been subdivided, while 34.8% of the settlements have not been sub-divided in the last ten years. Thus, the great majority of settlements have experienced some type of subdivision.

Several factors influence the settlement subdivision in these *seringais*. As presented in table 6-5 the main factors is marriage of the son/daughter of the household head (50%). This happens with the increase of family size in a settlement or due to the marriage of the son/daughter of the household. In this case, they usually divide a settlement by opening a new clearing for the house where the new family will be settled close to their parents. This practice also can have a considerable impact on land-use change, since with the establishment of a new family, new shifting cultivation plots and other land use initiatives will take place to provide subsistence goods and income for the additional household.

Table 6-4 Settlements subdivision by seringais in the CMER.

Settlements Subdivision	Seringais				Total	
	Filipinas	Humaitá	Porongaba	Paraguaçu		
	N°	N°	N°	N°	N°	%
Yes	13	9	11	10	43	65.2
No	6	2	5	10	23	34.8
Total	19	11	16	20	66	100

Another factor influencing settlement subdivision is the intent of some households to expand the legally deforested area in the settlements. In settlements with an already elevated deforested area and household heads that are cognizant of limitations in the Utilization plan, they subdivide the settlements, making a new settlement that might be occupied by a family member, have a new registration of the settlement with the Resident Association and thus have more areas for deforestation in “two” settlements. Another factor that often influence subdivisions is when a son or another relative moves into the same *colocação* and gets allotted part of the land with some *estradas de seringa* and land. This relative might be moving from close by or might originate in the city.

Table 6-5 Reasons for settlement subdivision in four seringais, CMER.

Reasons for subdivision	Seringais				Total	
	Filipinas	Humaitá	Porongaba	Paraguaçu		
	N°	N°	N°	N°	N°	%
Marriage of son/daughter	10	7	6	10	33	50
Settlement has not been subdivided	6	2	5	10	23	34.8
To expand area for deforestation	2	--	2	--	4	6.1
Lease	1	2	3	--	6	9.1
Total	19	11	16	20	66	100

This section demonstrates that not only are population levels and population density affecting factors in land-use change, but the particular dynamic of settlement patterns at the local level are of great importance in understanding how deforestation comes about in these areas. This is an area that needs increased research attention given the current poor understanding of what a *colocação* is, how this concept works at a specific geographical scale, and legal issues such as *colocação* delimitations and deforestation levels. What happens at the *colocação* level is also of crucial importance in understanding land-use change and land-use decisions that are made at this level.

6.6 Changes in the Production System: Seringal Paraguaçu

In the four study *seringais* the extraction of non-timber forest products, mainly rubber and Brazil nut, has suffered a drastic decrease, while pasture creation, and thus, cattle raising as well as agricultural production has increased. In this section I will discuss the changes in the production system between 1995 and 2000, looking at the Seringal Paraguaçu as a specific case. I selected this seringal because this is far from the other three seringais and is located in territory of the more distant city (Assis Brasil). Thus, changes in the production system are expected to be greater at least on other two seringais (Porongaba and Humaita) than in seringal Paraguaçu.

According to census data, in 1995, the total rubber production in the seringal Paraguaçu was 14,180 kilos. In 1998, the total rubber produced was 12,040 kilos, representing a decrease of 15%. By 2000, however, rubber production has suffered a drastic decrease, with a total yield of only 2,110 kilos, a decrease of 85% in just five years. Cattle raising, on the other hand, in 1995 had a total number of only 129 heads, followed by an increase of 255 heads in 1998 or 98%. By 2000 cattle raising experienced a very large increase of 344 heads, presenting a total increment of 167% in five years. Figure 6-6 illustrates these changes by presenting the average proportional production increments of rubber, Brazil nut and cattle heads per settlements. The average rubber produced per settlement in 1995 was 429 kilos, decreasing to 231 kilos in 1998 and 52 kilos in 2000. Conversely, cattle heads had an average of 3.9 heads per settlement in 1995, going to 4.9 in 1998 and 8.6 in 2000. This figure illustrates that from 1995 to 2000 the average production of cattle per settlement increased by 120%, while rubber production decreased by 88% and Brazil nut production by 32% in the same period. In addition to increased cattle raising, agricultural production in that *seringal* has increased particularly in the second period analyzed (1998-2000).

Figure 6-7 shows the average proportional production increments of agricultural production per settlements. It is noted that the two crops with highest increase per settlement were beans and corn, which are those with higher commercial value in the city, as opposed to manioc and rice, which are often produced for family consumption. The average bean production per settlement was 113.85 kilos in 1995, increasing

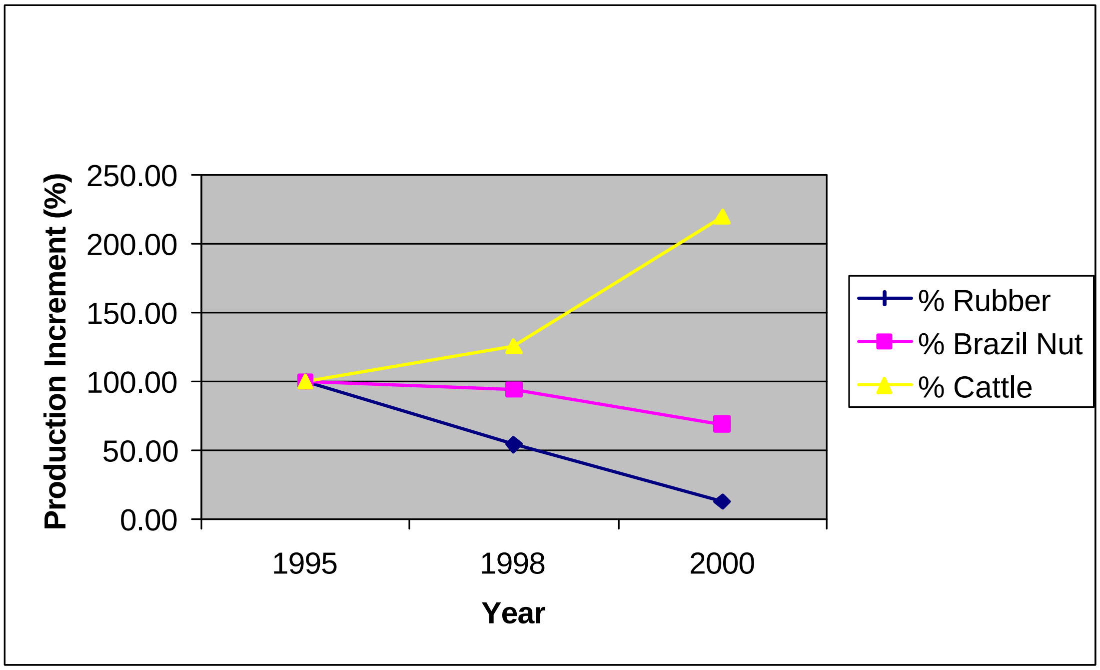


Figure 6-6 Average production increments per settlement in the seringal Paraguaçu

to 200.87 kilos in 1998, an increment of 76.43%. In 2000, the average was 577 kilos, an increase of 477.25%. Likewise, the average corn production per household was 244.23 kilos in 1995, increasing to 585.65 kilos in 1998, an increment of 139.8%. In 2000, the average corn production per settlement was 1044 kilos, an increase of 327.9% compared to 1995. Rice and manioc production per settlement experienced similar increases during the period 1995-2000. The former had an average production of 619 kilos per settlement in 1995 and reached a total of 1284 kilos in 2000, an increase of 107%. The latter had an average production of 226 kilos in 1995 reaching 440 kilos in 2000, an increase of 94%.

In general, these data demonstrate that until 1998, fewer households had increased their heads of cattle, but from 1998 to 2000 cattle raising increased in most settlements or the number of cattle in some households is very high, although I have no data on how many households are raising cattle. These data also show that by 2000 very few

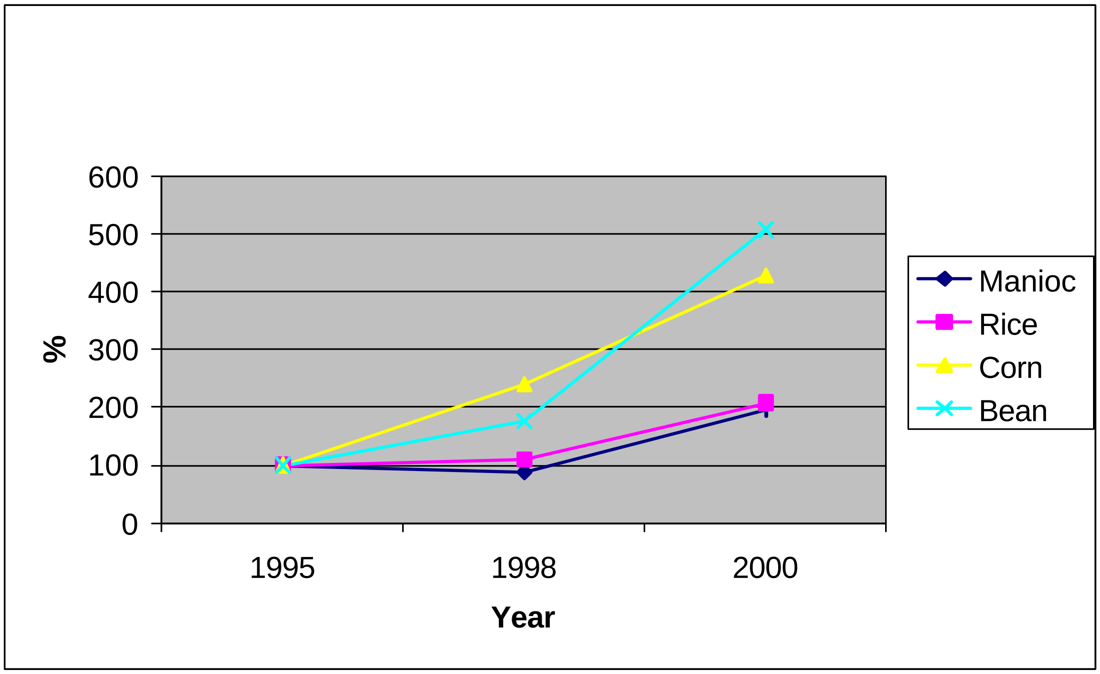


Figure 6-7 Average agricultural productions per household: Seringal Paraguaçu

households in that seringal were engaged in rubber tapping activities as their main source of income. Instead, rubber tapper families have opted for other economic activities that include cattle raising and agricultural production

The low rubber production can be explained by the extremely low prices for rubber, which are exacerbated by the fact that decades of low rubber prices have not motivated younger people to learn the skill of rubber tapping. Sons of the rubber tappers that do not know how to work with rubber, or have never done so, do not see the economic benefit of such a labor-intensive activity. Instead, they may engage in activities of agricultural production and livestock that not only require less labor but also are easy to transport and sell.

Overall the *seringal* Paraguaçu experienced an increase of all agricultural activity both for subsistence and commercial crops. The dramatic increase of cash crop production denotes the increased market orientation of the rubber tapper agricultural production. This focus on agricultural activities in the reserve is much more fixed than the traditional rubber extraction that depended on certain mobility. Also, the willingness to significantly invest in agriculture might also be a reflection of the more secure land tenure in the reserve and the lesser dependence on the *marreteiro.*

The implication of this change in land use choices is that, since agricultural production is increasing and land being increasingly converted into pasture for cattle production, the primary forest in these areas will be increasingly cut down for the new cycle of agriculture and then pasture. Often the profits from the sale of these agricultural products, together with others, such as small livestock (chicken), are invested in cattle raising, which for the residents represents an investment that can be easily changed into cash in times of hardship and new investments into houses, new activities and other assets.

6.7 Pasture and Cattle Raising Expansion in the Study Seringais

According to the State Production Secretary, the State of Acre has more than 1.5 million heads of cattle. In addition, data from the Fazenda Secretary of the state (SEFAZ) shows that cattle raising contributed over 50% of the State taxes collected in 1999. According to the 1996 Agro-pastoral census (IBGE) of the 23,788 small farmers (landowners or not) in the State in 1996, 81% had land converted for pasture and 55% had cattle. Yet the data from IBGE shows that between 1985 and 1996 there was an increase in 177% of cattle heads in the Acre's landholdings with less than 100 hectares.

These factors have a direct influence on extractivist communities in Acre. The CMER is located within the region with the most cattle raising and small farmers in eastern Acre. In fact, some *seringais* of the reserve border the biggest farm in the region. In addition, the access to the reserve area in many cases is by roads that lead first to the cattle ranch (e.g., *seringal* Porongaba) and colonization projects (e.g., seringal Humaitá). Thus, the development example that is set by the areas bordering the reserve is that of cattle ranching.

It is agreed upon in the Utilization Plan that rubber tapper families can have a small number of cattle in order to improve their daily diet and the transportation of their production. However, in the study *seringais*, an accelerated increase of pasture has taken place, compared to other areas of the CMER. The greatest increase is noted in the period 1995-1998. According to the indications in the census data, *seringal* Paraguaçu in 1995 has a total of 96 hectares pasture reaching a total of 210 in 1998, an increase of 118% in just two years. Likewise, *seringal* Filipinas had a total of 145 hectares of land in pasture in 1995, going up to 251 hectares in 1998, an increase of 73%. The other two seringais, Humaitá and Porongaba, which border each other, had the greatest increase in pasture in that period. The former had a total of 47 hectares of pasture in 1995, reaching a total of 208 hectares in 1998, an increase of 342%. The latter, had a total of 15 hectares in 1995, reaching a total of 109 hectares in 1998, an increase of 625% in land converted into pasture.

Figure 6-8 presents the average pasture area per settlement in the four *seringais* according to the census data. Seringal Paraguaçu and Filipinas present almost the same average increase in the 1995-1998 period, from 2.92 ha and 2.79 ha respectively in 1995 to 1998 and 4.5 ha in 1998. Seringal Porongaba had a constant increase in the period 1995-2000 presenting an average of 3.75 ha in 1995, 4.76 ha in 1998 and 6.83 ha in 2000.

The greatest increase was detected in the seringal Humaitá, which in 1995 had an average of 4.7 hectares per settlement, growing to 9.4 in 1998, followed by 9.7 in 2000.

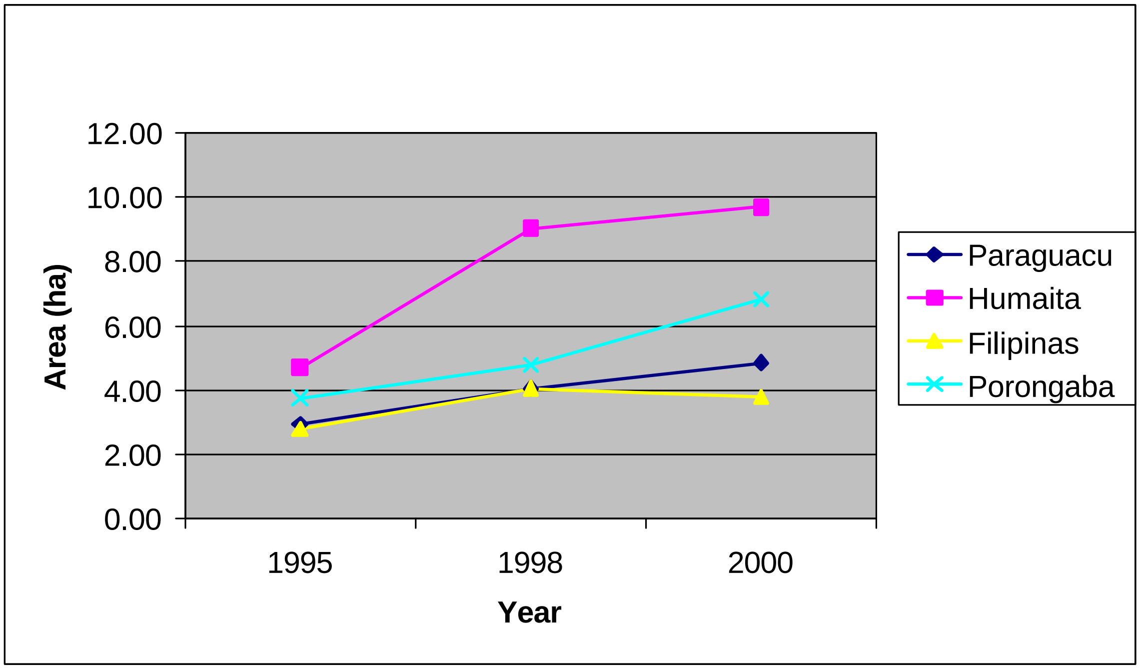


Figure 6-8 Average pasture area per settlement in the four study seringais

The perception among rubber tappers in these seringais is that the transformation of land into pasture will increase the value of the settlements, a perception that also is strongly defended by farmers in colonization projects in Acre. In many cases, to convert land into pasture does not necessarily mean that the rubber tapper will, in fact, raise cattle because it depends on the economic success of other productive activities, but it at least indicates their plans for future land use choice.

However, a confounding element in this study is that in some cases rubber tappers have recently moved to settlements in the reserve that might have pasture fields that were created by former residents of these settlements. Even though they have pasture, they may not plan on raising cattle or expanding pasture field. In that case, these residents have limitations in expanding land use, since the land designed for clearing by the utilization plan (10% of the settlement) is already compromised in pasture, precluding for instance new agricultural activities. In these areas of the reserve the recent productivity of extractivist and non-extractivist goods and the deforestation rates seem to mirror the development outside the reserve, though on a much smaller scale. The increase of pasture area and the declining importance of rubber production in these four seringais, and in the reserve as a whole, will greatly influence the future economic viability and conservation objectives of the reserve as well as with the very identity of "rubber tappers" as forest dwellers and conservationists.

6.8 Social Organization in the Reserve

In the historical rubber estates, the main organizational structure was the vertical hierarchy of patron-client relationships starting with the main boss (*seringalista*) and going down through intermediate bosses to the rubber tapper at the bottom. With the disarticulation of the rubber market, the collapse of the rubber market and bankruptcy of *seringalistas* who were increasingly replaced by cattle ranching in the region, rubber tapper communities started to slowly build their own social organization, mostly in the form of rural labor unions. In the region where the reserve was established, the main social organization was the rural workers union in Brasiléia and Xapuri, created in the 1970s. Through these, the rubber tapper community made a major step towards the consolidation of their social organization, creating the Rubber Tapper National Council in 1985, which led to the proposal of the extractive reserve.

When the Chico Mendes reserve was created the demand was voiced for a stronger social organization that would work together with the already established one, but would also have the role of administering and managing of the reserve together with the government agency. In this context, three Reserve Residents Associations were created in 1995, dividing the reserve into three major zones of representation corresponding to the reserve areas linked to each of three municipalities. These three Associations were the Association of the residents of the CMER area of the Xapuri (AMOREX), the Association of the residents of the CMER area of Brasiléia (AMOREB), and the Association of the Residents of the CMER area of Assis Brasil (AMOREAB).

The main goal of these Associations originally was to administer the Government project at a local level so that government resources could reach the communities in the reserve. The Associations then started to develop an affiliation process with the residents, which led to an improvement of the community organization with strategies of organization that now had to be approached in the reserve level, not at the seringal level as before. Through these organizations, many communities had access to better social services such as schools and health care, and received economic initiatives aimed at generating income such as training and equipment for particular economic activities, as well as transport support. However, the degree of association with these organizations differs in regions and from seringal to seringal. The levels membership with the associations are important indicators of the involvement of the residents in the rubber tapper social movement, in current projects, in new economic activities as well as credit opportunities.

Figure 6-9 presents the total number of residents associated with the AMOREX and AMOREB from 1995 to 2000. It clearly shows that there has been a constant increase in the number of people affiliated throughout the last years. For example, from

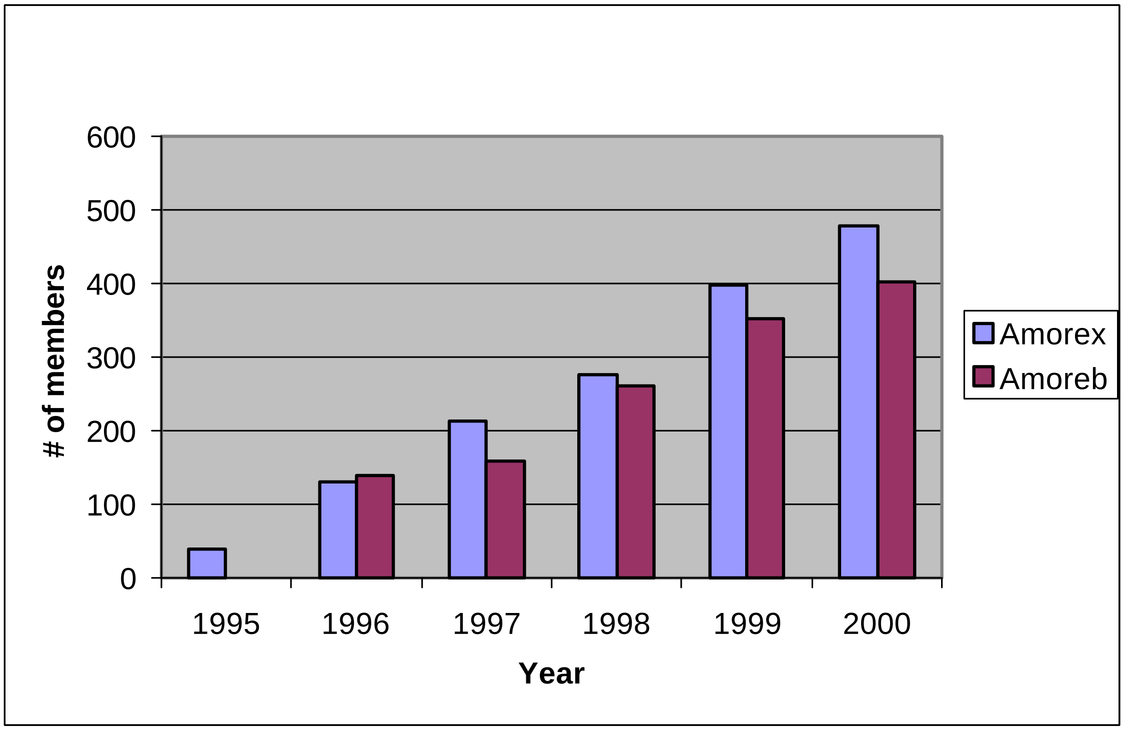


Figure 6-9 Total memberships in CMER associations

1996 to 2000 AMOREX grew from a number of 130 to 478 affiliated members, an increase of 267% in just four years. Likewise, AMOREB, which had an initial number of 139 affiliated in 1996, reached 403 members in 2000, an increase of 190% in the same period.

According to the Associations' directors, the increased affiliation was due to three main factors. First, women started to get associated due to government benefits for rural expectant mothers. Second, older residents also need to be affiliated to have access to a retirement plan. Affiliation means that they can prove that they live in the reserve, therefore are eligible for benefits. Finally, many rural credit opportunities for agricultural, pastoral and extractive activities are accessed through these associations.[23]

More recently, the new Acre government issued the “Chico Mendes Law” in 1999 that subsidizes rubber production throughout the State. To have access to this benefit and thus sell rubber production at higher prices, rubber tappers must be members of the Associations, which accesses these resources from the government and distributes them to tappers. As one can note, these reasons behind the expanding resident membership in the reserve are not necessarily directly related to land use change in the reserve.

However, the development projects and opportunities that are accessed through the social organization do indeed drive some of the more recent land use choices, such as increased agricultural production and in some cases cattle production (Prorural).

Also, once rubber tapper communities have access to different benefits, they also use them for more permanent investments into their settlements, which will likely involve increased agricultural production and pasture fields, whether they were originally intended for this purpose or not. Consequently, these government programs can directly affect the new land use choices practiced by the residents. As to the rubber subsidies, they strengthen a return to higher rubber production in the seringais. However, these subsidies alone will not have great impacts on land use choice, if the residents do not want to tap rubber as is the case with most young residents, or, like the elderly, see

[23]. In the Amazon the most important credit line is the FNO-Especial (*Fundo Constitucional de Financiamento do Norte*), federal funds that are explicitly intended for small holder credits in the Northern region of the country and are administered by the Amazonian Bank (BASA) in cooperation with extension and agricultural research institutions. For several years the main credit line accessible to rubber tappers was PRORURAL (*Programa de apoio a produção familiar rural organizada*), a general rural credit that finances agriculture, ranching and fishing and as well as processing facilities. Since 1997, the PRODEX program (*Programa de apoio ao desenvolvimento extrativista*) has been available explicitly for extractivist activities, such as rubber and Brazil nut extraction and agroforestry projects.

another source of income (e.g., retirement) as an alternative that allows them to invest their time in other activities that requires less intensive labor.

Generally, the *seringais* closer to the cities like the ones analyzed here, are also the seringais where communities have a higher level of organization in the reserve. Table 6-6 shows the residents membership in the resident association and the rural workers union in the four study seringais. Overall, it can be noted that 65.2% of the residents are affiliated to the Association, while 54.5% are affiliated to the rural workers union. These are very high levels of affiliation. Even though the rural workers union has a history of more than twenty years and the Association exists for only six years, the number of members with the Association is higher. This demonstrates clearly the more practical role of the Association in these seringais, which relates mostly with official government and development activities.

Table 6-6 Membership in association and rural worker union in the study seringais

Membership	Resident Associations		Rural worker Union	
	N°	%	N°	%
Yes	43	65.2	36	54.5
No	23	34.8	30	45.5
Total	66	100	66	100

Interestingly, the board of directors of the Associations, who makes the major decisions about activities and investments within the association, is composed mostly of tapper leaders of these four seringais. It seems that having better organization levels, and major representation in these organizations, led to the modification of the communities' economic perspective. These current leaders define the major decisions regarding investment in the reserve and very often the areas granted with investments are these represented by the director board. In addition, these decisions do sometimes consider family ties over community interest. For instance, two of the current Association board directors in the Xapuri Association came from the Seringal Dois Irmãos, which is the best structured seringal in Xapuri both in terms of social services and economic activities.

The goal of improving the level of social organization in the reserve does not exist in a vacuum, and communities have changed their economic and social perspectives, which in return have an indirect effect on land use activities. Paradoxically, contrary to the original purpose of the associations, the described land use changes might also very well have been a consequence of increased social organization. By mobilizing reserve residents within the resident Associations, these development incentives might have engendered the very changes they originally had hoped to stifle. The great challenge that poses itself for the associations in the next years is the reconciliation of the originally championed conservation and forest dweller values, with development incentives and opportunities that truly help increasing income. So far, few of the "official" programs have born tangible fruits in terms of income generation. Hopefully, these experiences will inform the decisions at the associations as well as the government agencies.

Today, associations face chronic problems related to financial dependence on government projects, personnel disputes among leaders and political interference from community leaders and local politicians. In some *seringais*, members resist contributing to the maintenance of an Association that is only remotely connected to their daily concerns. On the other hand, in other *seringais* residents have formed interest groups to influence the Association or to elect officials, competing only among themselves, instead of cooperating as a whole. For example, since the Association in Xapuri was created in 1995, a group of eight rubber tapper leaders from different communities has administered it. Every two years there is a general assembly to elect new representatives. These eight leaders that have political power in their communities established a rotation system whereby offices in the association's board are essentially exchanged between the same eight men. By blocking a newcomer's access to these positions, they manage to keep the benefits of being community representatives to themselves, which, in turn, assistance the communities they represent.

These leaders are usually the ones with better reading skills who speak more eloquently to the communities and influential outsiders. These representatives fail to identify younger local leadership, which would be based in the communities. Conversely, today, only two of these leaders still live in the *seringais* that they represent; the others have moved to Xapuri, only keeping their settlement and sometimes a family member in the *seringal*. It is evident that this group has not stimulated capacity-building of young residents and thus it is difficult for new leaders, and less politically networked *seringais* to compete for political office within the Reserve and strengthen locally-based social organization.

CHAPTER 7
SUMMARY AND TRANSITION

Rubber tapper communities proposed their own strategy of development in the form of extractive reserves and have given historical evidence of being capable of using forest resources without leaving a deforested landscape in their wake. Chapter 2 highlighted the evolution of the extractive reserve concept in the Brazilian Amazon context and analyzed the leading discussions about extractive reserves, discerning the major trends of conceptual debate. Some of the ideas that resulted in the creation of extractive reserves a decade ago have undergone several changes and that the ER experience thus far has been an extended pilot experiment in its character. Since the creation of the extractive reserves, both government and the local communities have learned many lessons. One such lesson is that a few small-scale, local initiatives cannot solve regional deforestation problems. Nevertheless, it still is one of the few models in which traditional communities have played a major role.

In addition, leaving aside barriers of a political and economic nature, the success of extractive reserves will depend on the ability of government agencies to cooperate with the extractive communities and maintain a level of dialogue, that allows the periodic redefinition of goals and mutual responsibilities. On the part of the communities, a continual effort will be required in order to maintain internal cohesion, common goals, and the ability to adapt to the changing socioeconomic context, which today is calling for a diversified tapper production system, causing greater impact on forest cover, as was noted with the increasing deforestation rates in the CMER.

Chapter 4 presents a brief overview of land-use in the state of Acre, and the areas surrounding the CMER, and the reserve itself, by examining deforestation rates in these areas. The deforestation process does not occur uniformly across the reserve, or even across a single *seringal*. In areas that are accessed by roads and are closer to the highway and towns, higher levels of deforestation are more common. Overall, it can be said that while the CMER is little impacted in many large areas, it is experiencing dramatic increases in deforestation in others. In addition, deforestation also occurs on a different and smaller scale, the *colocação* level. If the deforestation rates in more impacted areas are indicative of broader trends for future land use patterns in extractivist communities, there is reason for concern. Therefore, understanding the social dynamics of land-use change is of great importance for the future management of the reserve and the definition of conservation and development objectives within extractivist communities.

Chapter 5 presented some household determinants of diversified land use activities. The results show that key household characteristics have influenced land use strategies suggesting that attention needs to be placed on the household level factors affecting different land use activities. General trends of these household factors indicate that the changes taking place in land use activities are permanent, and demonstrate that deforestation will continue to increase as a result, a concern that must not be overlooked by household level development initiatives that call for the diversification of land use activities.

Chapter 6 attempted to analyze the effect of various socio-economic drivers on land-use change and deforestation rates within the CMER using as case study four seringais with particularly high deforestation rates. First, the role of population and settlement dynamic in the reserve was examined to explain why these four *seringais* not only have the highest population growth but also have experienced the most drastic land-use changes. Second, the significant changes in the rubber tapper production systems were discussed to explore the economic factors that are leading to land use changes. Finally, the social organization model in the reserve was examined to discuss how it may influence land use change.

Although overall population levels throughout the reserve have not increased significantly, they have indeed increased in the four study seringais, resulting in increased population density. Behind the increases in these numbers are hidden a number of processes. Exodus from the reserve into urban centers, immigration from nearby rural areas, urban centers and from other seringais within the reserve, and higher reproduction rates are just a few processes. The main source of origin of newcomers though in the four study seringais are remote seringais where the life as pure rubber tappers became too much of a hardship. A crucial process in occupation of space within the seringais and the accommodation of an increasing population is the increasing subdivision of the settlements. This increases population and settlement density as well as facilitates further deforestation rates in an area. Nonetheless, although generally higher population density and deforestation rates seem to bear a relationship, there is no clear-cut correlation between these two variables.

The changes in the rubber tapper production system over the last 5 years are striking. The system has been transformed from extractive production and subsistence agriculture to cash crop agriculture and pastoral activities. The low rubber prices have discouraged residents from rubber tapping. However, the new government policies have offered incentives for rubber tapper lifestyles. As a result, many families in the reserve returned to rubber tapping activities. In addition, government data shows that about eight hundred former rubber tapper families living in the cities returned to the forest. Although these numbers are questionable, about 40% of these families returned to municipalities holding territory on the CMER. In addition, this year many *brasilianos* (Brazilian rubber tappers in Bolivia) were kicked out because of logging concessions, and are looking for areas to settle. Many of these would like to settle in the CMER. Possibly, the recent rubber subsidy and other government programs might transform the current scenario somewhat in these more deforested seringais of the CMER.

A major and still little explored role in this process is that of the social organization in the reserve. While the rubber tapper social movement has articulated many of the original goals of extractive reserves and have promoted traditionalist values of rubber tapping, the more recent associations (created by the federal government) also act as a vehicle for larger development incentives in the reserve. Some of these, such as credit lines, can significantly influence and transform the rubber tapper production system, even though implemented with the best of intentions. The rubber tapper associations and the government and non-governmental organization working in the area face the great challenge to articulate a new vision and new objective of modern rubber tappers. In addition, the need to devise strategies that remain truthful to the assertion that extractive reserves can maintain forest cover and generate income, remains as alive as ever.

The extractive reserve model is dependent upon financial support from international institutions and the Brazilian government. Extractive reserves will need subsidies for a long period of time if they are to be consolidated as a model of conservation and extractivist development. Brazilian funds are not significant enough to support the extractive reserves' demands. Therefore, the reserves become even more dependent upon international resources, which requires a slow and complex negotiation that guarantees financial support for only a short period of time. Should these international investments be seen only as a payment for the conservation services provided by the reserve's residents? The answer for this question is no, and international support will not be permanent. However, how long will it take to reconcile income generation to the reserve's inhabitants with conservation practices? Neither the communities nor the international agencies know the answer to this question, resulting in a profound lack of definition for the model; thus, rubber tapper' tend to continue incorporating new forms of land use as a mean of income generation and economic development. What, then, are the new options for diversifying land uses the in reserves?

Land use regulations and enforcement at the community level are a major concern that will determine the future of extractive reserves. The Utilization Plan challenges the rubber tapper residents of the reserves to abide by the federal legislation while their economic development goals are as yet undefined. Due to this, and the experience of some years of implementation of the "laws" in the reserves, several of the norms of this plan have been questioned. For example, in the last two years, there is already a controversial discussion around the CMER, about a proposal to have "sustainable" timber extraction within the reserve, which is currently illegal according to the Utilization Plan. The current municipal administration of Xapuri, represented by rubber tapper leaders, has established a noble woods processing plant in Xapuri, in an attempt to create economic alternatives for the region. This proposal conflicts directly with the norms of the Utilization Plan, as the only timber supplies left in the municipal territory lie within the reserve.

Therefore, a strong lobby exists calling for changes in the Utilization Plan that can only take place if 51% of the reserve's residents, including those from the other four municipalities, agree with this change. In this case, municipal economic development goals could transform the natural resource regulations of almost all districts in Eastern Acre. According to local political forces and many of the residents within the reserve, timber exploitation will be approved soon. As this decision conflicts with international and national environmental funding policies for extractive reserves, two options remain: the loss of multimillion funding guaranteed for the next four years (by PPG-7) or a cancellation of any local decisions about this issue. Thus far, no decision has been made. However, it need to be said that a number of larger international donor organizations are supporting community based forest management (timber) in Amazonia. These efforts are still experimental and benefits to local communities have yet to be evaluated. Therefore, I suggest that federal extractive reserve refrain from this step until the economic and ecological viability of these initiatives has been demonstrated.

Who should have the authority to make these kinds of decisions? Local people with subsistence and economic development needs or international agencies that control the funds are mostly concerned with forest conservation? This dilemma demonstrates that the original idea of reconciling forest conservation and economic development of forest communities within extractive reserves still has a long way to go before it can become consolidated. The CMER is by far the biggest reserve in Amazonia and has been considered as an experiment to identify successful new income generation strategies and its later application to other reserves. If the current initiative carried out by the Xapuri mayor is a success, and other extractive reserves follow those proposals, the extractive reserve concept will pass though profound changes and has the risk of being shaped only in economic terms, as the traditional model of development of the Amazonia. The timber exploitation discussion shows the fragility of the extractive reserve concept when it comes to economic issues. The vision of the “inherently environmental rubber tapper” has made the rubber tappers’ struggle popular within the international community; however, their new economic perspectives and focus can invert this historical vision.

The tappers’ proposal for extractive reserves became an international symbol for ‘friends of the forest’ because they were broadcast as an “ecological” issue by global international communicators. But this tappers’ proposal is not “ecological” except in a tactical sense. The goal of the tappers’ proposal for creating reserves was not to preserve biodiversity, but to attain a forest version of land reform that would give them permanent rights to use the forests where they have made their frugal living for generations. As Schwartzman (1989) wrote, “extractive reserves are in essence a proposal for an ecologically sound and socially appropriate land reform in the Amazon”.

However, if the extractive reserve fails to increase the economic value of standing forests, despite the current national and international support, the criticism of the reserves will be confirmed and the pressure for other land use options will increase in these areas and so will deforestation rates. In addition, several others governmental and non-governmental development initiatives for Amazonian extractivism will be less effective and therefore extractivist perspectives of development in the region would suffer a setback. If they “survive,” it will take at least another decade before their success can be judged and by then the concept will have gone through several additional changes.

This research is not seen as an end in itself. It is but a step towards illuminating the dominant issues about tappers in the CMER. It can hopefully lead to a better understanding of the needs and problems of tapper communities in relation to the process of socio-economic transformation at present influencing their lives and destinies as extractivist communities. Areas for further research can be identified and a number of contributory issues illuminated. First, as observed in chapter 6, population density varies greatly across the reserve. Thus, population dynamic need to be examined at a seringal and reserve scale to discern the major factors causing population mobility in the reserve. Tapper mobility is important to the reserve model insofar as such model depends upon the formation of residents’ associations to collectively secure the designation of a reserve and to foster the social, political and economic changes necessary for the long-term success of the reserves. This mobility of residence also presents obvious difficulties for the creation of social relations among tapper communities over a period of many years. In addition, this mobility is related to economic factors. If, as intended, living standards improve within the reserve, then spontaneous immigration should be expected. Increasing living standards within the reserve could also favor out-migration, however.

One of the most challenging and important research topics in the reserve deforestation context of today is to integrate remote sensing methods with socio-economic analysis at a household level. Its value lies in the fact that it can be used to explore the link between small-scale land use change and the socio-economic factors affecting these changes and family land use decision-making. From this approach, it would be possible to characterize the general patterns of deforestation in the reserve and relate these to broad socio-economic processes affecting land use changes.

Another topic worthy of inquiry, although not directly related to this thesis, would be to map the dynamic of interaction and interest of institutions linked to the extractive reserve model in Amazonia. This would need to link the rubber tapper grass roots organization with national and international organizations and would focus on understanding how different actors and groups view, mediate and negotiate land use changes in the extractive reserve. This research would bring important insights in the different discussions of goals and views on reserves. Some of these institutions are primarily concerned with forest conservation and biodiversity and see the preservation of extractivist ways of living as a means to achieve their interest. Rubber tappers, on the other hand, aim to strengthen their livelihoods and to improve their well-being.

APPENDIX A
DATA CENSUS RELIABILITY AND UNCERTAINTY OF THE CMER

One important requirement of the Brazilian Environmental Agency (IBAMA) for the establishment of a Federal Extractive Reserve is a census survey prior to approval. As for the CMER the first socio-economic survey carried out was in 1992 by the Rubber Tapper National Council (CNS). After the establishment of the Reserve IBAMA assumed the legal responsibility of monitoring the reserve. The second census survey in the reserve was carried out in 1995. The reserve was divided into zones for each municipality and the Residents' Associations selected a group of residents who carried out the survey in the field with a technician from IBAMA. The data was gathered through structured interviews with mostly the household heads. Each Association had a group coordinator, who usually was an Association director, that was responsible for coordnating the group in the field and submitting the data gathered to IBAMA. The types of data gathered include personal and demographic data, production data, and agricultural plot, fallow, and pasture size data.

The reliability of the data gathered is affected by several factors. The first factor was the distance that the members of the survey group had to travel to cover the entire reserve. To reach the settlements, it might have taken between two to fifteen hours by foot, by boat, or by animal depending on the accessibility of each seringal. The second factor is the limited skill of the group members on formal education, in interviewing and in understanding the information gathered. Third, at times the household head might not be at home when the interviewers came and thus "indirect" data was collected from neighbors, workers, or the wife. Despite these limitations, it is still better to work with the residents than to work only with an urban technician, which would present others own challenges.

In the 1998 census the same methodology was applied, but with important differences. In the 1998 census each one of the members of the group was equipped with a GPS machine and trained in getting GPS reading of the settlements. This was introduced mostly for two reasons. First, in the previous census some cases were reported that members of the groups had not gone to the more distant settlements but had gotten the information through relatives of the residents of these distant settlements or by filling out the questionnaire using their own knowledge of the community. Also, at the same time, a mapping project of the reserve settlement was being carried out by a group of researchers of the Federal University of Acre, including myself. The opportunity to get GPS readings of the settlement of the entire reserve would not only increase the reliability of the census data, since the interviewers must go to each *colocação*, but also would be of great value for the mapping project. Thus, we gave basic training in GPS, mostly in teaching how to get the geographic coordinates of the settlement and recording it in the questionnaire. The 2000 census survey followed the same strategies, with the advantage that Association leaders and members were becoming increasingly experienced in these activities, and thus the reliability of the data tended to improve.

Despite the amount of information in the census, it has been explored very little. The use of this information is basically restrictive to keep a database with residents' names and their locations in the reserve. It is also meant as a tool to keep track of major trends within the reserve in terms of productivity and deforestation levels.

However, when comparing deforested areas according to the census data (adding up agricultural plots, fallow, and pasture at a seringal level) the total sum is very much smaller than that determined with remote sensing techniques (own observation). This might result from two factors. First, what is problematic about the census data is that it contains sensitive information, which will ultimately fall into the hands of government officials (IBAMA) that have a certain authority. A rubber tapper that is deforesting more than allowed is likely to understate his pasture and agricultural plot size. Second, a major, but hardly addressed problem is that of unreliable estimates of deforested areas and colocação area. A colocação is generally defined as the number of rubber trails X 100ha. Thus, a colocação with 6-rubber trails has approximately 600 ha, of which 10% would be 60 ha. However, nobody really knows the size of a *colocação*, and in real life the size of rubber trail might vary tremendously. Therefore, estimating the legal 10% limit of deforestation per household is extremely difficult. Nonetheless, the census data represents a valuable historical record of changing demographics, production and land-use that cannot be reconstructed otherwise. Also, the census data can represent the rubber tappers' estimates of production and land-use within their particular cultural, economic and political context. This is very valuable in itself.

APPENDIX B
QUESTIONNAIRE USED IN CMER SURVEY

Questionário no.________ Data: ___/___/___ Entrevistador:_____________________

Coord. Geográficas:

Latitude ______ °______' ______ ______" S

Longitude______° _______' _____ ______" W

I – Identificação da Colocação:

01 - Seringal:________________________________
Colocação:__________________________________
02 - Nome do entrevistado____
03 - O seringal esta ligado a que Associação:
_____AMOREX (Xapuri)
_____AMOREB (Brasiléia)
_____AMOREAB (Assis Brasil)

II - Dados da familia

A – residentes na colocação

No	Nome	Sexo M/F	Parentesco	Idade	Estuda S/N
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					

B – Não residentes na colocação

No	Nome	Sexo M/F	Parentesco	Idade	#Onde mora?	*Porque mudou?	Tempo que saiu (anos)
01							
02							
03							
04							
05							
06							

1 – Cidade mais próxima; 2 – Capital; 3 – outro seringal; 4 – mesmo seringal;
*1 – Para estudar; 2 – casou; 3 – para trabalhar; 4 - conflito com uso da colocação; 5 outros

III - Historia pessoal (chefe da colocação)

4 - Em que estado você nasceu? ________________
A - Idade? ___________anos
B - Desde quanto tempo mora aqui? _________anos
C - Onde morava antes? Colocação_________Seringal___________________
Município___________Estado______

5 - Qual a forma de aquisicão da sua colocação?
( ) Concessão de uso ( ) Herança ( ) Arrendamento ( ) Compra ( ) Posse ( ) divisão familiar ( ) Outro. Qual? ________________________

6 - Desenvolveu quais atividades, se você já tiver morado na cidade____

7 - Você já trabalhou em fazenda? ( ) Sim ( ) Não

8 - Você já trabalhou com agricultura fora da reserva ? ( ) Sim ( ) Não

9 - Você sabe se existe colocação sem morador neste seringal ?
( ) Sim Não ( ) Quantas____

10 - Alguém na sua comunidade se mudou recentemente?
( ) Sim ( ) Não Quando?_______________________________________

11 - No passado, (quando a reserva foi criada) haviam mais morados neste seringal? ( ) Sim Não ( )

12 - Você é o primeiro ocupante desta colocação ( ) Sim Não ( )

13 - Você sabe quando esta colocação foi aberta ( ) Sim ( ) Não Quando?____

14 - Você sabe quantos moradores já ocuparam esta colocação? ( ) Sim ( ) Não Quantos?____

IV – Produção (extrativismo e culturas anuais):

A – Dados gerais da Produção extrativista

Tipos	Mão-de-obra		Produção (qde)		Consumo (qde)		Venda (qde.)		Preço de venda (R$)	
	H	M	99	00	99	00	99	00	99	00
Castanha (latas)										
Borracha (kg)										
Mel de abelha (litros)										
Copaíba (litros)										
Outros:										

B – Dados gerais da Produção agrícola

Tipos	Mão-de-obra		Produção		Consumo (qde.)		Venda (qde.)		Preço de venda (R$)	
	H	M	99	00	99	00	99	00	99	00
Arroz Kg										
Milho Kg										
Feijão Kg										
Mandioca Kg										
Outros:										

C – Dados gerais da produção anual de animais

Tipos	Quantidade	Mão-de-obra		Consumo (qde.)	Venda (qde.)	Preço de venda (R$)
		H	M			
Galinha						
Porco						
Pato						
Ovelha						
Gado						
Outro:						

V - Uso da terra

A - Roçados na colocação

Roçado	Tamanho	Idade	Vezes utilizado	Razão da escolha*
01				
02				
03				
04				

* 1 – Capoeira; 2 - Transição capoeira/mata; 3 – Mata bruta; 4 – Mata sem castanha e seringa; 5 – perto da casa

B - Capoeira na colocação

Capoeira	Tamanho (hec)	Idade	Vezes utilizada	Vegetação original *
01				
02				
03				
04				

1 – Restinga; 2 – capoeirão;

C - Distribuição de uso da terra

Tipos	Tarefas	Hectares
Área de capoeira (total)		
Área de pasto (total)		
Área de roçado (total)		

15 - Número total de estradas de seringa na colocação:__________________________________

16 - Quantas estradas você cortou em:

1998______
1999______
2000______

17 – Você pretende cortar mais seringa ano que vem ( ) Sim ( ) Não
Porque?______________________________

18 – Está fazendo novo roçado este ano? ( ) Sim Não ( )

19 - Caso resposta negativa, porque não?
____

20 - Qual o tamanho da área de roçado para este ano? Capoiera___________Mata bruta_____________________

21 – Você Pretende aumentar a área de cultivo agrícola:
Sim (   )   (   )Não Porque?______________________

22 - Quais os produtos agrícolas que você pretende aumentar a produção?

(   ) Arroz   (   ) Feijão   (   ) Milho   (   ) Mandioca   (   )

outros____

23 - Quando você veio morar aqui já haviam áreas desmatadas?   Sim (   )   Não (   )

24 - Caso sim, quais eram os usos:
(   ) Capoeira abandonada   (   ) Roçados   (   ) Pastagem

25 - Alguém na casa é aposentado   Sim (   ) Não (   )

26 - Poderia dizer quanto você gasta por mês, na média, com as despesas da casa?
____

27 - Você já recebeu ou está recebendo algum tipo de financiamento do governo?
Sim (   )   Não (   )

29 - Caso sim, quais foram? (   ) Prodex (   ) Outros________________

30 - Qual a finalidade?____

31 - Caso resposta positiva. Pretende obter outros financiamentos?
Sim (   )   Não (   )

32 - Quais?____

VI - Transporte e comercialização

33 - Para quem você vende a produção extrativista?

Produtos extrativista	Local de venda			
	Núcleo da Associação	Cooperativa	Comercio na cidade	Marreteiro
Castanha				
Borracha				
Outros:				

34 - Para quem você vende a produção agrícola?

Produtos agrícolas	Local de venda			
	Núcleo da Associação	Cooperativa	Comercio na cidade	Marreteiro
Arroz Kg				
Milho Kg				
Feijão Kg				
Mandioca Kg				
Outros:				

35 - Como é feito o transporte da produção?

Trechos	Tipo de acesso				Meio de transporte			Tempo
	Rio	varadouro	ramal	rodagem	barco	animal	carro	
A - Colocação								
B -								
C -								

36 - De quem é o transporte?

( ) próprio ( ) Núcleo da Associação ( ) cooperativa ( ) Prefeitura ( ) fretado ( ) comunidade

37 - Quantas vezes vai a cidade? ( ) uma vez por mês ( ) duas vezes por mês ( ) uma vez em dois meses ( ) uma vez em três meses

VII - Extrutura Social e Participação

38 - Você é Associado a alguma organização comunitária?
Sim ( ) ( )Não

39 - Caso resposta negativa, porque não participa?______________
____

40 - Caso resposta positiva, quais as organizações ?

Associação ( ) Há quanto tempo? _________anos
Sindicato ( ) Há quanto tempo? _________anos
Cooperativa ( ) Há quanto tempo? _________anos

41 – Participou de alguma reunião este ano Sim ( ) Não ( )

42 - O que foi discutido nesta reunião?_______________________

43 - Você participa da execução de trabalhos em multirão Sim ( ) Não ( )

44 - Quantas vezes você já participou de Assembléias geral da Associação?
____

45 - Tem algum técnico extencionista trabalhando na sua comunidade?

Sim (   )   Não (   )

46 - Através do trabalho deste técnico, que novas idéias você usa no seu dia-a-dia?____

47 – Algum membro de sua família trabalha fora da colocação?
Sim (   )   Não (   )

48 – Em quais atividades?____

49 - Existem pessoas de fora trabalhando na sua colocação?
(   ) Não   Sim (   )

50 - Em quais atividades?____

51 - Esta colocação já foi dividida alguma vez? Sim (   )   Não (   )

52 - Caso resposta positiva,   quando? _________(ano)

53 - Quais os motivos para divisão?
(   ) Casamento do filho (a)   (   ) Arrendamento   (   ) Para ter mais área para desmatar (   ) Outros. Quais?_______________________________________

VIII - Gestão da reserva

54 - Neste seringal os moradores já tiveram problemas com
caçada por pessoas de fora da comunidades Sim (   ) Não (   )

55 - Pesca de pessoas de fora da comunidade Sim (   ) Não (   )

56 – Já aconteceu algum problema de posse de colocações dentro da comunidade
Sim (   ) Não (   )

57 - Na sua comunidade já houve algum conflito entre seringueiros e/ou pessoas de fora da reserva (fazendeiros, invasores, madeireiros) depois da criação da reserva?
Sim (   ) Não (   )

58 - Se a resposta for sim, descreva quais os conflitos:__________
____

59 - Você conhece o plano de utilização da reserva Sim ( ) Não ( )

60 - Você acha que a reserva precisa de um plano de utilização? ( ) Sim ( ) Não
Porque?____

61 - Você acha que após a aprovação do plano de utilização houveram mudanças no dia-a-dia dos moradores da comunidade? Sim ( ) Não ( ) Quais foram as mudanças?____

62 – Você acha que devem ser feitas mudanças no Plano de Utilização ?
Sim ( ) Não ( ) Quais?_______________________________________

63 – Você sabe quanto o plano de utilização autoriza desmatar?
Total da colocação? Certo ( ) Errado ( )
Por ano? Certo ( ) Errado ( )

64 – Já veio alguém aqui para fazer fiscalização nesta colocação?
( ) Sim ( ) Não

65 - De que organização ele era?
( ) IBAMA ( ) Associação ( ) Sindicato ( ) Outros

66 – Você estar pensando em mudar para outro lugar?
Sim ( ) ( ) Não. Caso sim, para onde pretende mudar?__________
Porque?____

67 - Na sua opinião qual é o principal problema encontrado na sua comunidade?____

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BIOGRAPHICAL SKETCH

Carlos Valério Gomes was born on October 24, 1968, in Ourém, State of Pará, Brazil. In 1989, he moved to Rio Branco, State of Acre in southwest Amazonia. There, at the Federal University of Acre (UFAC), he received his undergraduate degree in Geography in 1995. Upon finishing his study at UFAC, he spent 2 years as both an associate researcher with the Zoobotanical Park of UFAC and as a consultant to the on-going Extractive Reserves Project/Pilot Program for the Protection of the Brazilian Rainforests (PPG-7), under contract with the United Nations Development Program (UNDP). He was involved in the first large-scale settlement mapping of the Chico Mendes Reserve, community training programs, socio-economic surveys as well as preparation of the reserve-wide development plan. In 1999, he was awarded a Fulbright Fellowship (Amazon Basin Program) for Masters level studies in the United States. This thesis is the result of his masters program in Latin American Studies, with a concentration in Tropical Conservation and Development, at the University of Florida. In 2001, he was awarded a scholarship from the Brazilian Science Council (CNPq), of the Ministry for Science and Technology of Brazil, to continue his graduate studies seeking a doctorate degree in Geography at the University of Florida.