GEOGRAPHY IN THE JUNGLE:
INVESTIGATING THE UTILITY OF LOCAL KNOWLEDGE FOR NATURAL RESOURCE MANAGEMENT IN THE WESTERN AMAZON

By

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This thesis investigates whether a combination of local and scientific knowledge can improve natural resource management in the Model Rural Sustainable Settlement Project in Acre, Brazil. Participatory methods and Global Positioning System technology provide the georeferenced local spatial, social, and biophysical knowledge necessary to create a Geographic Information System (GIS) for modeling land-use and land-cover change. In this case, georeferencing local knowledge identified and corrected gross errors in existing maps, thus preventing grave complications for settlement planning. In addition, fieldwork revealed a strong local interest in extensive cattle ranching: a serious challenge to the settlement project's sustainability goals. These results indicate that the local knowledge-GIS combination bears continued investigation as a powerful tool for both natural resource management and settlement project creation.

CHAPTER 1
LOCAL KNOWLEDGE FOR NATURAL RESOURCE MANAGEMENT

Introduction

Settlement projects in the Brazilian Amazon have often been perceived as unsuccessful, since 30-50% of settlement farmers abandon their land with many relocating and cutting forests elsewhere on the Amazonian frontier (Almeida et al. 1995; Cronkleton 1998). The top-down, unassisted federal projects of the past are now largely recognized as undesirable (Almeida et al.1995; Moran 1981), with new efforts concentrating on local-level programs aimed at mitigating poverty and social conflict, while promoting sustainable use of natural resources (Almeida et al. 1995). The Model Rural Sustainable Settlement Project (MRSSP) analyzed in this thesis is an example of a local-level project and new settlement model attempting to improve natural resource management and thus lessen land ownership turnover and deforestation. This thesis investigates whether local knowledge (LK) can combine with scientific knowledge to improve natural resource management in the MRSSP. I conducted research in Acre, Brazil on one community of former rubber tappers within the project. In this case study, participatory methods (LK) and Global Positioning System (GPS) technology provide the georeferenced local spatial, social, and biophysical knowledge necessary to create a useful Geographical Information System (GIS) for modeling land-use and land-cover change (LULCC) and for natural resource management. Georeferencing local knowledge identified and corrected errors in existing official maps, thus preventing complications for settlement and resource planning. In addition, modeling LULCC with participatory

methods and GIS revealed local residents' strong interest in pursuing extensive cattle ranching: a serious challenge to the MRSSP's sustainability goals. These results indicate that the LK-GIS combination can provide important information and bears continued investigation as a tool for both natural resource and settlement project management.

Tropical forests play vital roles in maintaining biodiversity, carbon cycles, hydrology, and climate patterns (Laurance et al. 2001; Serrão et al. 1996). The Brazilian Amazon rainforest, containing 40% of the world's remaining tropical forest, is particularly important in maintaining global and regional systems. However, the Amazon rainforest's average annual rate of deforestation from 1995 to 1999 was 2 million hectares a year and shows no indication of slowing down (Laurance et al. 2001). Shifting agriculture and extensive cattle ranching are responsible for 80 to 85% of Amazonian deforestation (Serrão et al. 1996). While large-scale cattle ranches cause the majority of cattle-related-deforestation in the Amazon basin, small farmers are also intimately involved in cattle raising and pasture formation (Downing 1992; Faminow 1998; Hecht & Cockburn 1990).

Small producers are receiving increased attention due to their population growth in the Amazon and their association with deforestation and rural to urban migration. Non-indigenous populations in the Brazilian Amazon have increased from about 2 million in the 1960s to 20 million people in 2000 (Laurance et al. 2001). Many non-indigenous and indigenous small producers have no formal land title. The Brazilian government's reaction to these landless families is to funnel them into colonization projects. However, Brazilian colonization and settlement projects have had a large amount of landownership turnover, frequently 50% or more, which leads to increased deforestation in rural areas or increased pressure in urban areas (Cronkleton 1998). One researcher observed that

> The issue is no longer how to prevent deforesting farmers from migrating to the Amazon from the rest of the country, but how to ensure that farmers already in the Amazon stay where they have already deforested, thus reducing migration (and deforestation) farther inland. (Almeida et al. 1995: 5)

Improving the long-term natural resource management (NRM) of the small farmer is one method of limiting transmigration and deforestation (Almeida et al.1995). Natural resource management is defined here as a human activity, geared towards sustaining livelihoods and based on the utilization of natural resources of a given area (Pichón & Uquillas 1999).

Many development organizations, researchers and conservationists are increasingly focused on the use of local knowledge[1] (LK) to reach development goals (Agrawal 1997; Pichón & Uquillas 1999; Posey & Balée 1989; Redford and Padoch 1992; Smith 1999; Srivastava et al. 1996; Warren et al.1995; Western & Wright 1994; World Commission on Environment and Development 1987). Community or local knowledge has been integrated into many natural resource management initiatives.[2] This thesis will focus on local knowledge[3] as knowledge constructed over time and stressing familiarity with the local area and its resources.

In many cases, the origin of this knowledge is the local community.[4] The local community in this case study is defined as such because the residents refer to themselves

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[1] There has been some debate over the difficulty in isolating local knowledge from other knowledge systems see Agrawal (1995)for a detailed analysis.
[2] For a list of publications of such initiatives see Warren (1999).
[3] This thesis uses community, local and indigenous knowledge interchangeably as does much of the literature on the use of these knowledges (Agrawal 1995).
[4] Community is another problematic word that of late has received much attention. For a detailed discussion see Agrawal & Gibson (1999) and Smith (1999).

as the community of São Pedro. Of particular interest to sustainable natural resource management (SNRM) is local or community knowledge of setting, boundaries and land-use and land-cover change. Local knowledge of setting or place is central to SNRM because it encompasses knowledge of local resources and the landscape. Long-term residents[5] can be particularly knowledgeable of local resources and landscape. This rich knowledge can be helpful in building a sustainable use plan for the future. New arrivals are not likely to have this depth of experience, but they do carry knowledge of resources and landscapes that can be adapted or used to ease their transition into their new setting. Where long-term residents and new arrivals are both present, management strategies based on the knowledge of both groups can be used. Building on existing knowledge of the land and its resources and existing expertise in the local population increases the probability of project success (Warren 1999).

SNRM also benefits from a detailed understanding of limits. The Model Rural Sustainable Settlement Project (MRSSP), like any administered settlement project, will eventually have a fixed boundary. A boundary is a social construct, marking human-perceived differences in the nature and identity of places (Brunson 1998). Within that boundary, the MRSSP will promote a natural resource management philosophy. A detailed understanding of the boundary and the land inside is crucial to the successful implementation of natural resource management (Smith 1995). A full understanding of past and present boundaries, including location and type, can reduce conflict and improve SNRM. The MRSSP lacks data on its exact location, boundaries, and the natural resources within its boundaries. As seen in this study, local knowledge of setting and

[5] I define a long-term resident as someone who has lived over twenty years in the area.

boundaries provides information useful to the successful management planning of the MRSSP.

Local knowledge of land-use can also be crucial for SNRM. Management projects can use past and present land-use to understand resource use, local technology and landscape dynamics. Local research can link land-use decisions to larger socio-economic driving forces, like markets, and proximate causes, such as fire. An understanding of these and other issues related to land-use and land-cover allows a SNRM plan to build on existing knowledge and skills in the area.

However, local knowledge of landscape, boundaries, and LULCC may also be overemphasized as a means of improving SNRM. Local peoples' knowledge may be readily available from other sources or the knowledge may be incorrect and thus not useful for management planning. Certainly, the utility of local knowledge can only be evaluated on a case by case basis, since local people and their knowledge vary widely according to location. This study investigates the utility of combining local knowledge with GIS technology in one community of the MRSSP. This case study's results indicate that this local knowledge is useful to the project and, thus, should be investigated in other conservation and development projects as a tool for improving SNRM.

Participatory methods are a type of methods based on community participation and in part designed for the acquisition of local knowledge. Participatory methods rely on community members to participate in planning and decision-making about the natural resources in their environment.[6] The World Bank's Learning Group on Participatory

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[6] Participatory Rural Appraisal, Rapid Rural Appraisal, Appreciation-Influence-Control and SARAR are just a few examples of participatory methodologies. See World Bank (1996) and Chambers (1994a) for more information on participatory methods.

Development defined participation as "a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them"(World Bank 1996: 1). In addition to accessing local knowledge, participatory methods strive to empower the local people involved in the process while including all groups within the community.

Despite their growing popularity among development organizations, these methods are not without their critics. Participatory methods have been criticized for empowering some community members at the expense of others, for taking too long to implement, and for giving too much influence to the facilitator (Botchway 2001; Chambers 1994b; Twyman 2000). Nevertheless, these methods have demonstrated promising results in a wide range of development projects and their ability to empower local people while understanding stakeholder relationships and knowledge, could benefit SNRM initiatives in the future (Chambers 1994b; Poole 1995; World Bank 1996).

Previous to the inclusion of local knowledge and community participation into sustainable development, Western science and technology was the paradigm in natural resource management. Yet even as science and technology have greatly increased food production, local people in developing countries have seldom been successful with sustained economic production based on the Western model (Hayami & Ruttan 1985; Pichón & Uquillas 1999). Combining local knowledge with technology is increasingly being investigated. Pichón and Uquillas argue that Participatory Technology Development (PTD), a combination of local and modern technology and science, is the best path towards sustainable natural resource management (1999). Smith promotes EEZ (Ecological-Economic Zoning), a process based on combining indigenous and scientific

knowledge for natural resource management and territorial defense (1995). These types of approaches have the merit of integrating multiple worldviews and knowledges into SNRM.

One promising combination of local knowledge and modern technology involves the adoption and use of spatial information technologies in SNRM. Geographical Information Systems (GIS), Global Positioning Systems (GPS) and remote sensing are spatial information technologies that are already being used to manage natural resources. Remote sensing contributes detailed data on land-cover that are often unavailable through other means due to economic, temporal or labor constraints. GPS allows natural and social scientists to georeference data derived from both local and scientific knowledge. GIS can combine the data georeferenced using the GPS with the remotely sensed land-cover data. This combination allows the system to identify, organize and analyze a wide range of information related to the physical environment, the economy and social characteristics. This system also contributes to the informed decision-making needed for sustainable use of natural resources. GIS, scientific knowledge and local knowledge form a powerful combination because the GIS facilitates the melding of scientific data with local knowledge (Chapin 1998; Fox 1998; Harris & Weiner 1998; Kosek 1998). GIS also empowers local knowledge by presenting it in the dynamic visual form preferred by policy makers predisposed to the discourse of science and technology.

However, the combination of GIS and local knowledge can also be problematic. Although spatial information technologies (also called geomatic technologies) have become much more affordable in recent years, they still require considerable economic investment and technical facility. These can be barriers inhibiting local people from

gaining full control of the GIS and thus their knowledge in the GIS. This subordination of local knowledge to outside experts is a familiar dilemma for local people (Rundstrom 1995). Yet, when employed on their behalf, the GIS is often an extremely effective tool in policy arenas. The ideal situation is to train local people to create and operate their own GIS. However, this can alter internal power relations of a local community as the newly trained technological elite may become more powerful. Despite these shortcomings, the GIS-local knowledge combination bears investigation as a powerful tool for natural resource management (Watkins et al. 1997; Smith 1995).

Statement of the Problem

Natural resource management on Amazonian settlement projects needs to be improved to limit landownership turnover and, thus, deforestation by small producer settlers (Almeida et al. 1995). This study investigates the combination of local knowledge and GIS technology as a means for improving natural resource management. I focus on three crucial aspects of local knowledge: how local people perceive their setting, how people perceive the boundaries of their territory, and local land-use and land-cover change. I combined participatory methods and geomatics to access, organize and analyze local people's perceptions of setting, limits and land-use and land-cover change. The study investigates the contributions, if any, that the combination of local knowledge and GIS technology can make to the Model Rural Sustainable Settlement Project (MRSSP).

In the study, local knowledge of a community's landscape is contrasted with the knowledge that settlement officials have of the same area. In addition, the official knowledge of the project boundary will be contrasted with what one community considers its boundary to be. The implications of establishing community boundaries for land and resource tenure also will be discussed. The results find community knowledge

of landscape and boundaries useful to the MRSSP due to the current misrepresentation of the community and its resources.

Local knowledge of land-use may also be important for sustainable natural resource management. Knowledge of the resources, skills and techniques involved in land-use gives officials an opportunity to build a management plan based on existing resources and on local skills for both economic return and subsistence needs. In addition to past and present land-use and land-cover, this study models future land-use and its possible ramifications for land-cover. The study gives management officials an understanding of the land-use trajectory of current residents and the sustainability of that trajectory. This knowledge is potentially useful for assessing the impact of the future management plan. In this case, the findings showed residents allocating labor and resources into cattle ranching. Future projections demonstrated aggressive rates of pasture extensification. When shown the results of the LULCC model, settlement project officials were surprised at the rapid rate with which residents planned on increasing herd size and pasture extent. These findings are critical, as the former rubber tappers' desire for increased cattle production must be addressed for SNRM to succeed in the MRSSP.

Thesis Organization

This thesis is divided into six chapters. This first chapter introduces the central issues surrounding the problem statement and then states the problem. The second chapter focuses on the fascinating recent history and the unique geography of the state of Acre. The third chapter describes the study site in detail, articulates the research design, and provides detailed descriptions of both the participatory and spatial-information methods used. The fourth chapter uses field data to address the importance of community knowledge of place and boundaries in natural resource management. These data also

have important repercussions for boundary definition and conflicts over resources. The fifth chapter also uses field data but focuses on a 30-year period of land-use and land-cover change. Finally, the sixth chapter summarizes the findings and looks forward to new applications of local knowledge while placing the study in a larger context.

CHAPTER 2
DRIVING FORCES IN ACRE'S SEARCH FOR SUSTAINABLE DEVELOPMENT

Introduction

This case study analysis requires a multi-scale understanding of historical, ecological, geographical and social factors. Some of these factors are addressed at regional and local scales in the six sections of this chapter. The first section focuses on the history of Amazonian settlement initiatives. This history provides an understanding of national development policy in the region and describes the evolution of Amazonian settlement project models. The MRSSP is the Brazilian government's newest model in this progression. The second section introduces the state of Acre in order to overcome geographical generalizations about the Amazon basin (figure 2-1). In the following section the scale narrows further to describe the Juruá Valley, the site of the MRSSP and an area with little social and natural science documentation. In the fourth section I describe recent land-use patterns in Acre. These patterns will be later compared with the land-use patterns analyzed in Chapter 5. The fifth section describes the rubber tapper political movement, under the leadership of Chico Mendes, and the current state government, which grew out of the movement and its struggle for land. The majority of research participants share the rubber tapping tradition, although not necessarily the specific history of Chico Mendes' defenders of the rainforest. Finally, I describe the MRSSP and the institutions involved in the creation of this new sustainable settlement model. Dynamic institutional relationships and diverse institutional goals continue to affect both the MRSSP and the research, as discussed in this chapter.

Figure 2-1 Map of South America

The Emergence and Impact of Amazonian Settlement Initiatives

The last few decades in the Brazilian Amazon have been characterized by rapid change introduced by federal policy. The cycle began with the Brazilian government's decision to develop the region through the implementation of two general goals. The first goal was first articulated in the 60s and focused on developing the Amazon, while integrating it into the national economy. The second goal began with the creation of INCRA in 1970 and used Amazonia as an escape valve to relieve pressure in other regions due to landlessness and unemployment (Almeida 1995; Cronkleton 1998). The construction of roads was paramount to both goals and ignited modern Amazonian development.

Beginning in the 60s, the government and regional elite promoted large-scale capitalist development. The pursuit of timber, mining and later ranching was stimulated by the development of infrastructure, public financing, concessions to foreign companies, and tax credits and fiscal incentives to Brazilian companies (Bunker 1985). These development schemes took advantage of the traditional Amazonian land tenure system. This system, often based on extractivism, lacked detailed records and was subject to fraud. One impediment to the development schemes was a Brazilian law providing legal rights to land ownership through occupation. This made rubber tappers and untitled small holders legal squatters. Squatters obtained these rights, though often unaware of them, through living on and cultivating the land for one year and one day. With the collapse of the rubber economy and the withdrawal of the rubber estate owners, the forest was liberally sprinkled with squatters without legal documentation.

In an attempt to facilitate the government's development initiatives and make sense of the existing tenure regime, The National Institute of Colonization and Agrarian Reform

(INCRA)[1] was formed in 1970. The government created INCRA from weaker titling agencies to take charge of the administration of federal lands and colonization projects. INCRA's mandate was to: 1) separate public from private land and clarify tenure status; 2) appropriate unclaimed federal patrimony; 3) demarcate and survey; 4) title land, regularizing past titles and occupations; 5) expropriate for social purposes and agrarian reform; 6) settle and colonize; 7) maintain a cadastre with data on rural properties; 8) enforce and collect the rural land tax; 9) sell public land; and 10) arbitrate disputes (Mueller et al. 1994). The agency's initial focus was on large-scale land sales and titling rather than on colonization schemes (Bunker 1985). Investors, banks, and the military put pressure on INCRA to favor large commercial interests, as part of the government's push to supplant control over resources by traditional Amazonian elites (Schmink & Wood 1992)

Meanwhile, the government was feeling the pressure of increased rural unrest in Amazonia and Northeast Brazil. Violence was common between the rural poor and the new landlords who disputed access to land. The rural poor often were expelled from their land and migrated to cities or other rural areas, thus, keeping the cycle of unrest in motion. Settlers also followed the new roads into the Amazon. Both newly arrived and veteran squatters settled spontaneously along roads in an attempt to improve their lot.

The government galvanized INCRA into action to combat the growing rural unrest. INCRA began to introduce a series of colonization models in the 1970s and early 80s. Each successive colonization model became simpler to lower costs and responsibility. The first and most ambitious model was an integrated colonization project (PIC)[2] created

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[1] The Instituto Nacional de Colonização e Reforma Agrária
[2] Projeto Integrado de Colonização.

in 1970 that involved the surveying and titling of farm lots, the construction of basic infrastructure, and the organization of all services.[3] PIC project areas were divided into a grid of 100-hectare parcels spreading out from highways and smaller roads. While detailed, the plans were dictated from the Brasília with no comprehension of local topography or watersheds. Thus plots might be penciled in on swamps, ravines, streams or hills. This initial difficulty was compounded by the farmer's lack of technical advice (Schmink & Wood 1992) and lack of familiarity with the environment (Moran 1981). To further complicate matters, INCRA was slow to follow through with the promised services. The newly placed families were without roads, healthcare, and schools, and had great difficulty in accessing affordable credit. Meanwhile, in-migration was stimulated by pro-PIC government propaganda. PICs responded to the overwhelming in-migration by expanding projects to settle up to ten times the original number of farmers. Despite this, the PICs failed to settle the number of families they promised and some projects lost up to 44% of their original colonists[4] (Smith 1982).

In the mid 1970s, unsatisfied with the performance of the PICs, INCRA turned to new directed settlement project models called PADs.[5] PADs were streamlined versions of PICs that were to be easier and faster to implement while also giving INCRA less of a role in post-settlement services. INCRA's role in the PADs was 1) land distribution, 2) demarcation of territory, 3)administration of the project, 4) organization of the settlement

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[3] For a more detailed description see Smith (1982) and Moran (1981).
[4] See also Martine (1990) and Mahar (1981) for more information on PICs.
[5] Projetos de Assentamento Dirigido.

process, and 5) construction of the physical infrastructure (Cronkleton 1998). However, INCRA and the state agencies were unable to fulfill their obligations to older PADs while creating new ones.

As immigration increased in the late 1970s, INCRA failed to keep pace with settlement projects. PADs were deemed too slow and the new rapid settlement program model (PAR)[6] was promoted in 1980. INCRA hired more staff, cut down on required documentation for settlers and provided instant definitive titles for qualified families (Mahar 1981). The PARs essentially regularized invaded areas. Settlers responded by settling spontaneously in areas that were likely to be regularized.

In the mid-1980s the Brazilian focus shifted from Amazonian colonization and resettlement to land redistribution. The most famous organization in the land redistribution debate was, and continues to be, the Landless Rural Workers Movement (MST).[7] The MST's tactics consisted of organizing mass invasions of large, unproductive estates. The agrarian reform debate the MST began with the central government complicated matters considerably in Amazonia. The debate diverted attention from the recently settled and struggling colonists and paralyzed existing programs serving smallholders. To make matters worse, in 1987 INCRA was dissolved for a year and a half before being reinstated. This lack of stability caused much hardship in Amazonia where would-be and existing colonists relied on INCRA.

Over time, the Brazilian government's strategies for Amazonian colonization focused more on mitigating conflict than on effective colonization. Families lucky enough to be

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[6] Projeto de Assentamento Rápido.
[7] Movimento dos Trabalhadores Rurais Sem Terra.

settled were inadequately prepared and poorly assisted in their attempts to establish homesteads. Colonist families often chose to leave projects due to an inability to survive or an unwillingness to struggle on. Many families left even when their economic situation was improving and their farms productive (Almeida 1995).

The latest of INCRA's settlement project models is the sustainable development project (PDS)[8] created in 1999. This model breaks from previous settlement project models due to its emphasis on sustainability and conservation. The PDSs seek to settle populations in areas of environmental importance, as a strategy for conservation. Maria Helena Allegretti, Secretary of the Amazon for the Ministry of Environment (MMA),[9] described the model as,

> an alternative to conventional settlement projects, more suited to Amazonian specifications and the demand of its populations. The model respects the forest-based vocations of the region and minimizes the environmental impacts of settlement projects. This model, the joint effort of the Ministry of Agrarian Development (MDA)[10] and the Ministry of the Environment points to answers that public policy should give today to the necessity of development, inserting in political arenas the question of sustainability.[11] (Ministério de Desenvolvimento Agrário 2001: 7)

The PDS seeks to select production strategies only after balancing the land-use suitability of areas with the skills of those to be settled. Selected areas will have potential for sustained use, and current residents as well as future settlers will be surveyed to determine if they have skills compatible for sustained use of the area. Settlers without appropriate skills will most likely be included in the traditional settlement initiatives. The MRSSP is the first PDS to be formally created, although the entire management plan

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[8] Projeto de Desenvolvimento Sústentavel.
[9] Ministério de Meio Ambiente.
[10] Ministério de Desenvolvimento Agrário.
[11] My translation.

has not yet been fully elaborated. Another PDS, called PDS Morena, is being created in Amazonas state, while several other settlement projects may soon start the process to become PDSs (Raissa Guerra personal communication). Because the MRSSP is the first such example, its success or failure may have a significant impact on policy makers investigating possibilities for sustainable development in the Amazon and the rest of Brazil.

The State of Acre

The Amazonian state of Acre is the westernmost state in all of Brazil (7°07'-11°08'S, 66°30'-74°W), bordering the states of Amazonas (831 km of border) and Rondônia (22 km of border) and the countries of Bolivia (618 km of border) and Peru (1,564 km of border) (figure 2-2). The state covers 153,149 km², comprising 3.2% of the Brazilian Amazon. The land-cover of the state is largely described as dense and open evergreen tropical rainforest on terra firme with seasonally flooded várzea existing along some rivers. Acre is especially rich in its number and diversity of palms (Campos et al.2001; Daly & Silveira 2001a). The state of Acre also contains limited amounts of *campina*[12], *caatinga*[13], semi-deciduous forests and even some typically Andean vegetation along the western border (Daly & Silveira 2001b). Only 16,000 km² of Acre's land cover have been deforested or severely impacted by humans in the last 100 years (Governo do Acre n.d.). Thus almost 90% of the state is still in tropical forest. Over thirty percent

[12] Campinas are patches of low, stunted vegetation on extremely sandy soils (podzols). Often a thick layer of poorly decomposed litter lies on top of these nutrient-poor soils (Daly & Silveira 2001b; Smith 1999).

[13] Caatinga, also called Campinarana, is transitional from campina to mature forest. The usually slender trees have a canopy of no more than 20 meters and grow out of the nutrient-poor soils topped by poorly decomposed litter characteristic of both campina and caatinga (Daly & Silveira 2001b; Smith 1999).

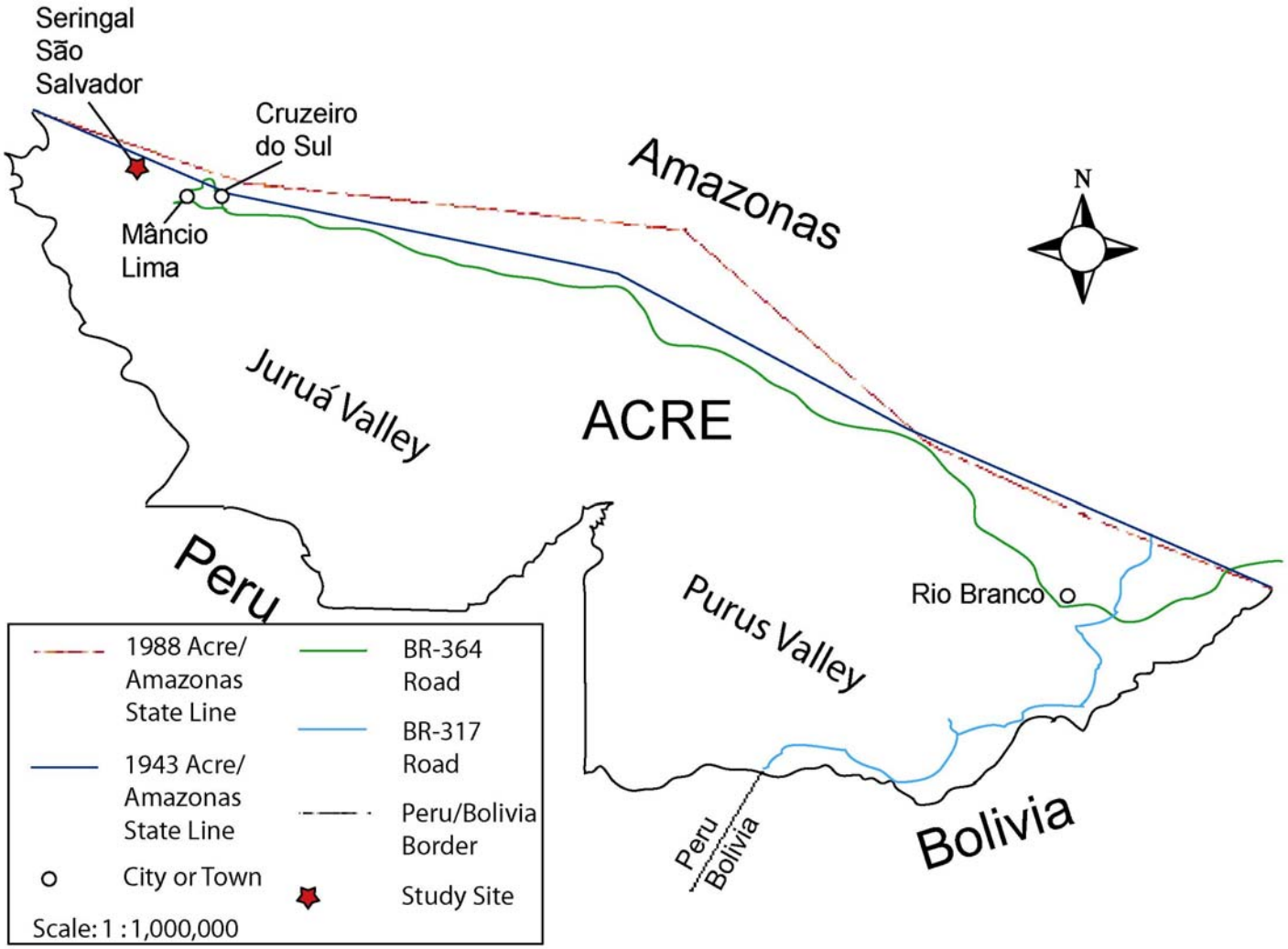

Figure 2-2 Map of Acre

of the state is protected in either a conservation unit or indigenous reserve (Governo do Acre n.d.).

The climate is tropical and humid and can be divided into dry (June-September) and wet (October-May) seasons. Total annual rainfall in Acre ranges from 1,600 to 2,750 mm. The average precipitation in the western part of Acre (Juruá Valley) is 2,200-2,300 mm/year, and in eastern Acre (Purus Valley) 1,800-2,000 mm/year. Annual average temperature is 24-26° C with a maximum of 32° C in September, October and November (Campos et al. 2001)

The main routes for road transportation are the BR-317 and the BR-364 (figure 2-2) highways. The BR-364 connects Acre with the rest of Brazil to the east, and theoretically connects the state capital, Rio Branco, to the western portion of the state. However, intense rain and the highway's dirt surface allow traffic to reach western Acre's largest city, Cruzeiro do Sul, only one month out of the year. This road currently is being paved. The BR-317, which connects Acre to Peru and Bolivia, also is being paved. The areas along these roads comprise most of the deforested lands in the state.

According to the 2000 census, the population of Acre was 557,226 people (IBGE 2001). The majority of the population was located in the cities and larger towns with Rio Branco's population at 226,134 and Cruzeiro do Sul's at 38,946. People of mixed indigenous, European and African heritage comprised the majority of the state's population. Much of the titled rural land in Acre is concentrated into large landholdings. According to INCRA-Acre, of the 10,455 rural surveyed land parcels, 3.7% of them contained almost 82% of the state's surveyed land (IMAC 1997). In 1991, the

anthropogenic areas of the state of Acre were estimated at 10,333 km². 85% of these were calculated to be in the Purus Valley (IMAC 1997).

Acre's Geographical Dichotomy: The Juruá and the Purus Valleys

Acre can be divided into two main watersheds. The northwestern portion of Acre is drained by the Rio Juruá, while the southeastern portion is drained by the Rio Purus and by the Rio Acre sub-basin of the Purus. The two halves of the state are divided by a ridge called the Fitzcarrald Paleoarch (Daly & Silveira 2001b; Patton et al. 1997). The Juruá Valley is wetter with relatively rich, younger soils and a less perceptible dry season. Low mountains border the western frontier with Peru: the Serra do Moa and Serra do Divisor. The eastern or Purus Valley has a pronounced dry season, poorer soils, less relief, slightly higher temperatures and less rainfall.

In 2000, the Juruá valley was less populated with only 157,536 people (IBGE 2001). Thus 28.3% of the people in Acre resided in the Juruá on 74,912 km². The population density of the Juruá (2.1 people per km²) contrasted with the population density of the Purus (5.2 people per km²). This was largely because the capital, Rio Branco, a city of 226,134 inhabitants, is located in the Purus Valley and also because of population growth along the state's paved roads. This dichotomy in population density is relatively recent. Until 1950 the population was evenly distributed between the two valleys, with 0.7 people per km² in the Juruá and 0.8 people per km² in the Purus.

While Acre is still relatively undeveloped compared to the rest of Brazil, the western half of the state is less developed than the eastern side. The eastern half is well connected to the rest of Brazil by the BR-364 highway, and the paving of the BR-317 highway will greatly improve transportation to the Pacific Ocean. The two valleys' marked differences in transportation infrastructure and settlement history are reflected in population

distribution. The Juruá Valley is historically more connected to the capital of Amazonas state, Manaus, than it is to the capital of Acre. Due to the lack of all weather roads, the major markets for the western side are down the Juruá River. This river provides transportation to the Solimões River and the city of Manaus. Historically, this was the route used to export rubber and now it is the export route for much of the manioc flour made in the Juruá. The manioc flour of the Upper Juruá valley is famous for its quality throughout the Amazon. Because of the lack of roads, development in the Juruá is concentrated along the extensive network of rivers. The western side of the state also has more land in indigenous reserves and conservation units, including the Serra do Divisor National Park (PNSD)[14] with 8,430 km². Another difference between the two halves of Acre is the lack of brazil nut trees (*Bertholletia excelsa*) in the Juruá Valley, an important food and income source in the Purus Valley.

Due primarily to increased their increased isolation, the rubber tappers of the Juruá Valley remained tied to the traditional rubber debt-peonage system longer than the more independent tappers of the Purus Valley. In part because of distance and the paucity of paved roads, the Juruá Valley continues to be more traditional today. There are many more international projects and research being conducted in the Purus. This is due to the Purus valley's relative accessibility, the presence of the Chico Mendes extractive reserve and the attention brought by the legacy of Chico Mendes.

The Evolution of Contemporary Rural Land-Use in Acre

Acre was annexed by Brazil in 1903 during the rubber boom. In Acre, the number of rubber trees (*Hevea brasiliensis*) in an area dictated land value. Because Acre had large

[14] Parque Nacional Serra do Divisor.

numbers of highly productive trees, rubber has dominated the economy since 1890. The rubber economy was driven by the *aviamento* system: foreign creditors lent money to lenders in the Amazon (*casas aviadores*). The *casas aviadores* then lent credit and goods to the owners of rubber estates (*seringalistas*). *Seringalistas* supplied tools, food and other dry goods to rubber tappers (*seringueiros*) in return for their labor. Rubber was then given to the *seringalista* by *seringueiros* to obtain credit. Essentially, the *seringalistas* kept the *seringueiros* in debt peonage through control of both rubber and supply prices. In addition, *seringueiros* in debt could only sell rubber to their *seringalista*[15].

The rubber tappers were primarily brought from the northeast of Brazil in two waves. The first wave of about 500,000 came in the last decade of the 19th century. The second wave was much smaller and came during World War II (Cartaxo Nobre 1998). In the 1920s, between the waves of tapper immigration, the price of rubber fell dramatically due to the creation of rubber tree plantations in East Asia. Nevertheless, people continued tapping rubber for lack of alternatives. A new rubber boom hit in World War II when Japan cut allied access to the East Asian plantations. The boom and financing by the United States brought a wave of laborers called *soldados da borracha* (rubber soldiers) into Acre. This boom was short lived, however, and collapsed with the end of the war and the increasing interest in synthetic rubber.

During the booms, tappers were entirely dependent on *seringalistas* for food and other supplies. Yet, when rubber prices slumped in the 1930s, rubber tappers diversified their activities to improve their livelihoods. Nuts, fruits, palm fibers and furs were collected

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[15] See Almeida (1996); Almeida & Menezes (1994); Bakx (1986); Weinstein (1983) for a more in depth description of the rubber system.

and eaten or sold while hunting and fishing contributed protein for consumption and sometimes profit. Cassava, corn and other crops were farmed and chickens, ducks and pigs were raised primarily for domestic consumption. This rubber tapper land-use system is described by Allegretti:

> A family's or group of families' landholding (colocação) forms the basic land production unit within the rubber stand. This landholding is defined by the combination of rubber trees in production or at rest, which are called trails (estradas de seringa); agricultural plot(s); areas utilized for hunting, fishing, and gathering; the site or sites designated for housing and processing of rubber; and the stream(s) or river(s) that invariably flow through the landholding. Each landholding is generally recognized and respected by all residents in a given area. Yet divisions between holdings are subtle. (Allegretti 1990: 258)

This land rights system, locally recognized and organized around key resources, was not reflected in any official registry or maps. The lack of documentation at the household and rubber estate (*seringal*) level continues today and is addressed in detail in chapter four.

The decline in rubber prices between the rubber booms and after World War II meant more freedom for the rubber tappers. However, their situation became more precarious with the loss of patron support. Independent rubber tappers had few means to borrow money in the case of illness and the remaining patrons of tappers were less able and willing to advance credit when rubber prices were low. Therefore, tappers struggled to live well in the forest and some migrated to towns where their lives were improved little if at all

After World War II, and even in the 1930s, subsistence strategies, tenure relations and the local economy became more diversified than the strict aviamento system at the height of the rubber boom. Nevertheless, the primary activity and identifying characteristic of the rural people in Acre continued to be the tapping of rubber. Rubber production

continued slowly after World War II. From 1943 to 1985 the Brazilian government protected the rubber economy through a government monopoly of the resource (Almeida & Menezes 1994).

In 1962 Acre became a state, and six years later it was connected by road to the rest of Brazil. In the 1970's governmental policies that promoted land sales to outsiders led to massive conversion of forest to pasture in eastern Acre, rural to urban migration, and challenges to rubber tapper tradition throughout the state. One policy of the Bank of Amazonia (BASA)[16] called in *seringalista* debts, thus encouraging the sale of large rubber estates. Another policy, promoted by an Amazonian development institution (SUDAM)[17] encouraged investors to invest land in ranching. The Purus Valley was much more affected by these policies than the distant Juruá Valley because of proximity to the rest of Brazil, larger *seringais*[18] (rubber estates) and higher levels of *seringalista* debt (Bakx 1986).

New landowners experienced difficulty in taking control of their land because it was occupied by *seringueiros* reluctant to move. Conflicts occurred, and many *seringueiros* were forced to migrate to urban shantytowns. Ranches of varying sizes occupied the land abandoned by the tappers in the southeast and north-central portions of the Purus Valley.

In Acre, INCRA initially focused less on colonization than on land tenure projects, and the latter tended to be in areas with the least conflict. Before 1974, INCRA

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[16] Banco da Amazônia
[17] Superintendência de Desenvolvimento da Amazônia
[18] Plural in Portuguese for *seringal* (rubber estate).

issued only 81 titles in Acre. In 1974, INCRA attempted to create PIC Xapuri, but it was a failure, settling only six families, all of whom left after two years (Bakx 1986). The growth of urban shantytowns in the mid-1970's forced INCRA to become more active in the region. Several PADs were started after 1975. These were based on 100-hectare lots to be used for diversified agriculture. As elsewhere, INCRA's ambitious plans met with mixed results[19]. Acre's PADs were characterized by a slow rate of settlement, a lack of services, a grid placed without concern for local topography, a settler selection process favoring out of state migrants, and misrepresentations of the project to lure the migrants (Cronkleton 1998).

Increasing immigration in the 1980's expanded existing PADs without alleviating many of their problems. INCRA was also shaken in the late 1980's after being temporarily dissolved. The institution weakened further when President Fernando Collar slashed INCRA funds in 1990. President Henrique Cardoso has since strengthened INCRA, and eleven PARs were implemented in Acre between 1994 and 1996. The pressure to settle has not diminished for INCRA-Acre as the MST has increased Brazilian political awareness of displaced people and urban shantytowns continue to grow.

New pressures are certain to arise with the Avança Brasil project[20], a federal development project, with the goal of investing 40 billion dollars in Amazonia between the years 2000 and 2007. This money is earmarked for new highways, railroads, gas lines, hydroelectric projects, power lines, and river guidance and control projects

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[19] See Cronkleton (1998) for a detailed analysis of the Peixoto PAD.
[20] Advance Brazil.

(Laurance et al. 2001). These upgrades in infrastructure (especially roads) will likely increase in-migration into the Amazon and Acre. Money for the Avança Brazil project is advancing the paving of the pacific bound BR-317. This road when paved will transform Acre from an Amazonian backwater to the principal avenue to the Pacific for north and central Brazil. In anticipation of the potential impact, the current state government of Acre is creating policies to help manage current and future development.

In 2001, 61 colonization projects in Acre occupied an area of 13,830 km² or 8.37% of Acre's territory (Governo do Acre 2001). Acre's department of the Brazilian Institute of Agricultural Research (EMBRAPA)[21] cite a list of problems of the projects:

> The demarcation of the lots (square lots with a set pattern) for the projects, without any investigation of natural resource relationships to soil, relief, drainage and vegetation, and without the participation of potential beneficiaries has created various problems: 1) Increased costs in construction and maintenance of the transportation network; 2) Lots located in soils inadequate for the level of capital and type of cultivation typically practiced by beneficiaries; 3) Irregular distribution of lots in relation to water access and natural divides; 4) Deforestation in areas containing rubber, brazil nut and other trees useful for management and extractivism; 5) Loss of biodiversity both above and below soil due to a lack of resource optimization; 6) Depreciation of natural resource value. (Valentim et al. 1999: 4)

INCRA, recognizing the need for an improved model of settlement project, joined with EMBRAPA and the Technology Foundation of the State of Acre (FUNTAC)[22] in an effort to find an alternative rural settlement model. In general, the model created, the MRSSP, strives to anticipate the challenges to the settled small producer. The model requires intensive study of the land and resources in the settlement area, and the incoming settlers and current inhabitants of the land to be occupied. The specific objectives of the project are to: 1) Promote rational land use through natural resource management; 2)

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[21] Empresa Brasileira de Pesquisa Agropecuaria.
[22] Fundação de Tecnologia do Estado do Acre

Establish a new methodology for settlement projects based on knowledge of natural resources and the knowledge and necessities of both local and future settlement populations; 3) Analyze natural resources for their sustainable use; 4) Improve natural resource management of settlement beneficiaries through agroforestry production, sustainable forestry and wildlife management that is adapted to local conditions and based on scientific studies of relief, soil, vegetation, hydrography and wildlife; 5) Structure and test the process for implementation in other Amazonian settlement projects; 6) Strengthen and empower local communities and community organizations to facilitate relations between communities and with insititutions; 7) Define and establish links between communities and existing markets; 8) Define and establish links between communities, institutions, NGOs and external agents (Valentim et al. 1999)[23].

Colonists in Acre, who often are migrants from other regions whose land-use systems are distinct from the rubber tappers system, resemble the Amazonian small producers in other parts of the region. The typical agricultural colonist family in Acre lives on a farm of less than 1 km² and grows annual crops for subsistence and perennial crops for both sale and consumption. The farmers practice shifting cultivation by clearing new plots, rarely measuring more than two hectares, in the dry season and burning them before the rainy season. Annual crops are planted for one or two years before abandoning the field, leaving it in fallow or converting it to cattle pasture. The family also raises small livestock and a few head of cattle. The majority of these farms use only the resources of the colonist family (Cartaxo Nobre 1998).

Long-time resident families of Acre also often fit this description. With the decline of rubber prices, many ex-rubber tappers now pursue similar land-use strategies. The

[23] My translation.

secondary activities of animal raising and subsistence crop production these former tappers learned during the lean years between and after the rubber booms are now often primary activities focused on income generation. There are still many locals, often living inside extractive reserves, pursuing extractive activities as their primary means of income: tapping rubber and collecting brazil nuts or other non-timber forest products. But these activities are becoming less popular (Gomes 2001), and many former tappers have been assimilated into settlement projects and are now small agricultural producers. As the children of rubber tappers and ex-rubber tappers grow into a system based less and less on extraction, they also may turn to activities such as agriculture or cattle ranching.

In addition to the land-uses of rubber tappers and small producers, Acre also has a large number of ranches and a number of companies focused on the extraction of tropical hardwoods. The majority of the ranches are located in the Purus Valley although extensive ones are found along the river networks of the Juruá Valley. Local residents and timber companies extract timber throughout the state except where lack of road or river access makes the activity extremely difficult.

Acre's Forest Government[24]: New Policies Growing from Rubber Tapper Roots

With the building of roads connecting Acre to the rest of Brazil, came the land speculators and, in response, the germination of the rubber tapper movement in the 1970's. The contests for land between rubber tappers and the new landowners often turned violent. Many rubber tappers avoided the confrontation by migrating to cities,

[24] Governo da Floresta.

other *seringais*, or even across the border to Bolivia. Others were simply expelled or received small amounts of money to leave. One organization supporting the tappers was the Catholic Church, which helped the rubber tappers to organize through the establishment of Christian Base Communities. The church then invited the Brazilian Agricultural Workers National Confederation (CONTAG) to open an Acre chapter in 1975. CONTAG organized resistance movements around a network of rural unions (STRs)[25]. In 1976 the rubber tappers began using their most effective method of resistance, the *empate*. Empates consisted of unarmed rubber tappers (men, women and children) appearing at the site of a forest clearing. The large group would appeal to the rancher's hired laborers, asking them to stop. Ranchers often brought in police or hired gunmen to intimidate the tappers. At times women and children were at the front of an empate, emphasizing the non-violent philosophy at the heart of the empate approach (Campbell 1996).

The church's role in the movement began to decline in the eighties as Brazil's political democratization led to the growing influence of leftist political parties. In 1985, rubber tappers held a national meeting in Brasilia and created the National Rubber Tappers Council (CNS)[26]. The CNS also proposed extractive reserves as a potential land reform for rubber tappers (Allegretti 1990; Allegretti 1995). As their cause became better known, the rubber tappers gained the support of international environmental groups, scientists and indigenous people. Despite the publicity and corresponding political power the movement gained, the violence continued. Several leaders were assassinated during

[25] Sindicato dos Trabalhadores Rurais.
[26] Conselho Nacional de Seringueiros.

the movement: Wilson Pinheiro in 1980, Ivair Higino in 1988 and their most famous and charismatic leader, Chico Mendes, in 1988.

The movement persevered despite the assassinations, and in 1987 the first extractive settlement was established. This was followed by the creation of the first extractive reserve in 1990. The creation of settlements and reserves diffused a great deal of the tension in Acre. Indeed, this was the likely goal of the government. Currently there are two extractive reserves, Chico Mendes and Alto Juruá, and eight extractive settlement projects.

Of these extractive land units, only the Alto Juruá Extractive Reserve is located in the Juruá Valley. This reflects the fact that the recent history of rubber tappers is very different in the Juruá. The lack of roads to the Juruá slowed or stopped ranchers from investing in the large cattle ranches now common in the Purus Valley: in 1996 90.5% of Acre's pastures were located in the Purus Valley (IMAC 1997). Thus, the Juruá did not suffer as many conflicts over land as the Purus Valley. In addition, the rubber tappers of the Juruá never reached the level of cooperation and organization that the Purus tappers needed to defend their extractive rights from ranchers. The Juruá tappers were rarely if ever mobilized and never became famous as Chico Mendes'defenders of the forest. One researcher relates that rubber tapper households that organized against ranchers may attribute more importance to the forest than those who never organized (Weigand 1996). This may be one factor that differentiates the attitudes of the Juruá tapper from the attitudes of the Purus tappers who organized to protect their livelihoods. Despite these differences, the rubber tappers of the Juruá and Purus both share the same *seringueiro* culture and the same former livelihood based on the *aviamento* system.

The current state government of Acre, the Forest Government grew out of the rubber tapper social movements in the strife-filled years of the 70's and 80's. The government is a coalition of 13 parties dominated by the Worker's Party (PT)[27]. Governor Jorge Viana, a forester, first won major office as Mayor of Rio Branco in 1992. Two state senators also come from the party: Tião Viana, Jorge's brother; and Marina Silva, a charismatic woman born and raised in the seringal. The Forest Government's perspective on development is best described in the words of Governor Jorge Viana:

> Historically, government policies aimed at promoting human occupation and economic development in the state of Acre, and in the Brazilian Amazon as a whole, gave little attention to concerns of social equity, cultural diversity and environmental sustainability. Deforestation was often synonymous with "civilization." Beginning in the 1970's, the expansion of extensive cattle-ranching, colonization and logging activities resulted in the felling and burning of millions of acres of native forests in the state. In addition to its environmental impacts, this process contributed to the exodus of thousands of families to the peripheries of cities, together with the breakdown of traditional economies based upon non-timber forest extraction. The notion that progress in the Amazon depends upon the removal of the forest has been proven false by the disappointing results of big projects installed in the region. At the same time, traditional populations of the Amazon, while resisting predatory forms of occupation and resource exploitation, have demonstrated that regional development must be conducted in an intelligent manner, preserving natural resources and valuing forest-based activities and local knowledge. Today, the society of Acre is increasingly aware that the development of our state must be closely linked to the conservation of natural resources and biodiversity. Such concerns are an integral part of the state government's strategy for sustainable regional development. With community participation and respect for traditional populations of the region, we are building a more just and egalitarian society, a society that respects cultural and biological diversity and that is committed to the conservation and wise use of natural resources. Our goal is to demonstrate to present and future generations that development does not depend on the destruction of the forest, but rather its survival. (Governo do Acre n.d.: 31)

The state government has followed through on many of these initiatives. For example, Acre is the only Brazilian state with its own legislation on biodiversity resources

[27] Partido dos Trabalhadores.

(Governo do Acre n.d.). An ambitious Ecological-Economic Zoning (ZEE)[28] project has also been implemented. This project calls for the creation of synthesized thematic maps at the scale of 1:250,000. These maps are slated to serve both the government and diverse sectors of regional society (Governo do Acre n.d.). Forty-eight thematic and indicative maps have been created to date. The ZEE project strives to combine local participation and technical scientific knowledge. Project promotional material states, "Our challenge is to identify and document with ample local participation, the potential and limitations of sustainable natural resource use for each hand's breadth of land…Technical-Scientific knowledge is a fundamental tool to plan natural resource use and biodiversity conservation" (Governo da Floresta 2001: 1).

One concern is the amount of local participation and the legitimacy of mapping every hand's breadth if maps are produced at the 1:250,000 scale. Local people may have difficulty participating, as their communities and land may not be large enough to gain representation on maps covering immense areas. Nevertheless, the ZEE project can conceivably guide development through the use of these small-scale maps.

Another government policy to promote sustainable development is the establishment of the Chico Mendes Law in January of 1999. This law subsidizes the tapping of rubber with the state contributing R$ 0.40 per kilo of rubber produced. This amounted to U.S.$ 0.21 per kilo in August of 2000. The law requires that tappers receiving the subsidy be members of an association or cooperative. The state's objective is to organize rural producers and make rubber tapping attractive, reversing rural-urban migration and improving extractivist employment, income and environmental preservation associated

[28] Zoneamento Ecológico-Econômico

with the livelihood (Nobre 1999). Along with this measure the government is investing in value-added processing of rubber and brazil nuts, as well as diversification of non-timber forest product marketing. As of 1999, the projected rubber processing plant in Cruzeiro do Sul was not yet operative. In sum, the forest government of Acre is the Amazonian leader in finding innovative policies to reconcile the development and conservation of the state. However, it remains to be seen if this government's policies can produce lasting results.

The Model Rural Sustainable Settlement Project of the Western Amazon

The germination of the MRSSP involved a number of separate institutions pursuing their own agendas. In 1999, INCRA acquired a property in Northwestern Acre to be used as a resettlement project. The area, Seringal São Salvador, covered 278 km² of forest bordering the Serra do Divisor National Park (PNSD).

Before INCRA acquired Seringal São Salvador, EMBRAPA began developing strategies to improve future settlement projects in the region. Their goal was to create a process, including planning, implementation and monitoring stages, making future settlement projects both economically and environmentally sustainable. EMBRAPA began work on two settlement projects in the Purus Valley, Seringal Caquetá and Alcobrás, in 1998. EMBRAPA's focus for this process involved studies of natural resources, soils and water before settlement design. In addition, they focused on possible forest and agriculture management strategies relevant to the existing natural resource base (EMBRAPA 1998).

During this time period, SOS Amazônia, a Brazilian NGO focused on conservation, and the Brazilian Institute of Environment (IBAMA)[29] were faced with their own dilemma. After carrying out a detailed analysis of the Serra do Divisor National Park, SOS Amazônia realized that many of the families living inside park boundaries wanted to move out.[30] Data collected by SOS Amazônia indicated that some of the families living in the SDNP would like to be relocated out of the park (personal communication from S.O.S. Amazônia). The PNSD residents wanted to leave because of the absence of basic infrastructure, the lack of public services, and the additional land-use restrictions within the conservation area (personal communication from S.O. S. Amazônia).

The Acre Group for Agroforestry Research and Extension (PESACRE),[31] a not-for-profit NGO, was invited to do conduct a comprehensive baseline survey of the São Salvador site in July 1999. A multidisciplinary team of agronomists, anthropologists, biologists and foresters conducted the fieldwork. The team traveled throughout the site identifying ecosystem variation, observing communities and their agricultural systems, and interviewing residents to better understand the local perspective on agricultural and environmental conditions. Following the appraisal, specialists from the PESACRE team assessed local wildlife populations and hunting pressure; gathered more in-depth information on the distribution and use of oxbow lakes; and examined local commercialization networks and market opportunities. At the conclusion of the study, PESACRE's team decided that the fragile resource base and size of the current

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[29] Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis.
[30] Living within Brazilian national park boundaries is illegal according to Brazilian law although relatively common in many Amazonian national parks.
[31] Pesquisa e Extensão em Sistemas Agroflorestais do Acre.

population made the São Salvador area a poor location for relocating families who wished to leave the PNSD. The team also felt that the intensive agriculture or timber extraction typically practiced in colonization projects had little potential and could have negative impacts on the site (PESACRE 1999). EMBAPA also surveyed the site, contributing a soil analysis and forest study to help define natural resource management strategies. PESACRE reasoned, "While São Salvador is not a suitable location for relocating the families out of the SDNP, as a result of the research conducted, PESACRE and EMBRAPA may have averted the social and environmental difficulties that likely would have resulted if INCRA's original plan had gone forward" (PESACRE 2000: 1).

After accepting PESACRE's decision that São Salvador was not adequate for PNSD family resettlement, some institutions became less active in the project. Currently, the main institutions actively contributing to the MRSSP are INCRA, EMBRAPA and PESACRE. These three institutions continue to coordinate with the municipal government and the Moa River Agricultural Producers Society.[32]

Since the decision was made not to resettle residents, PESACRE and EMBRAPA have continued working in the settlement area. EMBRAPA produced project maps of soils, vegetation, agricultural suitability, agroforestry suitability and agro-ecological zoning. PESACRE produced studies on commercialization, hunting, non-timber forest products and fishing in addition to a baseline document focusing on socio-economic and ecological issues. PESACRE personnel have been using participatory methods to develop cohesive community organizations within the project. With facilitation by PESACRE, communities developed community hunting, fishing and extraction

[32] Sociedade Agrícola de Produtores do Rio Moa

guidelines. PESACRE continues to work on the identification of income generating activities with low environmental impact. While PESACRE and EMBRAPA worked in the field, INCRA overcame some bureaucratic hurdles to formally create Brazil's first PDS in São Salvador in 2001. The next major step is the demarcation of reserve and community boundaries and the creation of a management plan.

CHAPTER 3
COMBINING PARTICIPATORY METHODS AND GEOMATICS IN THE REMOTE RAINFOREST OF THE JURUÁ VALLEY

Introduction

This chapter describes the research site and the research methods used in obtaining data. The methods used are an innovative combination of participatory methodology and spatial information systems (geomatics). These methods determined how local knowledge can contribute to natural resource management in the MRSSP. The methods chosen were selected for multiple reasons.

Participatory methods were used in part because PESACRE was already using participatory methods in their fieldwork in the MRSSP and planned to continue using the methods. Thus, my methods followed an existing pattern, although the participation was more intensive than PESACRE's due to the length of time I spent with one community. The methods also potentially encouraged the people to take a more active role in working with PESACRE and building a management plan for the MRSSP.

Geomatics were chosen because my primary interests of land-use and land-cover change and local and official boundaries had strong spatial elements that could be answered in part by georeferencing local knowledge with geomatic technology. The field site chosen was conducive to the use of geomatics because of the uncertainty of area maps. I combined both methods, participatory and geomatic, to investigate the potential of this combination for local natural resource management and for future research

endeavors. I found the combination of methods to be promising for the MRSSP, other conservation and development initiatives, and future research.

However, the methods were extremely challenging to implement in the field. Participatory methods require large amounts of energy and time, and a willingness to endure the daily hardships of the community studied. Participatory methods are also not easily replicable given their emphasis on participation and flexibility. Unfortunately, this drawback complicates the future testing of results based on these methods. Geomatics, in turn, are largely reproducible, but present technical challenges, especially when used in remote areas. Finally, combining geomatics and participatory methods requires some creativity and flexibility. Geomatics are predicated on accuracy above all, while participatory methods often blur the line between advocacy and analysis, and move at the pace of the community. Thus one must sacrifice some of the accuracy to participate in the lives of the community; however, this means that the final result has the level of accuracy most relevant to community life.

Seringal São Salvador: Transforming Tradition

Seringal São Salvador is located along the Moa and Azul rivers in the western portion of the Upper Juruá valley and falls within the confines of the Municipality of Mãncio Lima in the Brazilian state of Acre (figure 3-1). Mâncio Lima has a population of 11,074 people (IBGE 2001). However, 5,774 of the inhabitants live in the municipal capital of the same name. The town of Mâncio Lima lies about 70 km downriver from São Salvador following the Moa and Japiim Rivers. This downstream distance can be covered in 5 ½ hours in a lightly loaded canoe with an outboard motor, but the return trip to São Salvador can take twice as long. The largest city in the Upper Juruá valley, Cruzeiro do Sul (pop. 38,946), lies approximately 50 km down the Japiim and the Moa

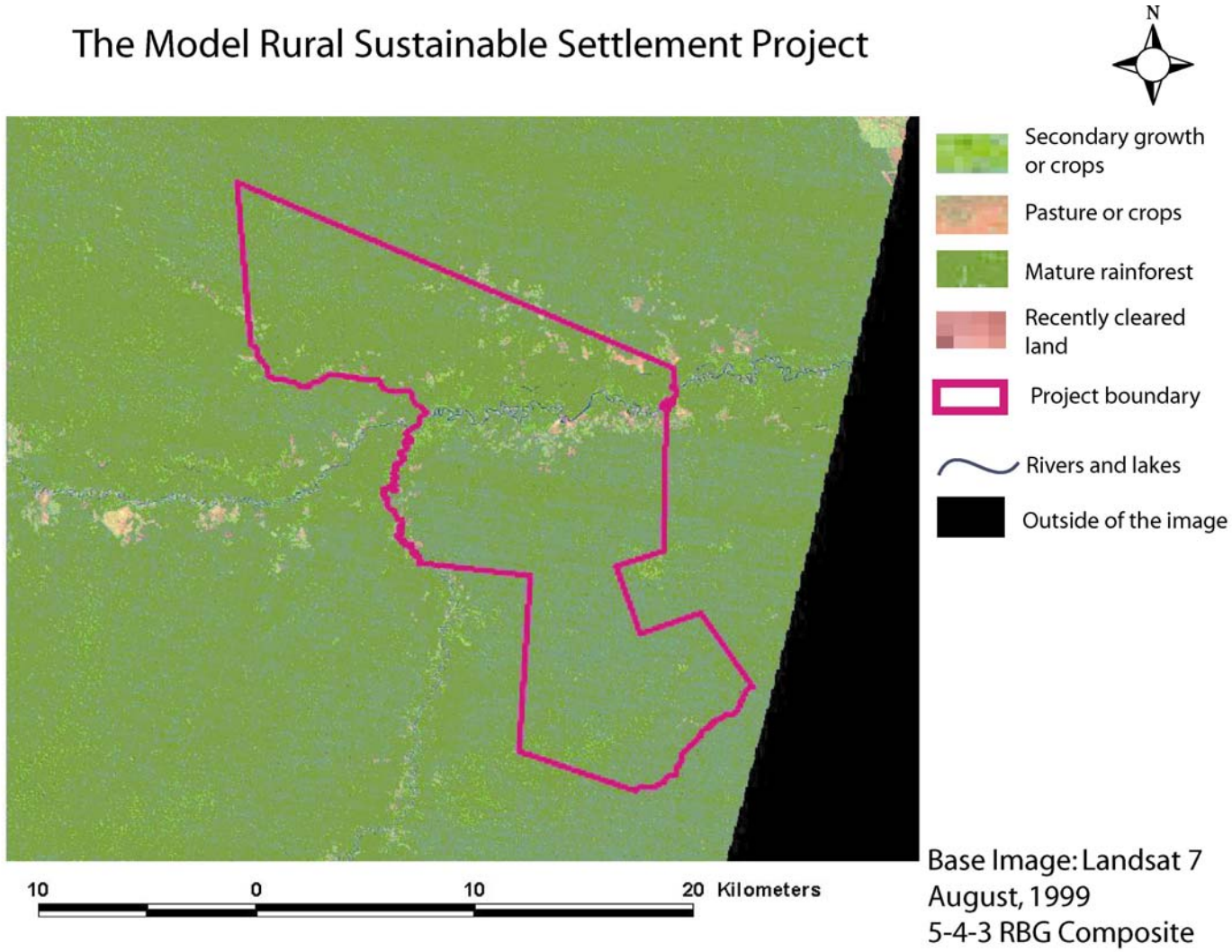
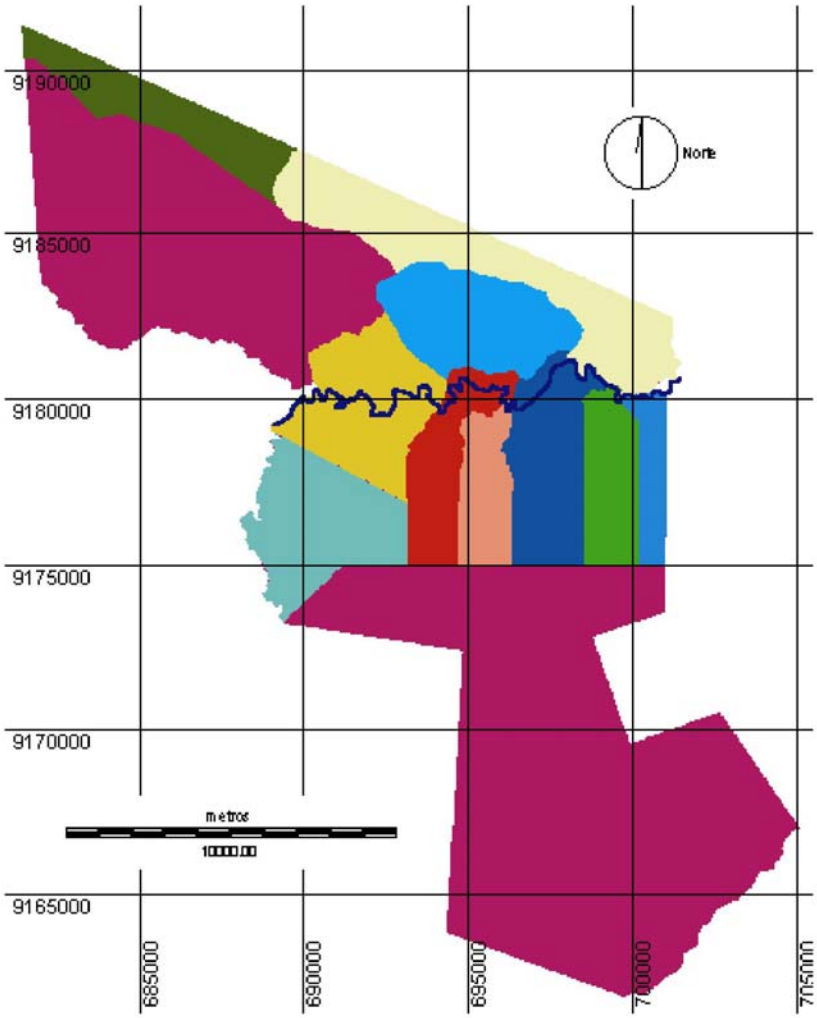


Figure 3-1 Map of Seringal São Salvador/Model Rural Sustainable Settlement Project

Rivers from Mâncio Lima. However, there is a paved road connecting the two towns and traveling between the two takes a little over an hour by bus. Seringal São Salvador is bordered to the west by the Serra do Divisor National Park, the Nukini Indigenous Reserve and the Valparaiso and Timbaúba Seringais. To the north the Seringal is bordered by the State of Amazonas and by the Peri Peri Seringal. To the east lie the Seringais of Monte Belo, Belo Monte and Boa Vista. To the south lie Fortaleza Seringal and the Bom Jardim Creek. The 282 km² area is largely characterized by dense tropical forest (82%) with várzea (seasonal floodplains) being the other principal land-cover. All rivers and creeks in the Seringal are white water streams with seasonally fluctuating water levels.

The Seringal's inhabitants are primarily former rubber tappers and their descendants with over 50% of the population younger than 18 years of age. The population is divided into 10 communities. Eight of the 10 communities (Rio Azul, Vai-Quem-Quer, Girassol, Conceição, São Francisco, Prosperidade, Boa Vista and São Salvador[1]) lie along the Moa and Azul Rivers while the other two communities, São Pedro and Timbaúba, lie along the São Pedro and Timbaúba Creeks respectively (figure 3-2). The houses are within a few minutes walk of the creek or river in order to facilitate transportation and water collection. Each community contains 5 to 24 families and 25 to 95 inhabitants respectively. The total population of São Salvador is approximately 500 people. The communities can only be loosely termed as such, since their formation took place in the last five years. However, the communities now refer to themselves as communities.

[1] Also called Sede or Engenho.



Legend:

Communities:	Area (ha):
Azul	1.603,26
Boa Vista	449,37
Conceição	1.589,04
Girassol	952,56
Prosperidade	1.350,36
São Francisco	867,51
São Pedro	2.252,52
São Salvador	705,96
Vai-Quem-Quer	1.494,99
São Pedro additional area	1.135,26
Remaining area	15.817,05
Total:	28.217,88

Figure 3-2 Map of the Communities in Seringal São Salvador

Before community formation took place, the social organization of the seringal was almost entirely based on the extended families. Politicians distributing goods for popular support created the communities since they could only give goods to individuals with complete documentation, yet desired to gain the support of their neighbors as well. Thus, they formed communities according to geographic proximity and the presence of documented individuals (PESACRE 1999).

The social center of the seringal is located in the center of the seringal along the Moa River. This area was the principal post for distributing goods during the rubber era and continues to be a gathering place for residents. This community, São Salvador, contains the community center, the Baptist church, the soccer field, the local telephone, the generator, the community television and one of the state-sponsored schools.

There is no health post in the seringal, although three health agents work in the various communities. The seringal has one other state-sponsored school along with at least five schools sponsored by the municipality of Mâncio Lima (figure 3-3). Despite the schools, over half of the inhabitants, mostly older residents, are illiterate (PESACRE 1999). There is no garbage service and inorganic garbage is usually thrown in the yard or river while organic might be eaten by animals or also thrown out. Latrines are uncommon. The most popular form of transportation in the area is by canoe, either powered by small outboard motors of less than 10 horsepower, or by paddle. The markets for products or resources collected in the seringal are Mâncio Lima and Cruzeiro do Sul. Generally, higher prices can be obtained in Cruzeiro do Sul, although another day is necessary for

transport (Shaeff 1999). Prices for products are highest when the road from Cruzeiro do Sul to Rio Branco[2] is passable.

With the decline of rubber production, the inhabitants of Seringal São Salvador are now involved in agriculture, animal raising, subsistence hunting and subsistence

Figure 3-3 The municipality sponsored school in São Pedro Community. Making friends with the children proved to be very helpful in gaining the trust of the parents and facilitated the use of participatory methods in the community. UTM 18M E0693775, N9185434, June 29, 2000.

fishing. The most common agricultural product is cassava (manioc), a food staple prepared in many ways that is highly marketable when processed into a dry flour called farinha (figures 3-4, 3-5). Corn and rice are also produced and sometimes sold. Animal husbandry is also commonly practiced, with pigs, ducks and chickens the most popular animals. In 1999, only 9% of the residents had cattle (PESACRE 1999). Cattle owners

[2] This road is usually open only one month out of the year.

Figure 3-4 Farmer with cassava roots in his São Pedro cassava field. The field contains local varieties of cassava: mariajuma, mulatinha and rasgadinha. Cassava is the staple food of the region. UTM 18M E0692785, N9186979, July 3, 2000.

rarely have more than a handful of cattle, although in 1999, one cattle owner had 35 head (PESACRE 1999). Milk is produced only for consumption. High quality timbers near water sources have been heavily exploited, and residents still sell timber when possible despite the illegality of selling timber without a permit. Other products extracted from

the forest include nuts, fruits, fibers, oil, vines, and honey among others. These non-timber forest products (NTFPs) are usually not sold, although residents use them

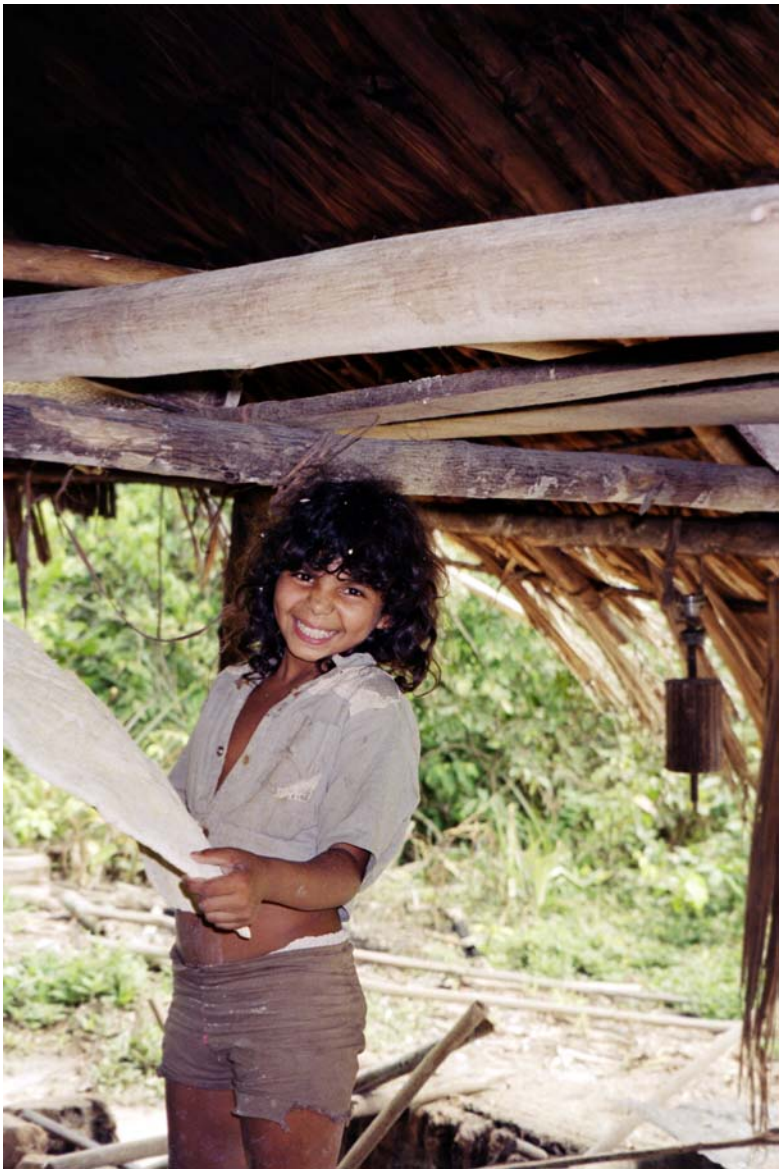


Figure 3-5 Young girl with *beiju*, a dried manioc flour pancake, in a São Pedro cassava processing house. Beiju, one of the many forms of edible cassava, is commonly eaten for breakfast and for snacks. UTM 18M E0692643. N9186924, July 3, 2000.

extensively. Hunting and fishing are both common, and serve as the main source of protein (figure 3-6). Commercial hunting has become less common due to an increasing

scarcity of game animals and government pressure, while commercial fishing has virtually stopped in the last few years. In the past, commercial fishing vessels from

Figure 3-6 Farmer with a *surubim* fish he killed with a machete in the São Pedro Creek. Fish is a favorite food in São Pedro and an important source of protein. In São Pedro, men, women, and children participate in fishing. UTM 18M E0695957, N9183944, August 2, 2000.

Cruzeiro do Sul would penetrate into the local lakes, rivers and creeks. Since the community began working with PESACRE and EMBRAPA, these boats no longer fish in the seringal (Camara 1999). PESACRE speculates that the commercial fishermen are

wary of the agencies now working in the area. Fishing for subsistence is commonplace, however, as families consume 10kg of fish a week on average, although the size and quality of fish have gone down in recent years (Camara 1999). Pensions and municipal and state salaries provide much needed cash for families: 32% of households within the seringal are estimated to have income from pensions or salaries (PESACRE 1999).

This seringal was chosen for the study because it is the site of the Model Rural Sustainable Settlement Project. This project is an initiative between the National Institute of Settlement and Agrarian Reform (INCRA),[3] the Brazilian Agricultural Research Institute (EMBRAPA)[4] and the Agroforestry Research and Extension Group of Acre (PESACRE).[5] The objective of the partnership is to plan a sustainable settlement project. This planning includes consulting the inhabitants of the proposed settlement area and scientifically evaluating existing and potential natural resources. According to the partnership, the end result will be a settlement project that is more sustainable: economically, ecologically and socially. The project has been created due to a lack of satisfaction with earlier rural settlement projects, and has the central goal of keeping people settled for the long term (Valentim et al. 1999). Because the MRSSP is a model, the process used to establish the project and management plan is as important as the project itself. The government of Brazil looks to improve on past settlement projects, and

[3] Instituto Nacional de Colonização e Reforma Agraria.
[4] Empresa Brasileira de Pesquisa Agropecuária.
[5] Grupo de Pesquisa e Extensão em Sistemas Agroflorestais do Acre.

depending on its success, is prepared to duplicate the process used in the MRSSP (Valentim et al. 1999). I was invited by PESACRE to participate in the establishment of this model project and have been able to proceed only because INCRA, EMBRAPA and PESACRE provided advice and resources fundamental to the success of this study.

Research Methods

Stages of the Fieldwork

Institutional interviews and archival work

This thesis is based on three months of fieldwork, May through August of 2000, within the state of Acre in the westernmost portion of the Brazilian Amazon. I spent the initial twenty-five days in the state capital of Rio Branco conducting informal interviews with organizations working in the MRSSP and consolidating existing maps, historical documents and other data relevant to the study site. I did not use a questionnaire for these interviews, but focused on the organizations role in the project and their interpretation of its goals. I interviewed the manager and the project coordinator of the National Institute of Settlement and Agrarian Reform (INCRA) and gained an understanding of the history and logistical challenges of the project. I also interviewed the project coordinator and soil subproject coordinator for the Brazilian Agricultural Research Institute (EMBRAPA). EMBRAPA provided more specific information about ecological and agricultural challenges of the region in addition to sharing their existing data focused on the soils and agricultural and agroforestry potential of the project. EMBRAPA was generous in allowing me the use of their Landsat 7 composite image of the area.[6] The director of S.O.S. Amazônia, an NGO focused on the conservation of the

[6] This image will be explained in more detail later in the chapter.

Amazon, was also helpful in providing access to documents concerning the biodiversity of western Acre at regional and local scales. The Environmental Institute of the State of Acre (IMAC)[7] also was helpful and provided geographical data in map form. Finally, the project coordinator and three researchers and extensionists for the Agroforestry Research and Extension Group of Acre (PESACRE) were interviewed extensively about the project, its inhabitants and the future management plan for the project. PESACRE also provided existing documents on the hunting, fishing, and commercial potential, and social-economic situation of the project.

Preliminary field visit and site selection

I spent five days in the municipal seat of Mâncio Lima preparing for the trip to the forest, and informally interviewed key informants of INCRA in Cruzeiro do Sul and PESACRE in Mâncio Lima. These informants provided more detailed knowledge about the inhabitants of Seringal São Salvador and the uncertainties regarding the existing boundaries of the project. With Eduardo Amaral "Cazuza" Borges, PESACRE extensionist, I targeted three communities (Girassol, São Pedro and Vai-Quem-Quer) within the project as possible research sites. We then began a four-day initial field visit. Cazuza Borges' role on the trip, in addition to setting up community meetings for the next trip, was to introduce me as a member of the project team. All three communities were interested in collaborating, as they understood that my work would facilitate the establishment of the project. During this trip I used a Global Positioning System (GPS)[8] to locate the communities in relationship to the project boundaries and known watercourses.

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[7] Instituto do Meio Ambeinte do Acre.
[8] Garmin 12XL.

The São Pedro Community presented the most challenges to the project due to a lack of information about its location and inhabitants. The members of Girassol and Vai-Quem-Quer had already been interviewed by a multidisciplinary PESACRE team. The team had interviewed the majority of the Seringal to identify the inhabitants and gain baseline information useful for management planning. The São Pedro Community was known to have more households than the 6 that the team interviewed. The PESACRE survey reported, "The community of São Pedro is composed of 6 families, totaling 35 inhabitants. It is situated on the bank of the São Pedro creek, tributary of the Moa River, extreme east of São Salvador. It shares a border with Peri Peri Seringal and the state of Amazonas. The lack of visible seringal boundaries make it impossible to know if the families are located in Acre or Amazonas. This is due to the uncertain boundaries of the two states"[9] (PESACRE 1999:12). PESACRE assumed, given the map of the area, that no more than 6 families could reside along the São Pedro Creek before the creek left the northern boundary of the project and the state of Acre. Cazuza Borges and I agreed that it would be most useful to the project for me to study this community, due to the mystery of its location and the possibility that additional people would need to be interviewed and identified as being part of or outside of the settlement project.

I then spent 5 days in Mâncio Lima preparing research instruments and coordinating logistics for the next trip. I interviewed the president of the Producers Association of the Rio Moa,[10] a veteran resident of Seringal São Salvador, in conjunction with one of the formal representatives of São Pedro community. The goal was to gain a better

[9] My translation
[10] Sociedade dos Produtores Agrícolas do Rio Moa

understanding of the location of the São Pedro creek and thus the community. The other formal representative of the community was also interviewed and asked about the location of the community in relation to the state and municipal maps. During the interviews I introduced and explained the GPS and showed enlarged printouts of the Landsat image of the project. I also asked the president and representatives questions concerning the number of households in the community.

Primary fieldwork

The first intensive field trip started with a community meeting on hunting and fishing rules, that also served to introduce me to the community. The trip then continued for twenty-one days. I followed this three-week trip with a three-day stay in Mâncio Lima where supplies were replenished, research materials improved and two informal interviews conducted with community members passing through town. I left for the final intensive seventeen-day field trip to community São Pedro after the three-day stay. These intensive field trips will be detailed later in this chapter.

Exit interviews

In the three days subsequent to the final field trip, I conducted informal exit interviews with the INCRA official in charge of the project in Cruzeiro do Sul, the PESACRE extensionist in charge of the project in Mâncio Lima, and the mayor of Mâncio Lima . Between August 10th and 17th I also interviewed in Rio Branco the INCRA, EMBRAPA and PESACRE project liaisons. Appendix A includes a list of some of the questions asked in these exit interviews.

The following paragraphs describe the fieldwork undertaken in the two intensive field trips to São Pedro community. I spent thirty-seven days in the community during these two field trips. I spent one of these days with the community of Vai-Quem-Quer to gain

an understanding of the southern limits of community São Pedro and their relationship with Vai-Quem-Quer and vice versa.

Sampling

Sampling became difficult after we selected the community of São Pedro over the study of both Vai-Quem-Quer and Girassol. The goal had been to study communities in their entirety and eliminate the need for random sampling. This was impossible in São Pedro community because I planned a three-day participatory methodology for each household and the thirty-eight days available were not enough to interview all the households. In the first day, Cazuza Borges and I identified twenty-one families as being part of the community, but only ten households could be interviewed in the available time. Before sampling, I was able to identify all 24 households in the community. The selection of 10 households out of the total of 24 was governed in part by logistical constraints. I relied on the families for transportation and also could only conduct research with families that were present. Gasoline was scarce, traveling by paddled canoe difficult, and families were frequently absent as they were in town stocking up on supplies for the dry season. I also selected households according to length of residence in the area. Six of the sample's households had lived in the area between 3 and 39 sequential years and thus offered knowledge of local history. Three of the families had moved into the area in the past three years and were helpful in focusing on the in-migration associated with the project. One household had lived in the area for twenty years but spent ten years away before moving back during the fieldwork. I also chose households to represent different geographic locations. As I wanted to understand the boundaries of the community, it was important that households located near the community's boundaries be interviewed. In addition, I selected to represent the diversity

of age present and therefore selected a sample with heads of household ranging from 69 to 25 years of age. Finally, I interviewed the members of the only female-headed household in São Pedro, to provide for more gender diversity.

Format of Household Fieldwork

I worked with each of the ten families save one for three consecutive days. I worked with the tenth family for three days, but the days were spread over a twenty-one day period due to logistical constraints. Each of the ten families worked with participated voluntarily. The three days were divided as follows: one day focusing on the past (in particular the year 1990), one day on the present (the year 2000) and one day on the future (the year 2010). I worked with each family as a complete unit whenever possible, and asked questions to get perspectives from household members of diverse genders, ages and occupations.

I almost always conducted participatory methods in the evening to insure participation by the whole family. We used candles and flashlights for illumination due to the lack of electricity. Each of the three evening sessions included household mapping, matrix ranking for food and income, and some semi-structured interview questions. The first evening sessions, focusing on 1990, also consisted of constructing a timeline for both head of household and spouse. The second evening session focused on the present, 2000. The third session consisted of working on modeling the future in 2010. This third session was predicated on the question, "Presuming that you receive the land that you want, what activities will you be doing in 2010, and where and to what extent will you be doing them?" The sessions usually followed dinner and tended to take two or three hours. I stayed with the family during each of the three-day sessions. These methods will be explained in more detail below.

During the day, I conducted land-use walks with household members to map the units of land in production. If all of the land units were mapped, then the day would be spent identifying the boundaries of both the household and community, or in participant observation. Land-use walks, community boundary walks and participant observation will also be addressed later in the chapter.

The three-day household interview format was useful in a variety of ways. First, it allowed me to spend one evening focused on each specific time period. Second, it allowed me to use the daylight to map all of the land that each household had in production[11] and also to map the community limits if time and location allowed. Third, over time I established a rapport with the household that greatly facilitated fieldwork. With each successive day, the households became more comfortable with the research instruments and me. Fourth, the three days provided many opportunities for participant observation that would not have been possible in a shorter time period. Finally, the three days were sufficient to introduce both the concept and printout of remotely sensed imagery, and to approximately locate the creek, house and land units on the image. This gradual introduction was extremely helpful in the third evening's mapping of future land-use. The printouts and GPS stimulated a great deal of discussion about land-use, land-cover, the household, the creek and the maps.

Household Mapping

I used household mapping strategies with each family for 1990, 2000 and 2010, producing 3 maps per household. The household mapping concept was adapted from Landscape/Lifescape Mapping as described by Diane Rocheleau and Laurie Ross (1995).

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[11] Up to 14 land units per household.

Household mapping was most effective when I had an opportunity to walk around the household land area prior to using the mapping technique. While household mapping should ideally be drawn by the participants, this was not possible in São Pedro. The participants were extremely reluctant to use the markers, and thus I was forced to draw following their physical directions (mapping with fingers). The household members gathered at night around a 26" by 37" sheet of manila paper spread on the floor. The first task was to locate the house and creek. In the case of São Pedro, the creek was always used as the primary point of reference due to its importance and proximity to the houses. Following this, the household members pointed out where the house, important landmarks, fields, pastures and other units of household land were located and their size, products, land-cover history and frequency of burning and rotation. The households mapped the diverse land units' distance from the house. Households identified neighboring houses, and I recorded their proximity on the map. I also drew animals or showed drawings of animals. Then I asked the participants if they raised that animal, why they raised that animal, and how many they raised or would raise depending on the time period being discussed. I used a reference questionnaire so as not to forget any of the questions and to record information directly when necessary. Reference questionnaires for past, present and future household mapping exercises are included in Appendix B. I also used the map to record information about the household members, household location and the location of community boundaries.

By the third night, the night focused on the year 2010, the families were accustomed to the two-dimensional visual representation of their land and resources. The household had at that time also become familiar with the concept of both GPS and satellite imagery and

seen the printouts of the composite image where I had located the creek, house and land-use units. I then used this printout to verify the location of the land-use units of both the household and neighbors and as a recording tool for the household mapping on the third night. The third night's fieldwork was based on the household's responses to the question, "Presuming that you receive the land that you want, what activities will you be doing in 2010 and where and to what extent will you be doing them?" We would discuss the ages that everyone in the household would be in 2010. Using the printout, the household member, usually the head of household, would delineate with his or her finger the extent of land that they thought would be in use. Frequently, a discussion with the household would take place before outlining the future land-use. This delineation was based on the size and location of their land units and the creek in 2000 that were already on the printout. In addition, the household talked of the lay of the actual land when discussing their future and the size, location and products of the land units to be. The households never said that the future they pointed out was a certainty but rather what they hoped would occur, given the land they sought and good luck in the ten years following 2000.

Matrices of Resources

The matrices of resources were conducted immediately following the household mapping. The matrix of resources was adapted from the Center for International Forestry's *The BAG: Basic Assessment Guide for Human Well-Being* (Colfer et al. 1999). I conducted two types of matrices. One centered on income earning activities, the other on food consumption. The whole household was invited to participate, but participation in this activity was frequently limited to the adults of the family, due to the late hour.

Before this activity began, I made 47 8” by 8” cards using poster board. On each card I drew and colored a picture representing a food item or income generating activity. I drew the objects with help from assorted photographs, members of São Pedro, Cazuza Borges and his cook, Cila. Thirty-nine of the cards were food items. Many of these thirty-nine cards were also real or potential income sources. Eight cards were not food items but specific income generating activities that were prevalent in the area. It is certain that there were other foods eaten and other income-generating activities in São Pedro, but according to the community, I accounted for the most important foods and activities. When a food or activity card was lacking for a matrix, I used a blank card to represent the missing item or quickly drew a new card. I used a table to record the results of the matrices for past, present and future. Sample tables are included in Appendix C.

The income matrix was conducted first. Initially, I spread all of the income generating activity cards on the floor and the household members were given one hundred beans per household to distribute onto the cards. The household members understood that an activity’s economic importance was ranked by the amount of beans on the card. The more beans, the more important the activity. This initial version was difficult due to the floor space needed for forty-seven cards and the time needed for the placing of 100 beans. Therefore, I adapted the income matrix. The number of beans was reduced to fifty and the household first selected the cards that earned income during that time period (1990, 2000 or 2010) before placing only those cards on the floor for matrix purposes. I recorded the results of the matrix after the household analyzed their choices and made their final decision on bean placement. This exercise was necessary because the residents, many of whom were illiterate, did not have accurate records for income. In

some cases, this might have been the first time they conceptualized the amount and sources of their annual income.

The food matrix was more time consuming than the income matrix due to the variety of foods consumed by the households. It was often difficult to place all of the cards on the floor given the small rooms and large numbers of people in the houses. Originally the food matrix required one hundred beans. I then reduced the amount of beans to fifty but finally had the household select the ten most important foods in the stack of food cards and arrange them on the floor in order of importance. They defined importance by amount consumed during the year.

Historical Timelines

The historical timeline activity was adapted from Slocum and Klaver's Time Line Variations (1995). We used the timeline on the first night of fieldwork when activities focused on the past. It was the first activity on the first night because I found it helpful in gaining an immediate understanding of the past and present of the household. We constructed timelines for the head of household and his/her spouse or another adult if the spouse was not present. I drew two lines on a sheet of 26" by 37" paper. Each of the two people were asked to talk about their past. The timeline was frequently amended as the participant remembered a forgotten detail or rearranged dates. The timelines were general in nature and built around important aspects of the participant's life (birth, marriage, migratory history, the birth of children, death of relatives, and any accidents). I wrote or drew important actions or time periods along the timeline. Discrepancies between the timelines of life partners allowed the participants and me to improve the accuracy of both timelines. The questions asked during this exercise are in Appendix D.

Participant Observation

I used participant observation as a secondary but important source of information. When time allowed, I would join in a household or community activity and later record any insights gained. I relied on Bernard's *Research Methods in Anthropology* for guidelines on how to be a participant observer (1994).

Interview Guide

I constructed an interview guide to help me focus during the evening fieldwork, to facilitate the recording of information and to record background information needed by PESACRE. PESACRE had interviewed the majority of the residents within the project and had requested similar information from families that had not been interviewed by them. A sample interview guide is included in Appendix E.

Land-Use Walks

The land-use walks I conducted were adapted from Lori Wichhart's work in *The PRA* Handbook (1995). The land-use walks were fundamental to the success of the household mapping and matrix ranking activities, as the walks allowed me to refer to the actual geography of the land when using representative tools. During these land-use walks a household member would lead me around their land. The person leading was the male head of household or an older male child. Social dynamics made it difficult for female household members to singly guide me, a male researcher. The objective was to map all of the land that the household had in production, including the yard area, pastures, farm plots, fruit orchards and when possible, recently cleared land. After arriving at the land unit, the guide led me to the points that formed the edges or corners of the unit. I marked GPS waypoints on arrival at the corners or edges of the land unit. Each land unit had between four and eleven waypoints made. In this manner, I recorded pastures, fields,

orchards, home gardens, yards and recently deforested areas. While inside the land unit, I asked questions about the products within the unit and their utility to the household. I also recorded GPS reference waypoints in areas of different land-cover between and beyond the land units. I later used these waypoints to ground truth the base image. Before the first land-use walk of each household, I introduced the Global Positioning System and the satellite concept and showed an image printout of the enlarged area. The first point taken would be of the house, and the house would be located in relation to the creek. I discussed and noted aspects of the land between the land units such as topography, boundaries between household areas, sites of timber extraction or canoe building, and sites of houses used for manioc processing. During the land-use walk the participants and I would discuss the location on the printout of the various land units in relation to each other, the creek and the house. By the third evening, I had the locations of the existing land units plotted on the printout. We conducted land-use walks every day until all of the household's land in production was measured. I did not measure the older growth and secondary forest used for hunting, vine and wild fruit gathering during these land use walks. This was a regretted omission of the study but a necessary one because of the large stretches of forest used by each household and the difficulty in identifying its limits.

Mapping of the Watercourse

I began the mapping of the creek during the three-day exploratory visit of São Pedro. The existing maps' representation of the creek was uncertain as the waypoints collected by the researcher did not correspond with the maps. The GPS was set to tracback[12] mode

[12] Tracback is a feature of the Garmin 12XL GPS that allows for automatic waypoint establishment and plots a course following these waypoints.

during the ascent of the creek. This registered the general course of the creek though it did not record every turn made by the boat.

At the beginning of the next field visit to the community, I mapped the creek again using the GPS until I reached the second most distant resident from its mouth. The first day of fieldwork consisted in paddling four and a half hours upstream on the creek (figure 3-7). Four of those hours were spent farther upstream than the most distant resident from the creek mouth. I mapped the creek along the way. On return, fieldwork with the ten-targeted families resumed. However, I continued to use the tracback feature each time I traveled along the creek. I also took GPS waypoints for each of the ports used by the households, which added to the creek data. Finally, immediately after a series of severe rains, I contracted a community member to take me down the portion of the lower course of the creek that had not been recorded yet due to low water levels. I recorded this portion again using the tracback feature and later drew the creek on the printouts to facilitate the participatory methods described earlier.

Mapping of Community Limits

Community-based mapping has become increasingly common in recent years as geomatic technology becomes more user-friendly and less expensive. There are many published accounts of community-based mapping that were useful examples for this study and that also describe the extreme sensitivity of this practice (Bird 1995; Brown & Alechandre 1995; Chapin 1998; Chapin et al. 1995; Flavelle 1995 ; Fox 1998; Jarvis & Stearman 1995; Kosek 1998; Marozas 1991; Monteiro 1994; Nietschmann 1995; Peluso 1995; Poole 1995; Rocheleau 1995; Rundstrom 1998; Saragoussi et al.(In preparation); Smith 1995; Stone 1998; Toledo Alcaldes Association 1997). Peter Poole sees these local mapping applications falling into five categories which generally precipitate each

other in the following sequence: recognition of land rights, demarcation of traditional territories, protection of demarcated lands, gathering and guarding traditional

Figure 3-7 A São Pedro resident paddling a dugout canoe on the São Pedro Creek. These canoes or larger ones with an outboard motor are the primary means of transportation within the community UTM 18M E0690698 N9186185, June 28, 2000.

knowledge, and management of traditional lands and resources (1995). This aspect of the study focused primarily on defining community limits and comparing those limits with existing maps of the area.

The mapping of community limits was conducted during the three-day household sessions, or at times during daylight hours of the three-day sessions if land use walks had already been conducted. The community limits were only established in a general sense. This is partly because the limits had not been precisely defined in the past nor marked on the ground and also because of the impossibility of cutting a path through the rainforest. Instead I walked the existing hunting and transportation trails radiating from the community. The most important landmarks (according to the community guide) were marked as waypoints. Two communities bordered São Salvador to the east and south. To the west and north of the community existed tens of kilometers of rainforest with a few abandoned rubber tapping sites. These sites were well known to the veteran members and active hunters of the community.

I investigated the limits to the south of the community with various members of the community and took GPS waypoints of important landmarks. In addition, I spent an evening with the community to the south and facilitated the construction of a community map focused on their perceived northern boundary (figure 3-8). I also investigated the limits to the east of the community with the community member most knowledgeable of the area. I georeferenced his understanding of the limits between his land (also the limits of the São Pedro community) and the neighboring community, Peri Peri. The limits to the north of the community were investigated using three different southerly hunting trails. Landmarks were georeferenced according to the knowledge of three separate guides. I investigated the limits to the west by going four hours upstream northwest of the last inhabitant of the São Pedro Creek.

Figure 3-8 Vai-Quem-Quer Community residents display their community boundary map. The entire community participated in the construction of this map. UTM 18M E0694462 N9182385, August 3, 2000.

Community Meeting to Discuss Limits

After compiling these landmark waypoints, I created a 9' by 4' map showing the course of the creek from the Moa River until its last waypoint taken during the fieldwork. The map showed the larger clearings or developed areas along the creek in both São Pedro and the communities that bordered it. On the last day of fieldwork, I held a community meeting. I showed the map and placed the houses of the community inhabitants with the help of the community. A discussion began, with the community deciding what the limits of São Pedro were. The community relied foremost on the knowledge of both veteran and outlying members to identify approximately where the community's boundaries might be. No map had ever been made of the community's boundaries and it is likely that the community had never devoted so much thought to their

community's limits. At the conclusion of several hours the community arrived at a consensus of where its approximate limits were. The limits corresponded to many of the landmarks that I georeferenced earlier with the GPS and I recorded these landmarks on the map as well (figure 3-9).

Figure 3-9 The community of São Pedro display their community map inside the school in São Pedro. UTM 18M E0693775, N9185434, August 6, 2000.

Use of the Global Positioning System

The Global Positioning System (GPS) I used, a Garmin 12XL receiver, was a crucial research instrument. I recorded the waypoints in Universal Transverse Mercator units so as to make distance estimates in meters from the units. The datum used was South American 1969, which uses the same ellipsoid as the Australian National Datum[13]. The

[13] At the 1967 meeting of the IUGG held in Lucerne, Switzerland, the ellipsoid called GRS-67 was recommended for adoption. It is used in Australia for the Australian

receiver performed very well under most conditions. During land-use walks the waypoint was marked and the number and place immediately written down in a field notebook. Many times I also sketched the point's location in the notebook. It was important to always carry a number of extra batteries and a plastic bag to protect the instrument from heavy rains or immersion in the creek. I found it helpful to turn on the GPS before beginning work, leaving it outside for five minutes while it connected with as many satellites as possible. This insured that it would have a stronger connection when one reached the land unit to be measured. The GPS did have problems connecting under heavy canopy. Thus, the tracback feature was unreliable under the canopy despite its utility on the water. Instead, I stopped at important landmarks and tried to connect to the satellites. Connection to satellites might have been facilitated by an antennae. I recommend using an antennae as at times I had to bind the GPS to the tip of a 15' pole and hold the pole and unit overhead for five minutes to get a connection. The same procedure would have to be used with an antennae but in that case one could see if the GPS had connected rather than guessing with the entire GPS unit in the air. Waypoints were almost always marked when at least four satellites had connected strongly to the GPS. The exception was during the community boundary walks when five-meter accuracy was impossible under the canopy. On returning to the house I was working from, I transferred all waypoint numbers, descriptions and coordinates into another field book. I also recommend the purchase of a GPS computer cable to transfer the data directly into a computer as entering the data by hand is a laborious process.

Geodetic Datum (Australian National Datum) and in South America for the South American Datum 1969 (U.S. Defense Mapping Agency 1984).

Remote Sensing Imagery

EMBRAPA gave me an August 1999 Landsat 7 5-4-3 band composite image of the area (Path 5, Row 65). This 1333 Column and 1167 Row window had no cloud cover and had been registered previously. There was no complete metadata on the exact nature of that registration. It had been registered with four Ground Control Points with an RMS error of .000545 kilometers. The reference system was denoted as Plane.

After the preliminary field trip, I created color printouts of the image. Using the GPS waypoints marked on the trip I identified the clearings that were associated with the residents of São Pedro. This was facilitated by the landscape, since the image showed the area to be almost completely covered by forest with occasional patches of other land-cover (later identified as pasture, orchards and fields). Unfortunately, São Pedro Creek did not show up in the image, although the Moa River did. The creek is too dry in August (one of the driest months of the year) to be identified on the satellite image. I was unsuccessful in finding a cloud-free image of the area at any other time of year but the dry season.

I printed out forty enlarged areas of the image to use with community residents. In addition, using Idrisi software, I overlaid a Universal Transverse Mercator (UTM) grid onto five enlarged areas of the image and printed them out. These printouts were necessary to match waypoint coordinates with the image printouts. However, the grid made the image more difficult to see and was thus not used during the household interviews. Instead, when I mapped the creek, land unit, or other feature on the gridded printout, I transferred it onto the plain printout for household mapping. This process was time consuming and difficult due to the light conditions and lack of appropriate work-space. Printing both a gridded and non-gridded version of each scene used in the field

would have been an improvement. More than one non-gridded printout may be useful if multiple participants are going to be mapping. I used onion paper extensively to reuse the printouts without marking them permanently. However, this is not ideal as the onion paper makes printouts difficult to use under poor light conditions. A waterproof cover is also helpful as ink jet color printouts are highly susceptible to smearing in the rain. I also suggest, as it was recommended to me, to find and register one's own image before going to the field, thus having the complete metadata available and the desired datum and reference system.

Geographical Information System

I constructed a Geographical Information System (GIS) using the spatial and ethnographic data gathered. This GIS uses Arc View software with the August 1999 Landsat 7 5-4-3 band composite (Path 5 Row 65) as the base image. I created two vector data files (shapefiles) of the 77 polygons representing land units in 2000 and the 51 polygons representing land units in 2010. Other vector data files in the GIS include São Pedro's houses, two neighboring communities' houses, São Pedro's ports, São Pedro's manioc processing structures, São Pedro's self-defined limits, household limits between 6 São Pedro households, two interpretations of the state line (and northern project boundary) according to the federal constitutions of 1942 and 1988, the official approximate project boundary, the hydrography according to the official maps, the location of São Pedro creek, and soil studies and agriculture and agroforestry suitability studies of the project. Attached to the vector data files is tabular information entered from the ethnographic field methods discussed earlier.

The most difficult part of constructing the GIS was using a base image in an unknown projection with very little metadata. The key individual with knowledge of the data had

left the state of Acre, and I was unable to access the appropriate metadata. Nevertheless, the image almost exactly matched the GPS waypoints taken in the study. The difference was a maximum of 20 meters. Due to my extensive notes and waypoints (over 800 points taken), the forty days I had spent in the community, and the limited amount of clearings in the rainforest, I was able to identify this discrepancy. At times I was measuring plots of land that entirely encompassed a clearing: walled in on all sides by mature rainforest. This made matching the land-unit to the clearing on the image a straightforward exercise. I resampled the image to 26 ground control points while projecting the new image in WGS 1984. This resampling had an RMS error of .0077. The resulting image shifted only slightly but did match better with the land-units measured. The result is a GIS containing new data of local creeks, the community boundaries of São Pedro and the land-use and land-cover change of the community.

CHAPTER 4
A COMPARISON OF LOCAL AND OFFICIAL INTERPRETATIONS OF SETTING AND BOUNDARY

Introduction

This chapter defines the setting and boundaries of the community of São Pedro[1] according to the community of São Pedro. I contrast this local knowledge of setting and boundaries with the official knowledge of INCRA. The purpose of this comparison is to recognize the contributions that local knowledge of setting and boundaries can make to natural resource management. In the first section of the chapter I compare knowledge of setting. I use archival research to find important inconsistencies between existing INCRA maps while the results of the participatory mapping exercises reveal official maps to be in error concerning the location of the São Pedro Creek, the community of São Pedro and the boundaries of the MRSSP. Satellite imagery alone could not identify these errors due to poor resolution, seasonal cloud cover and dense jungle canopies. If local geographic knowledge is not incorporated into the MRSSP, then the reliance on incorrect maps will greatly complicate management planning.

In the second section I analyze the mismatched boundaries caused by existing distorted maps and by variance between state lines and community interpretations of local boundaries. The second section also describes existing resource conflicts and land tenure issues that transcend both community and official boundaries. Recognition of

[1] São Pedro may not fit many definitions of community, as described in Chapter 2. However, the people there now refer to their area as a community and the term will be used for the purposes of expediency and ease of reading.

boundary options and resource conflicts can improve natural resource planning while reducing resource conflict. Before addressing these issues I introduce the crucial role that maps have in the process. My results find that local knowledge of setting and boundaries is potentially useful in correcting existing maps, reducing conflict over resources and improving natural resource management.

Knowledge of setting is crucial to natural resource management, since good management requires baseline information on resources and terrain. Boundaries help define the areas to be managed while also playing an important role in conflicts over resources and land tenure. The location and type of boundary can create or reduce conflict depending on the resource and situation. Local people, because of their local knowledge, can be an important source of resource, terrain and boundary information. This is especially true in the Amazon region where robust data and adequate maps are scarce.

The creation of modern NRM plans and settlement projects is based on maps, which have frequently been made without local people's participation. In the past, these maps have been accepted due to the lack of an alternative. Recently, however, disagreement between local perceptions and official maps has become well documented, giving rise to many alternative mapping initiatives (Bird 1995; Brown & Alechandre 1995; Chapin 1998; Chapin et al. 1995; Flavelle 1995 ; Fox 1998; Jarvis & Stearman 1995; Kosek 1998; Marozas 1991; Monteiro 1994; Nietschmann 1995; Peluso 1995; Poole 1995; Rocheleau 1995; Rundstrom 1998; Saragoussi et al; Smith 1995; Stone 1998; Toledo Alcaldes Association 1997). These mapping disagreements can frequently escalate into map wars where one is forced to map or be mapped (Toledo Alcaldes Association 1997).

Unlike some of the map wars in the counter-mapping literature, this Amazonian study does not concern a violent struggle for land rights. However, different perceptions of land tenure boundaries have created tension over resources: several farmers' free range pigs ate neighboring crops, another farmer planted on a neighbor's land without permission, and outsiders strung nets across the São Pedro Creek. This tension currently surfaces between communities and community members, but could become a local people versus "official expert" controversy if existing official maps are not modified to reflect local geographic knowledge. Both officials and locals are interested in representing the land as accurately as possible, in order to create and ensure the success of the MRSSP. However, differences in perception about setting, limits, land tenure and resource use may require some painful compromises, such as a reduction in free-range pig raising and cattle ranching or an adjustment of community boundaries. Local knowledge of setting and boundary must be presented accurately, so that all stakeholders may have an improved understanding of the São Pedro area, residents, resources and land-use. If local knowledge is not presented, then the current misconceptions of landscape, boundaries and resource use might be incorporated into the MRSSP.

Map Power

The power of maps is undeniable (Monmonier 1991). Harley has deconstructed maps, finding them to be important instruments of imperialism and nationalism where those with strength in the world add to that strength through the power of maps (Harley 1989). The European colonial powers used maps for legitimizing conquest, economic exploitation and cultural imperialism. Some of the current conflicts in Africa can be partially blamed on colonial maps that claimed land and resources while ignoring existing social and political structures. As important sources of information, maps are guarded

and often deliberately distorted to further a goal. Soviet intelligence controlled and suppressed cartographic information to such a degree that United States intelligence service pocket maps of Moscow were more accurate than the maps of Moscow produced for the Soviet Union's own citizens (Monmonier 1991). Maps of the same area can say very different things depending on the data used and the goals of the mapmaker. The choice of one map over another can therefore have important consequences for the landscape represented.

Maps of the Brazilian Amazon present their own special challenges. Because the area is largely frontier and little is known about its vast areas, maps are few, rarely challenged by others and often wrong. Brown, an Amazonian researcher, says, "In many developing countries… the basic maps have inadequate detail, are out-of-date or inaccurate, or all three"(Brown & Alechandre 1995: 55). Smith describes official maps in Peru, " Because of their scale and their sources, they have a relatively large margin of error built into them; using GPS, our team has confirmed on-the-ground errors of 500 meters and more for features on these maps" (1995: 43). Thus, Amazonian government officials and others using area maps are challenged to make important decisions with very little, and often erroneous, information about the areas they are deciding on.

INCRA is no exception. INCRA, like other government organizations working in the Brazilian Amazon, depends in part on geographical data from the Radar Survey of the Brazilian Amazon project (Projeto RADAM or RADAMBRASIL). The Ministry of Mines and Energy conducted this survey between 1968 and 1977. The program used synthetic aperture side-looking radar imagery in an attempt to catalogue the biological and mineral resources of the Brazilian Amazon. This immense undertaking produced

maps of the geology, mineral deposits, waterways, soils, vegetation and potential land use for the region. Thousands of site visits were made to support the radar data, but because of the breadth of the Amazon, this ground truth information is inadequate at many scales. The Amazonian maps produced by RADAMBRASIL are based on surveys at 1/100,000 (Rankin 1985).

The Juruá Valley portion of RADAMBRASIL appears to have been elaborated in two periods: February to June of 1974 and February to May of 1976. Both of these periods are during the Upper Juruá Valley wet season. This process included radar, infrared photographs and fieldwork on the ground. Virtually all of INCRA-Acre's maps of the region are based on the RADAMBRASIL study. The exceptions are new maps being created by the Ecological-Economic Zoning (ZEE) initiative of the Forest Government of Acre. Even these new maps still have to rely on the RADAMBRASIL project for most information on waterways smaller than rivers. At the level of the settlement project, maps based on RADAMBRASIL can provide some general information but may be missing details or have incorrect information. A missing cartographic detail or slight inaccuracy can have important ramifications for a settler whose lot is penciled onto the map. Indeed, any error in the making of maps or the transferring of information from one map to the next can create havoc in a settlement project. INCRA has a history of ignoring topography or smaller waterways due to a lack of detailed maps and ground truth studies (Cronkleton 1998). However, the arrival and increasing affordability of spatial information technology, and collaboration with other groups with baseline data, indicate that INCRA may be improving its record. Yet, dense cloud cover, thick jungle canopies and limited resolution complicate interpretations of satellite imagery. Spatial

information technology, in the absence of accurate maps, therefore requires extensive ground truthing and local geographic knowledge. The MRSSP is an opportunity for INCRA to investigate whether local geographic knowledge can be useful for future settlement projects.

Shifting Names and Phantom Creeks

In this portion of the chapter, I will compare INCRA maps to demonstrate some geographic uncertainties of the area. This exercise shows that existing maps of the area are inconsistent in addition to being incorrect. The inaccuracies of these maps indicate a need for improved mapping of the area. Following this comparison, I will introduce the community map of the area and compare it to INCRA's official maps. The community map is much more accurate in its depiction of the São Pedro Creek and the location of the São Pedro community. The accuracy of the community map will force the MRSSP to make some important decisions regarding the demographic and geographic reality of the community of São Pedro.

To indicate some of the problems with the current system, let us look at six INCRA maps of the MRSSP area. All six maps (figures 4-1, 4-2, 4-3, 4-4, 4-5, 4-6) have the RADAMBRASIL project as their data source.[2] The earliest map is the RADAMBRASIL map from 1977 (figure 4-1) and the latest from May of 1998 (figure 4-6). A quick glance at the five maps shows that the waterways are all based on RADAMBRASIL data and the length and direction of the waterways is consistent. Figure 4-6 is based on this as well though some detail has been omitted. Let us focus on the three creeks[3] indicated by

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[2] Unfortunately, some maps lacked complete legends or metadata. Nevertheless, the data is sufficient for this exercise focused on place names. Where data is available, it is included.

[3] Igarape in Portuguese, Ig.or IG. on many maps.

arrows. Each creek runs into the Moa River from the north and all can be readily identified and compared between maps. Focusing on creek A, we progress from figure 4-1 to figure 4-6. Figure 4-1 calls the creek Paraná João Bezerra, figures 4-2 through 4-5 name it the São Pedro, while figure 4-6 supplies no name. Creek B remains nameless. Creek C reveals the largest range of possibilities: in figure 4-1 it is the São Pedro, in figure 4-2 the Soco, in figure 4-3 the Sacado, in figure 4-4 the Saco and in figure 4-5 back to the Sacado and in figure 4-6 it becomes the São Pedro.

It is unlikely that the local people living along creek C use these four names interchangeably when referring to their water source. One can imagine their reaction on being told what the name of their creek is. The comparison brings to mind a quote from a Nicaraguan skipper looking at the United States Defense Mapping Agency's charts of the local Nicaraguan reefs: "None of the names we use are here. This is not a map of our reefs. This map is like a birth certificate with the wrong name on it" (Nietschmann 1995: 36).

This point is underscored by the switching of the location of Seringais Belo Monte and Monte Belo from figure 4-1 to figure 4-6.[4] The map comparison points out the human error associated with mapmaking and the lack of reliable data in the area. The question that arises is, for example with creek C, what is the correct name of the creek?

[4] These *seringais* are to the east of São Salvador. It is unfortunate that mapmakers have to contend with naming scenarios like these adjoining land units whose only difference in name is the order of the two words.

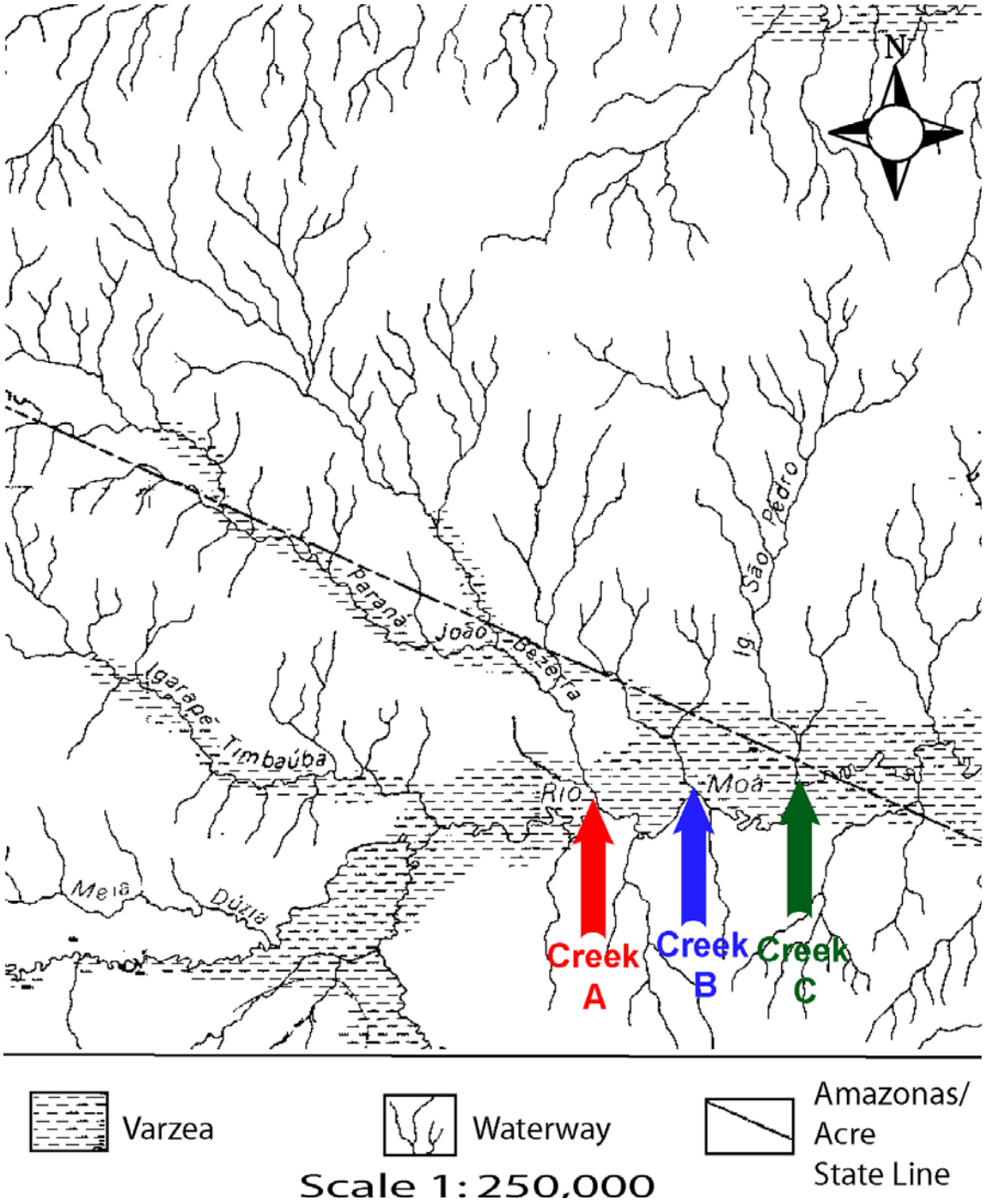

Figure 4-1 INCRA map of Seringal São Salvador region. This 1977 map is from the RADAMBRASIL project of the Brazilian Ministery of Mines and Energy.

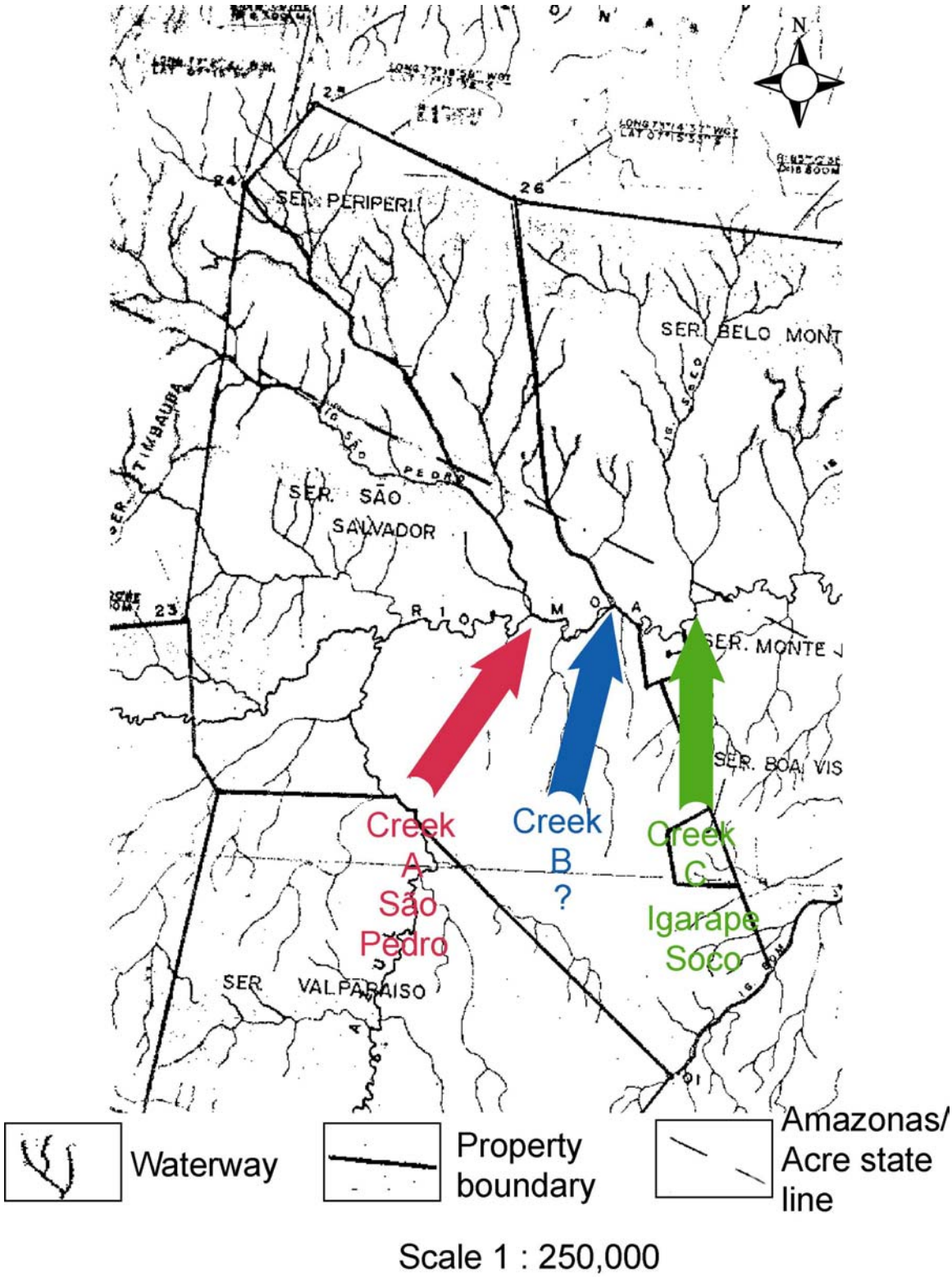

Figure 4-2 INCRA map of Seringal São Salvador. This Map of the Projeto Fundiario Alto Juruá was made June 9, 1979.

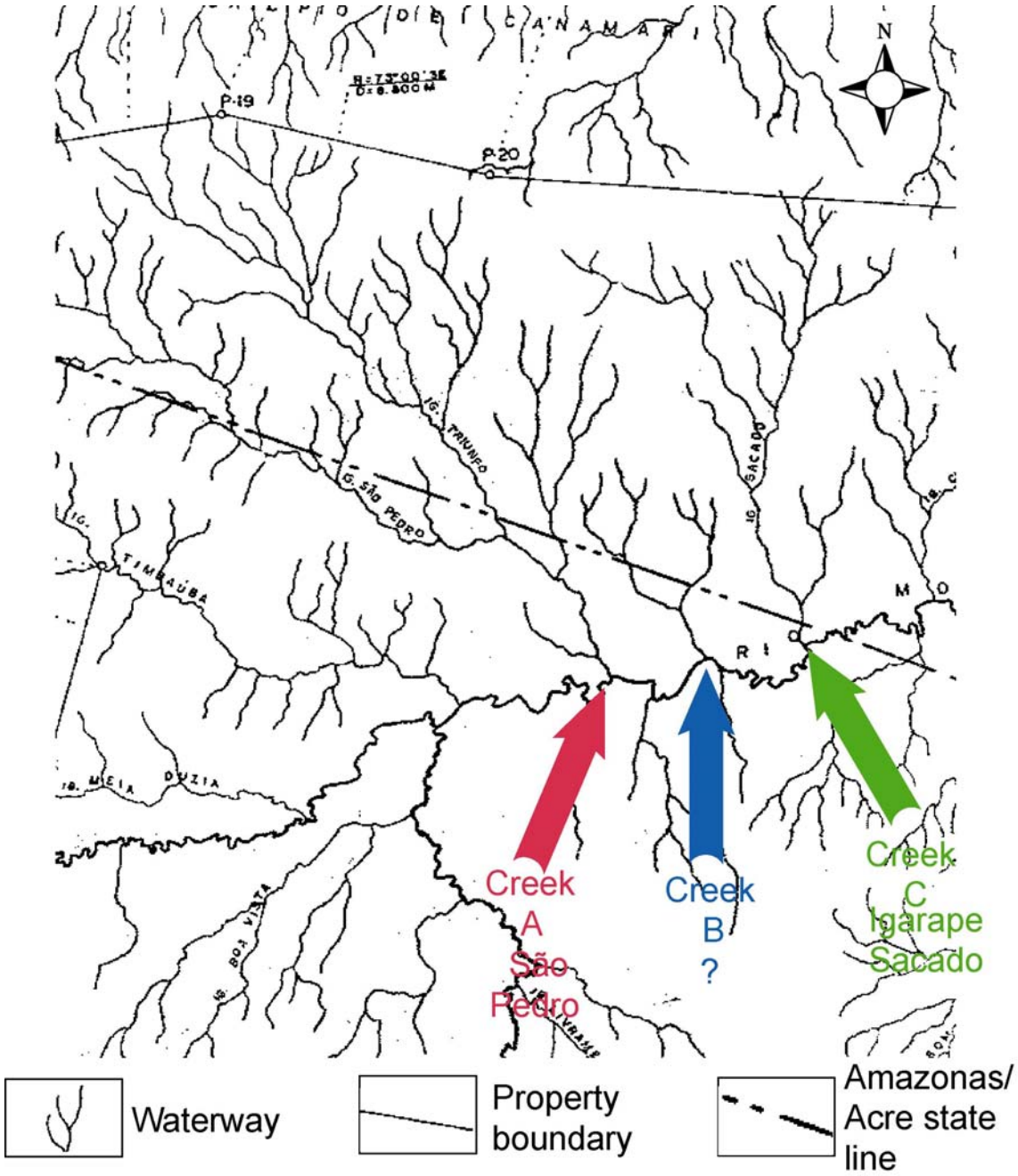

Figure 4-3 INCRA Map of Seringal São Salvador region. No meta data available.

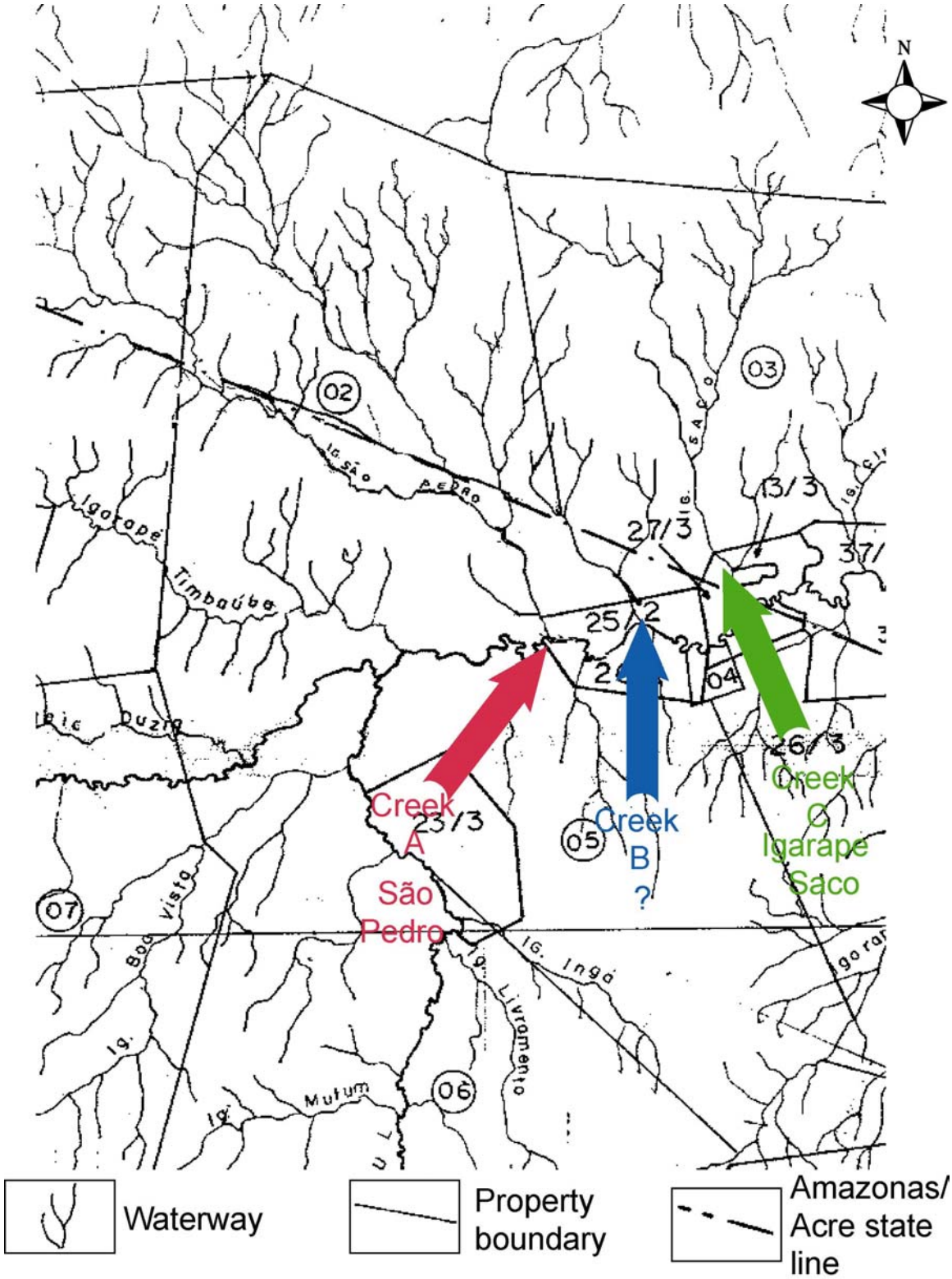

Figure 4-4 INCRA Map of Seringal São Salvador. No metadata available.

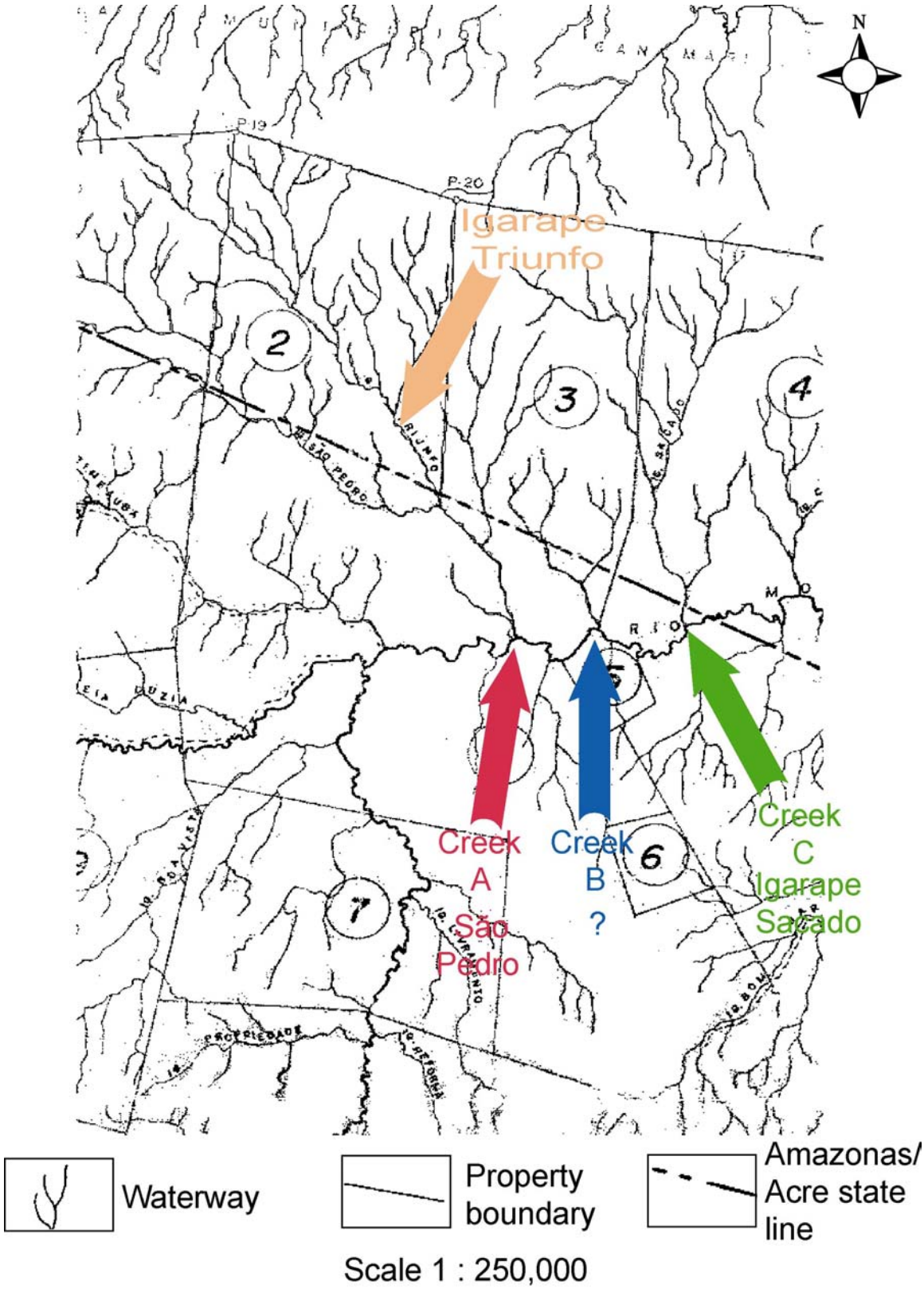

Figure 4-5 INCRA Map of Seringal São Salvador. This map of the Projeto Fundiario Alto Juruá was made after 1979.

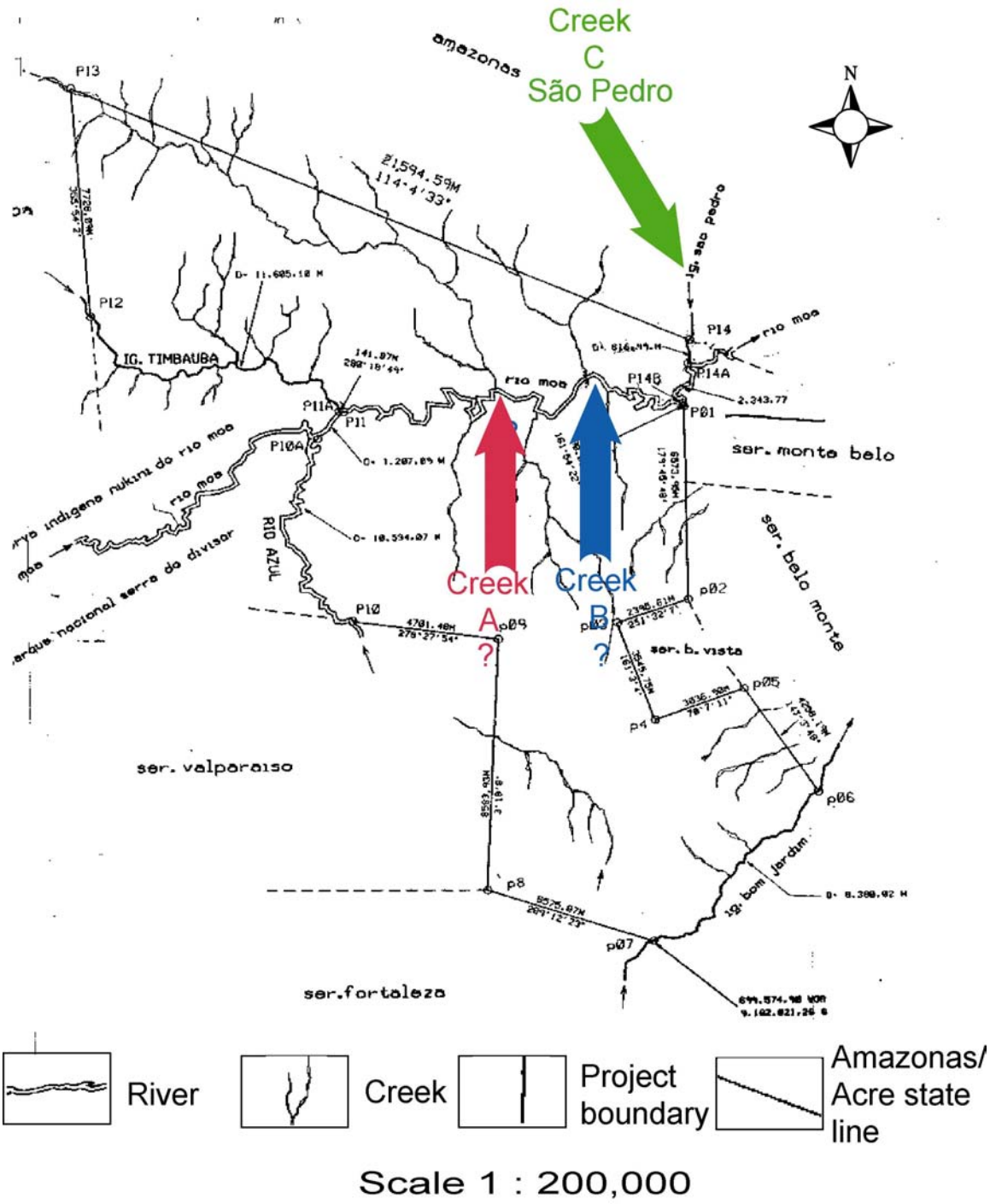

Figure 4-6 INCRA Map of Seringal São Salvador. This map was made May, 1998.

This is followed by: who knows what the correct name of the creek is? Finally: does it matter what the name of the creek is?

The people most likely to know the correct name of the creek are the people who live along it. Unfortunately, rural producers, such as the people living in the area, are not likely to be readily available to INCRA. Even if present they might not be comfortable with modern cartographic methods. Therefore, given the logistical constraints of taking a full day canoe trip up the Moa River to the community, the third question might be asked: does it matter? A cartographer might say that it matters because accuracy matters. More specifically, in this case, it matters because the creek is the boundary between the Peri Peri Seringal and the São Salvador Seringal. São Salvador is in process to become a settlement project and the estimated boundaries are needed for its creation. However, if existing maps are incorrect and satellite imagery has insufficient resolution to address a problem at this scale, then local geographical knowledge must be incorporated to correctly map the area.

PESACRE sent a multidisciplinary team up this creek and all others in Seringal São Salvador while compiling the baseline data on the inhabitants. Although they gathered an impressive amount of information, the multidisciplinary team continued to struggle with the location of the Seringal's limits. INCRA provided figure 4-6, a rough estimate of the limits. PESACRE personnel did not see figures 4-1 through 4-5. That the residents live along the water facilitated the data collection. But how far up Igarapés Timbaúba, São Pedro[5] and Rio Azul did the research team need to go before exiting the project? Team

[5] As shown on figure 4-5.

members had almost no experience with their GPS, but wanted to clarify the uncertain boundary areas along the three waterways. The most puzzling area was the São Pedro, where GPS coordinates taken from a boat put the team in the middle of terra firme on the map. This led team members to question both their ability to use the GPS and the accuracy of the map.

When PESACRE showed the map (figure 4-6) to the local people and asked about the three creeks, they were told that the creeks did not exist. Verifying the existence and pinpointing the location of the three creeks was crucial to address land tenure issues and to develop a management plan for the people of the MRSSP. Cazuza Borges, PESACRE extensionist, was rightfully concerned about this issue:

> The map produced by INCRA…. has a series of errors identified in our fieldwork…. we need to have better maps from INCRA with better satellite imagery. Certainly, we need to invest more time in the search for better data, like satellite images, aerial photos and other maps to have a more realistic picture… INCRA has not mapped the area for many years…. The location of the seringal is complex. It abuts other seringais, the state of Amazonas and the PNSD. However, none of these boundaries is actually defined…. Surely, INCRA has a good cartographic base and a skilled mapmaker who knows the region well and could contribute to the elaboration of new maps of São Salvador.[6] (Borges & dos Santos 1999: 1-2)

Unfortunately, INCRA did not have anyone with a detailed knowledge of the area. Sebastião Dumont, an INCRA official, recognized the possibility that RADAMBRASIL data could be wrong: "The location of the creeks could be incorrect. The RADAMBRASIL was done in 1977 and with few resources. It could have grave distortions… In the Japiin River we found a creek that moved a kilometer and a half and another one that disappeared completely." In addition, existing satellite images did not visually represent any bodies of water in the area except a few lakes and the Moa and

[6] My translation.

Azul Rivers. This issue is common for any researcher using Landsat satellite images of the Amazon. Dense clouds cover the Amazon during the majority of the year. This usually makes high quality imagery of the land-cover available only during the dry months. Unfortunately, the dry months are also the time when water levels within the Amazon are at their lowest and waterways shrink. These creeks are frequently closed over by the jungle canopy and thus difficult to see from above. The 30-meter resolution of the image then makes creek identification difficult. This was the case for satellite imagery of the São Pedro Creek.

EMBRAPA overlaid the watercourse data from RADAMBRASIL onto their satellite image.[7] The yellow RADAMBRASIL hydrography is shown in figure 4-7. Because the creeks did not show up in the imagery, RADAMBRASIL data are the only creek data available. PESACRE's work was complicated by the geographic uncertainty of the area, and the team worked only with the first six families on the São Pedro Creek, which they interpreted as creek C on figure 4-7. They assumed that any family farther up the creek was in the state of Amazonas and thus outside of the project boundary. Figure 4-7 shows the project boundary in violet. The diagonal northern boundary on the map also functions as the state line, dividing Acre to the south from Amazonas to the north.

The uncertain geography was problematic, as PESACRE was unable to answer residents' questions concerning their inclusion or exclusion in the INCRA settlement. INCRA's maps were flawed and technology, in the form of satellite imagery, had proven inadequate. Community members could not make sense of the creeks on the map.

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[7] August 1999 Landsat 7 5-4-3 band composite (Path 5 Row 65)

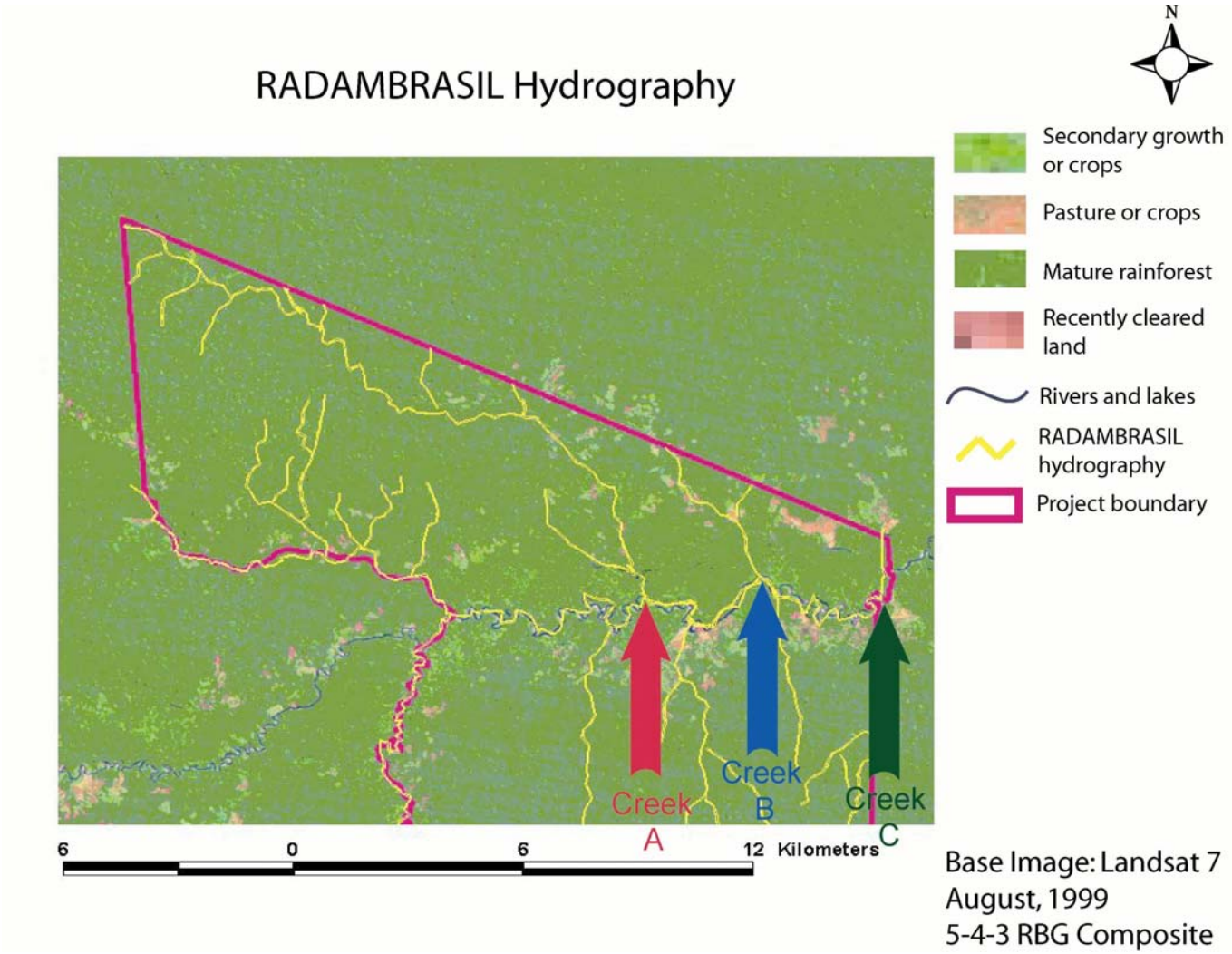

Figure 4-7 Map of RADAMBRASIL hydrography

This is the environment in which I began the research. I was able to map the São Pedro creek using a GPS with the help of community members. Georeferencing local knowledge, in the form of the name and location of the São Pedro, identified a greater problem than the misnaming of creeks. The RADAMBRASIL data were wrong. INCRA may have had four names for one creek but it was immaterial, as that creek, as represented, did not exist. Figure 4-8 shows the correct location of the São Pedro in dark blue against the incorrect RADAMBRASIL data in yellow. Where the RADAMBRASIL project identified three creeks, there is only one. The São Pedro's source is off the map to the northwest but the map does show the general direction of that source (general direction of São Pedro Creek). The map also uses two GPS points to show the general direction of two of the main tributaries of the São Pedro: the Triunfo and the Vai-Quem-Tem. The Triunfo can also be located by name on figures 4-2 and 4-5. One important cartographic issue is seasonal variability of the waterways in the area. The RADAM project conducted research during the wet season. São Salvador is largely várzea near its main rivers and creeks. These areas are flooded in the rainy season and the radar survey named these as permanent creeks despite these areas being underwater for only part of the year. Thus, they are impermanent waterways that cannot be relied upon for transportation, water collection or fishing during the entire calendar year. It is understandable that the radar would show these areas as water during the rainy season. However, the map is inadequate as a base map because it misrepresents the reality of the landscape and the inhabitants.

The represented creeks are also wrong for other less easily explained reasons. There is no creek C running south into the Moa. Instead, the mouth of creek C is the

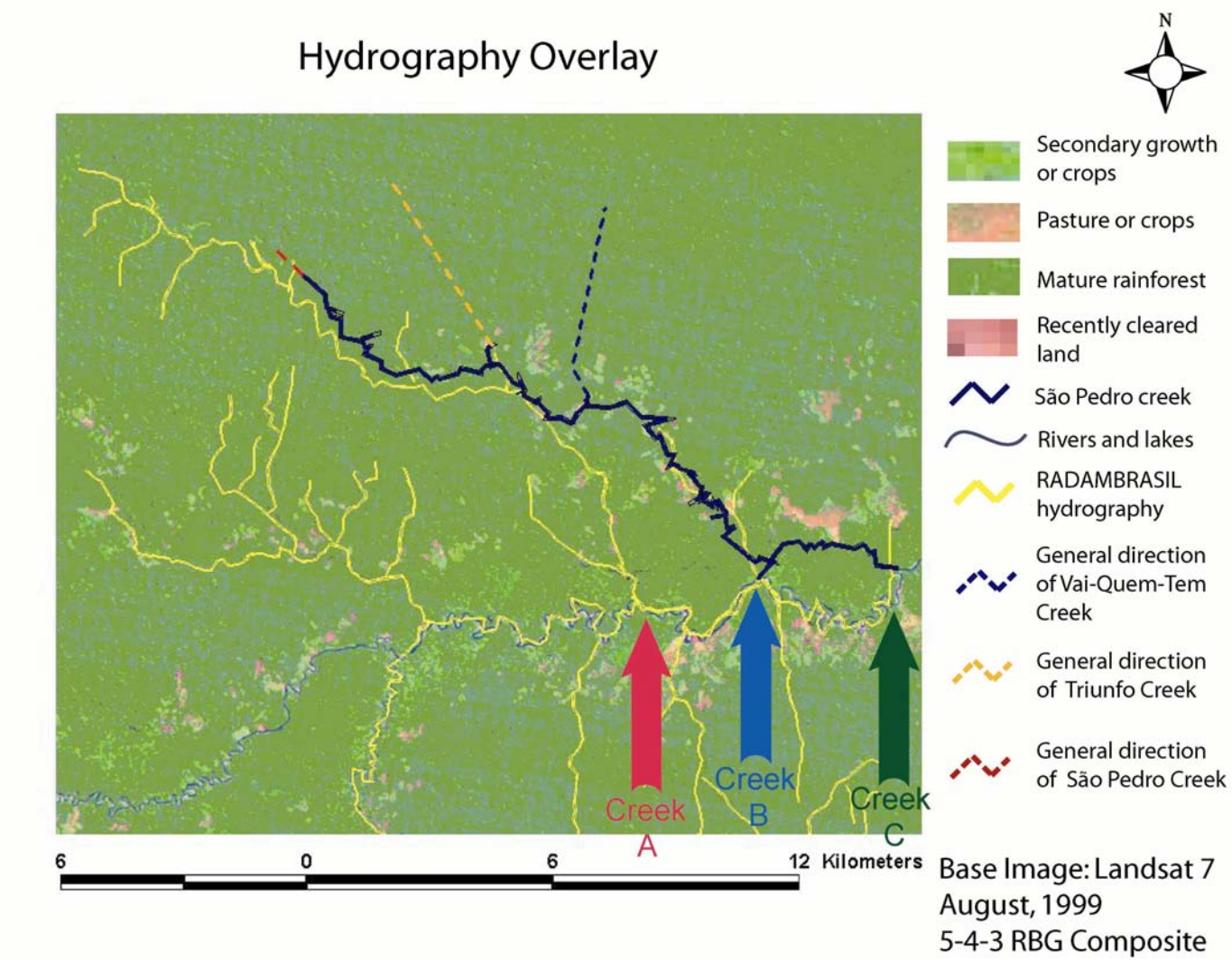

Figure 4-8 Map comparing RADAMBRASIL and community creek data.

location of the mouth of the São Pedro Creek.[8] But, as shown in dark blue on figure 4-8, the São Pedro creek runs east into the Moa. The RADAMBRASIL creek C, in yellow, running south into the Moa might only be a rainy season event or perhaps a cartographic error. Another error is the gap between creeks B and A. The real São Pedro, in dark blue, connects the two RADAMBRASIL creeks, in yellow. Community members unanimously declared that the creek always ran east/southeast across that area. They were also unanimous in their declaration that the São Pedro only ran south into the Moa at the second mouth. This mouth is pointed out in red on figure 4-9. One creek variation documented by local residents was this second mouth that broke through to the Moa River giving the creek two entrances from the Moa. According to residents, eleven years ago, water only flowed to the Moa through the second mouth during the wet season. A decade ago the creek permanently broke through and now in the dry season runs faster than the first mouth. Residents denied that any other changes had ever occurred. They agreed with one elder resident, who, when asked about other changes, said, "This creek has been the same way all my life." Even this new mouth formation does not explain the cartographic inaccuracies. RADAMBRASIL's three creeks are one. The name of the creek is the São Pedro. Paraná João Bezerra is a name that local people never used for any body of water in the area. The creek called Soco, Saco, Sacado and São Pedro is the São Pedro but is also incorrectly represented as flowing from the north. According to the community of São Pedro, the Socó creek is the next major creek to the east of São Salvador Seringal. The Saco and Sacado are not known.

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[8] As named and understood by the community of São Pedro.

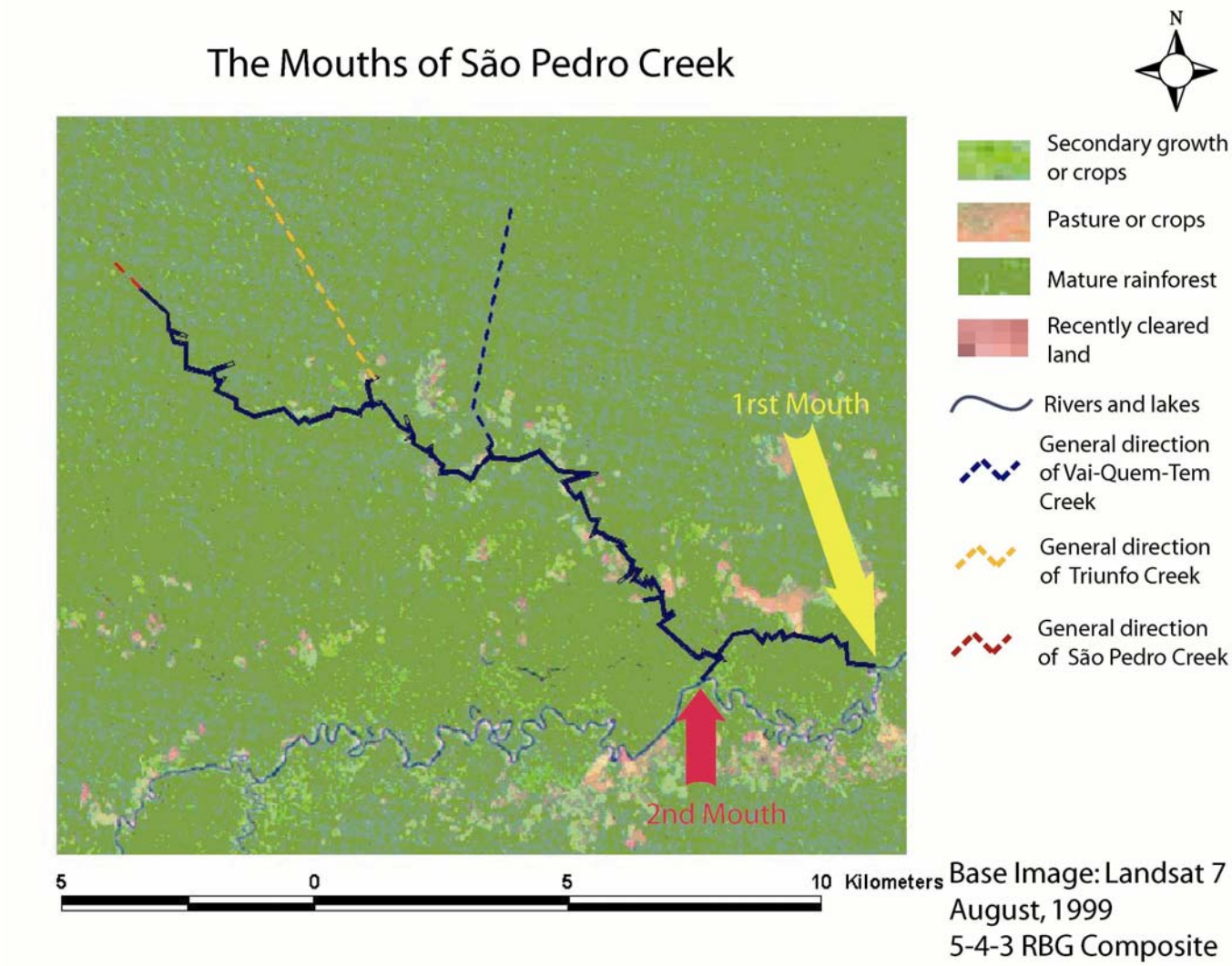

Figure 4-9 Map of the Mouths of the São Pedro Creek.

The poor representation of these creeks, both in name and location, is critical. Any management plan of the area must deal with the geographical reality of the São Pedro Creek with all of its ramifications for location, transportation, resource availability and other issues. The imposition of the existing official map onto the landscape could cause grave problems in the project. The majority of the São Pedro Creek and the community of São Pedro would be wrongfully excluded from the project, while the inclusion of two non-existent creeks would cause great confusion for management planning.

Mystery Boundaries

In this portion of the chapter I will address four important boundary issues of the community of São Pedro. The first issue I will discuss is the ambiguity of the Acre/Amazonas state line along with the ramifications this uncertainty might have for the MRSSP and São Pedro. The northern border of both the project and the São Pedro community is the Acre/Amazonas state line. The principal difficulty is the existence of two disputed state lines. Selecting one or the other will radically change the amount and location of land officially controlled by the MRSSP and the São Pedro community. Currently, community members are actively using land outside of the state and project boundaries.

I will also discuss the moving of project boundaries due to the improved understanding of the São Pedro Creek location. Superimposing the correct creek location on the official map transforms the outer boundaries of the MRSSP. The creek functions as an administrative boundary, and thus any correction of its course on the map also changes the boundary.

In addition, I will analyze the community of São Pedro's boundaries. The São Pedro community has its own culturally and ecologically grounded community boundaries. Not

surprisingly, these do not always conform to official project boundaries regardless of the corrected creek location and the adoption of either interpretation of the state line.

Finally, I will address the real and potential inter and intra-community boundary conflicts. These conflicts involve resources and land tenure and are important to recognize given that boundary selection can increase or decrease conflict in an area. Understanding the types of resource conflicts can help decide which type of boundary is appropriate and where the boundary should lie.

PESACRE only studied the six southernmost households of the São Pedro community during their participatory survey. They decided not to study more households, as the existing map indicated that any additional families would be north of the state line and thus in Amazonas state. The project's northern boundary is Amazonas state because INCRA-Acre is in charge of the project and has no jurisdiction in Amazonas. This state line is not marked on the ground. With the community's help, I was able to identify the 24 houses of the São Pedro community. A comparison of coordinates of the houses and the state line revealed that all 24 were within the boundary of Acre. Figure 4-10 shows the location of the houses and the state line/northern project boundary. I interviewed the yellow houses shown in figure 4-10 for three days apiece. The red houses constitute the remaining houses in the community. Again, the georeferencing of community knowledge proved crucial. The combination of technology and local knowledge transformed the São Pedro community from a place divided by or outside the map into the largest community within the project.

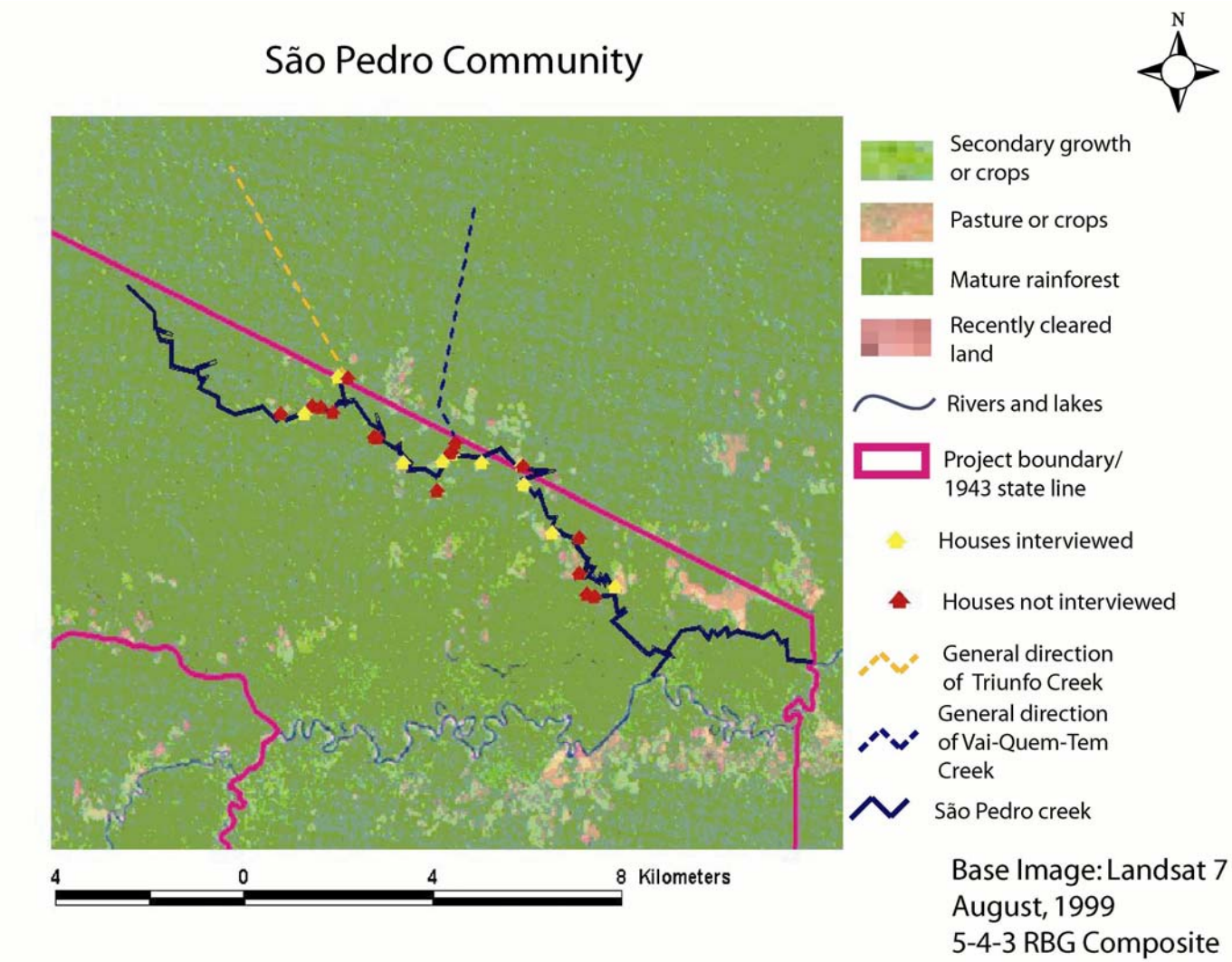

Figure 4-10 Map of the São Pedro Community

The state line of Acre/Amazonas remained an issue in São Pedro because the community straddles the political boundary. An imaginary line connecting Latitude / Longitude coordinates 7°07'32.71"/ 73°48'02.82" and Latitude / Longitude coordinates 07° 37'40.59"/ 72°39'30.82" dictates who lives in Amazonas and who lives in Acre: anyone living north of the line is an Amazonas resident; anyone living south of the line is a resident of Acre. The violet project northern boundary line in figure 4-10 also represents the state line. Only Acre residents were inside the INCRA project and thus able to receive its benefits and or suffer its drawbacks. There were also larger ramifications concerned with one's affiliation with the state of Acre. One might become an Amazonense[9] when one's whole life one had considered oneself Acreano.[10] A newly identified Amazonense might need new documentation and the time and capital costs needed to get it: getting to the nearest administrative center of Amazonas state requires at least three days of travel. Before the INCRA project, the locals did not doubt that they were Acreanos; this first became an issue in 1996 when INCRA officials interviewed creek residents only on the southern side of the creek. When asked why they did not talk to the other residents, they said that the northern side of the creek was in Amazonas.

The Acre/Amazonas line bears further investigation because of its history and the national, regional and local mystery of its location. Figure 4-11 shows the permutations the line has gone through in its history, as well as the shifting borders of the state of Acre

[9] A person from Amazonas.
[10] A person from Acre.

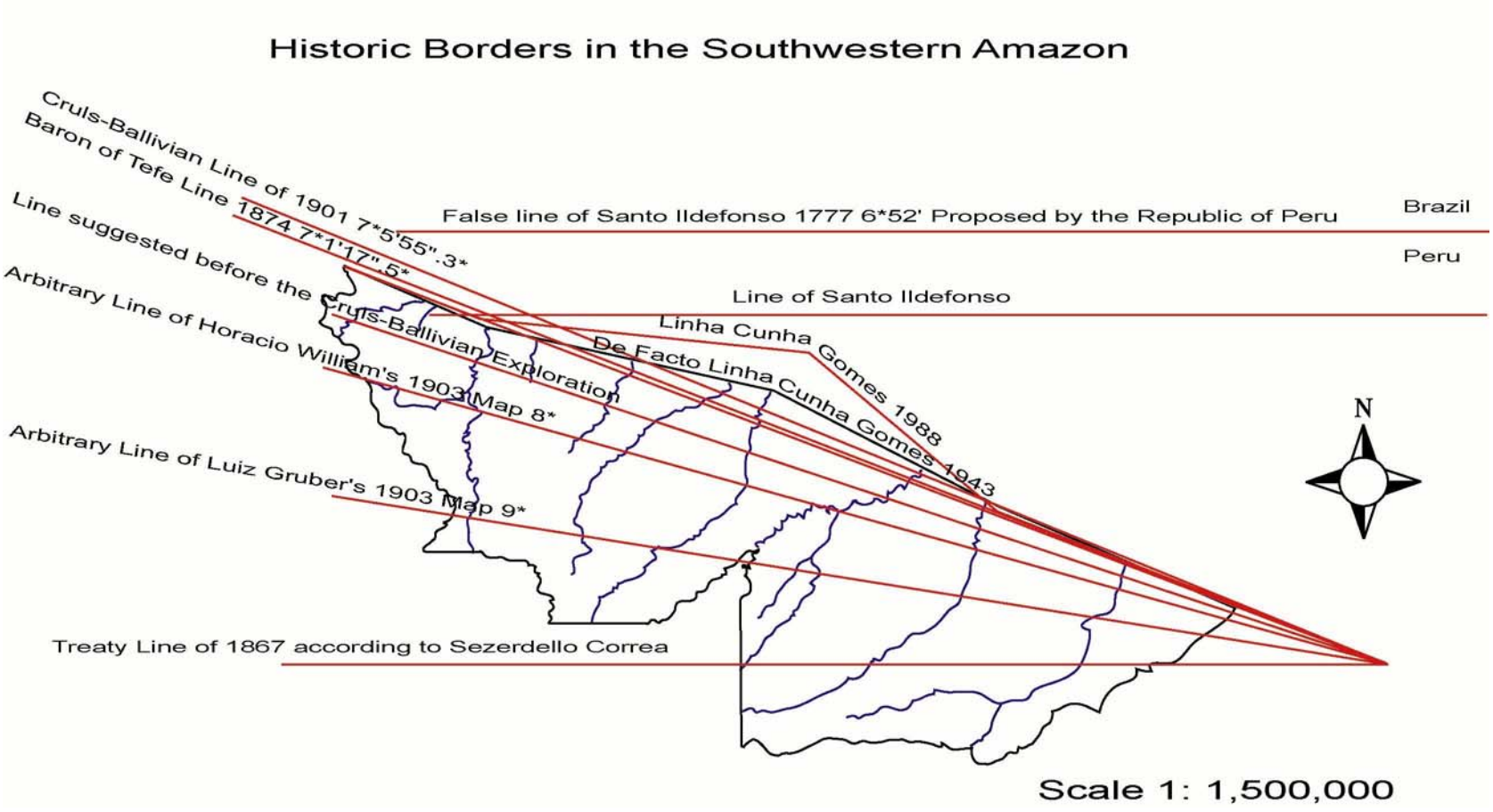

Figure 4-11 Map demonstrating the diverse lines promoted as boundaries between Brazil and Bolivia/Peru or the Republic of Peru and the states of Acre and Amazonas.

and the nation of Brazil.[11] Of particular importance is the comparison of the current line, De Facto Linha Cunha Gomes 1943, and the boundary called Linha Cunha Gomes 1988. The 1943 line is the state line as it is recognized today. According to one official in INCRA, this line is not legal but is the line currently used by both the states of Amazonas and Acre.[12] However, the 1988 line represents the new state line as stated in Article 12, paragraph 5 of the 1988 constitution.

According to one INCRA official, the reason behind this move was to create more space in Acre for the expansion of the cities of Cruzeiro do Sul and Sena Madureira. Both are located on the border, and apparently were also the reasoning behind the creation of the 1943 line. Given the constitutional article, the logical assumption is that the 1988 line is the official state line. However, IBGE, the Brazilian National Institute of Geography and Statistics, resists demarcating the new line[13] despite an order from the Brazilian Supreme Court. Why the federal organization resists is not clear, although one member of INCRA speculated that Amazonas, a powerful state in Amazonia, has influenced IBGE. Amazonas is choosing not to recognize the 1988 line because of potential loss of territory. The dilemma of this uncertain state line creates a fuzzy official state boundary between the 1943 and 1988 line. Fuzzy or ambiguous boundaries are common among many traditional peoples. However, most internal official boundaries

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[11] After rebellions of Brazilians against Bolivia in 1899 and 1902, Brazil bought Acre from Bolivia for 2 million British pounds and a promise to complete the Madeira railway into Bolivia. This purchase was the Treaty of Petrópolis, December 17th, 1903 (Hemming 1987).

[12] For more information on the Linha Cunha Gomes controversy, one might consult with Vicente Brito of INCRA-Acre who is both knowledgeable and passionate about the subject.

[13] The 1943 Linha Cunha Gomes lacks any visible demarcation in the São Salvador region.

have more clarity than the fuzzy official boundary created by the 1943 and 1988 Linha Cunha Gomes.

Despite the controversy caused by the multiple lines, in 2000 INCRA-Acre was committed to working with the 1943 state line as the *de facto* state line until informed otherwise by INCRA national headquarters. However, communications received in 2001 referred to the eventual expansion of the state, and thus the project, to the 1988 state line. Although the state line may be uncertain, INCRA has now officially created the 282 km² area project, and the 1943 line is the northern boundary. However, on the ground, the only boundaries visible in 2000 were ecological ones. In working and living with the people of São Pedro, it became clear that they were managing land north of the boundary. While all of the houses of São Pedro are inside the state line, the fields of many of the community residents lie north of the boundary. These fields are shown as irregular blue polygons on figure 4-12. The majority of the terra firme on the north side of the creek lies in Amazonas. Community members plant almost exclusively on terra firme. In addition, São Pedro and other communities of São Salvador use the lands to the north of the boundary for hunting (figure 4-13). Up until nine years ago, when residents were still tapping rubber, various rubber trails and at least three São Salvador colocações were located north of the border. One of these colocações, known as Japonesa Colocação, was 7.5 km north of the northernmost house in the community. In a hike[14] to and from the deserted colocação a community guide and I encountered multiple bands of 9 different

[14] This hike to and from the Japonesa colocação took two days. We walked for six and a half hours before arriving. The return trip took slightly less time.

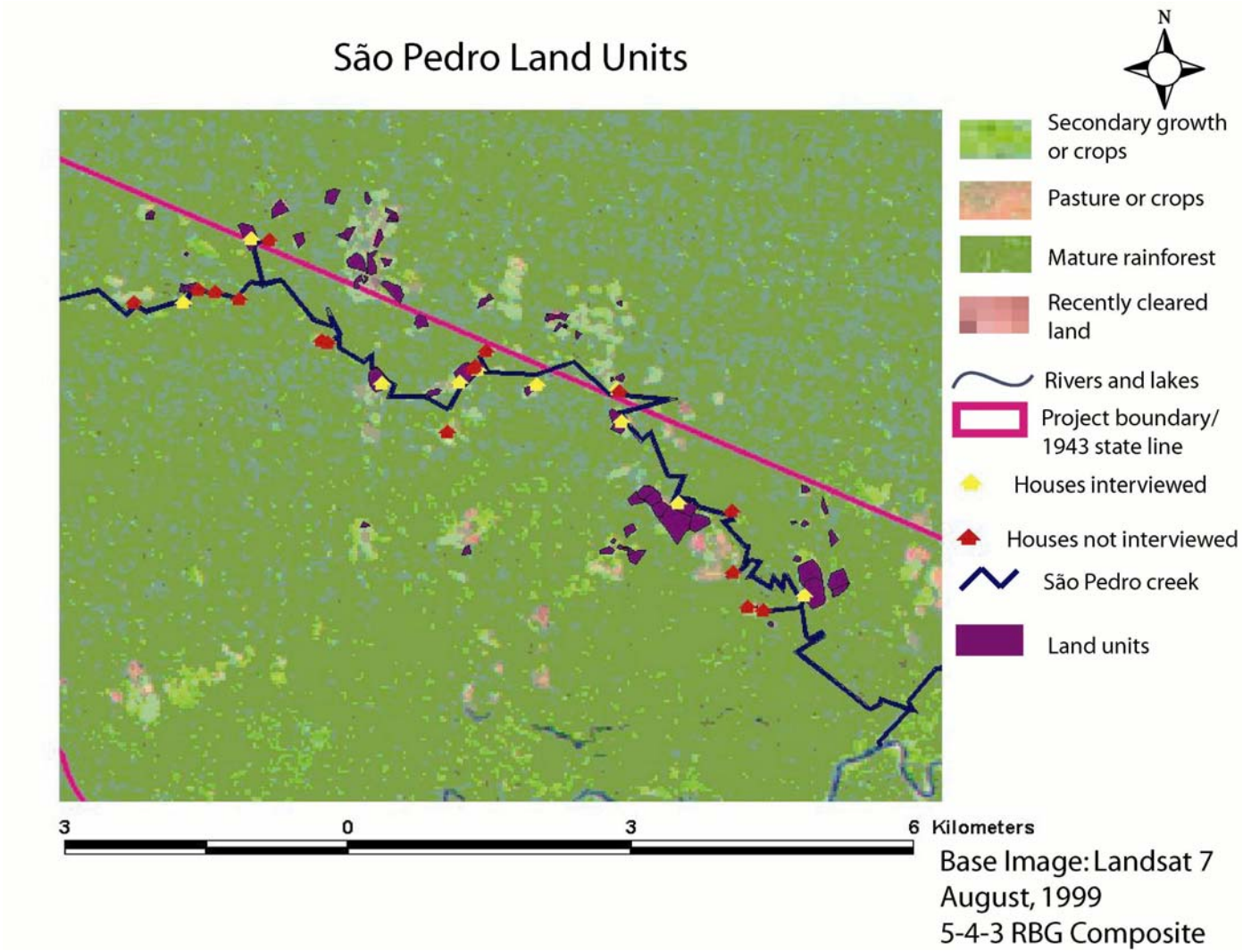

Figure 4-12 Map of the land units in the São Pedro Community

Figure 4-13 São Pedro resident holding a Nambu Galinha shot on a hunting trail north of São Pedro in Amazonas state. This area is rich in game and has numerous hunting trails and hunting lean-tos constructed by São Pedro residents. UTM 18M E0697419 N9184814, August 3, 2000.

types of monkeys (Saguinus spp., Saimiri spp., Cebus Apella, Lagothrix spp., Alouatta seniculus, Pithecia spp., Ateles spp., Callicebus spp. And Cebus spp.) (Fonseca et al. 1996; Fragoso & dos Santos 2000; Kinzey et al. 1997). The general direction of the hike can be seen on figure 4-14 by following the dotted line from São Pedro Creek to Japonesa Colocação (represented by the violet house to the north). Numerous game birds were also seen as well as abundant peccary and tapir tracks. Community members also extract timber and non- timber forest products from this area north of the state line.

The current and historical community land-use north of the boundary for perennial and annual crops, hunting and extraction challenge the notion that this community is

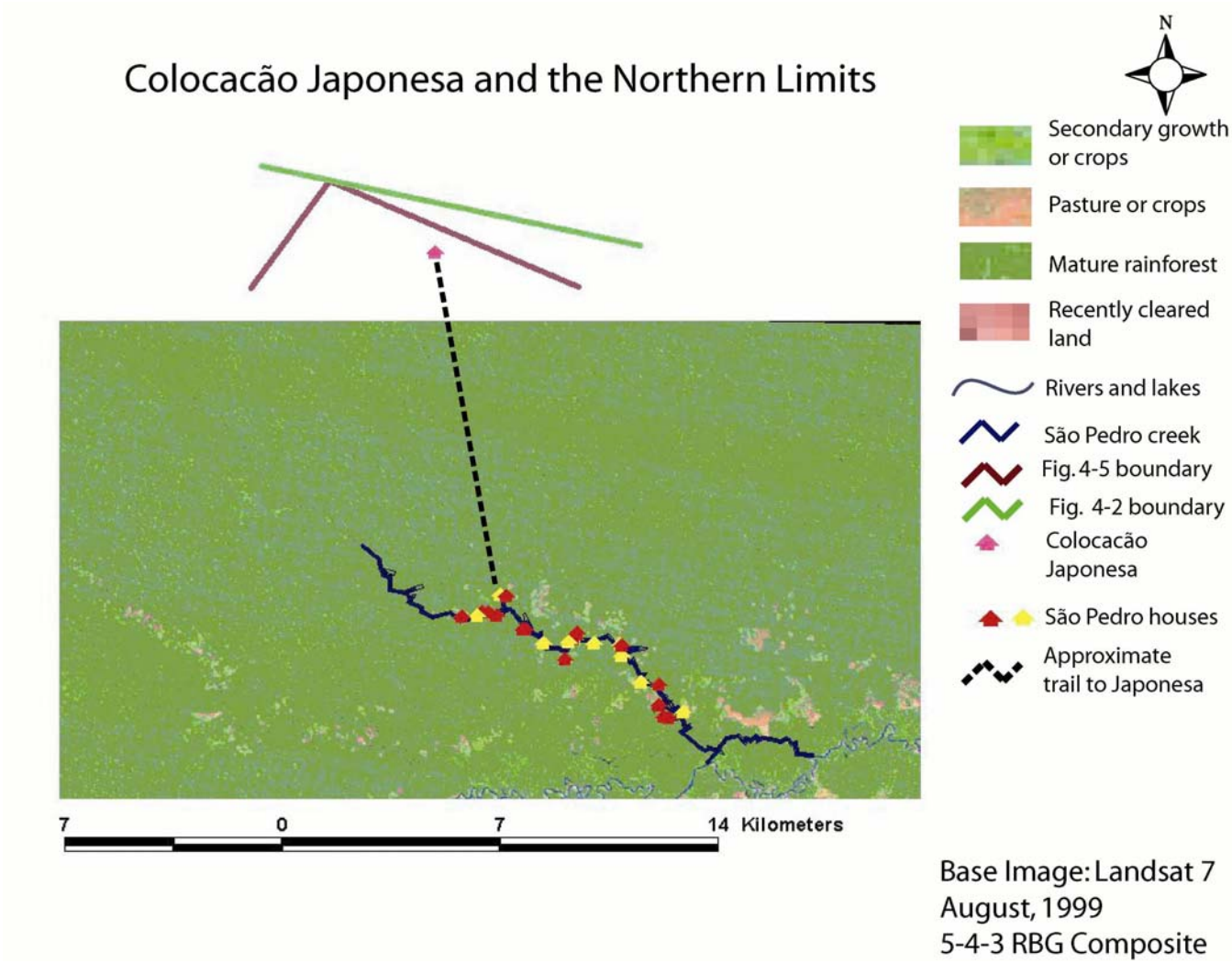

Figure 4-14 Map of Colocão Japonesa and the Northern Limits.

bounded by the state line. This community data is supported by INCRA documents (figures 4-2, 4-4 and 4-5 for example) demonstrating that historically the São Salvador Seringal has extended to the north of the state line. Figure 4-14 shows the northern official boundaries of São Salvador according to figures 4-2 and 4-5 (in green and purple) in comparison to Japonesa Colocação (the violet house). Participatory mapping with the community yielded a map of community boundaries (shown in yellow) overlapping the official state lines (in red and violet) (figure 4-15).

The community limits shown in figure 4-15 were created in a community-wide meeting. The northern limits of the community were cited as the watershed divide between the Moa and Ipixuna (Boa Fe) Valleys. This natural boundary resonates with the community to a much greater degree than the invisible state line. The community decided that the Japonesa Colocacão (violet house to the north of limits in figure 4-15) was not part of the community limits despite historically being tapped by community residents. The rationale was that the colocação is on the other side of the divide and thus should be part of Boa Fe. Contact with people from the other watershed is minimal, although a far-ranging São Pedro hunter might occasionally see a hunter from the other side. The western boundary the community cited was the former Vinte-Quatro Colocação which lies about four hours paddle farther up the creek than the last resident of São Pedro. Community members tapped the trees of this colocação before the decline of rubber prices. This distant boundary is also characterized by limited contact with outsiders. There is a hunting trail of the Timbaúba community that passes through Colocação Vinte Quatro but nobody lives farther up the creek. São Pedro community members hunt paca on this section of the creek (figure 4-16). I noted an abundance

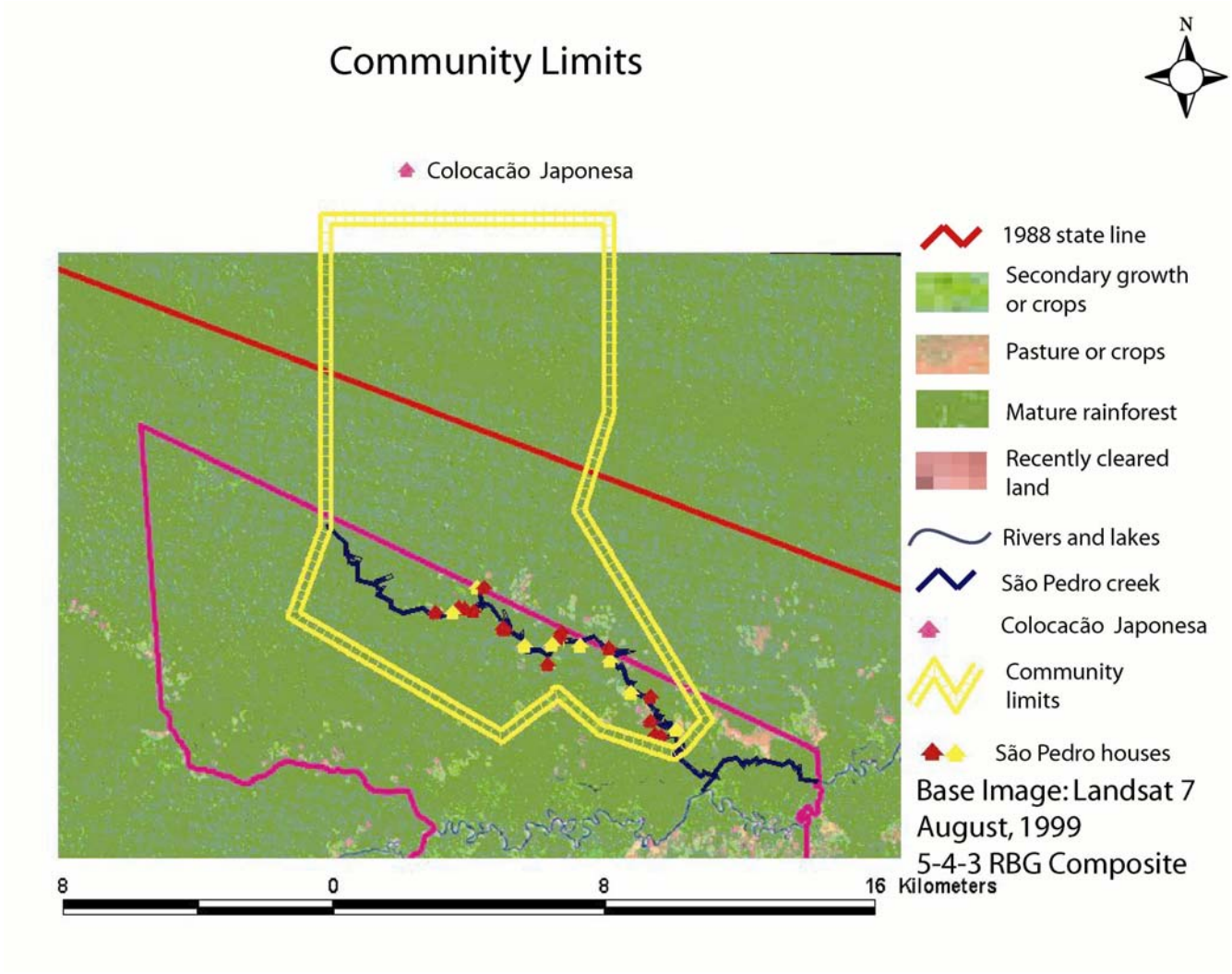

Figure 4-15 Map of the Community Limits of São Pedro.

Figure 4-16 Three generations of hunters squat next to a paca killed by a shotgun trap. Paca is one of the most prized meats of the forest. Wild game is a primary source of protein for community residents. UTM 18M E0693821 N9185426, July 7, 2000.

of paca tracks alongside this stretch of the creek.

The southern and eastern limits are close to other communities. To the south lies the São Salvador community of Vai-Quem-Quer. To the east is another seringal by the name of Peri Peri. The southern boundary is already a source of contention between the communities of São Pedro and Vai-Quem-Quer. Three principle issues have been raised. One issue was the clearing of São Pedro secondary growth and its subsequent planting of manioc by a Vai-Quem-Quer community member. There have been no confrontations over this boundary issue. Both parties are aware of the issue and the individual from Vai-Quem-Quer does not intend to pursue further cultivation in the area. The São Pedro individual is not interested in confrontation if nothing else comes of the incident.

The other two issues are more contentious. One issue is the placing of nets by non-community members across the mouth of the São Pedro Creek. This action, according to São Pedro residents, limits their own fishing ability by disrupting the flow of fish up the creek. Their community fishing rules[15] have now banned this activity, but it remains to be seen whether future confrontations will take place if nets continue to be strung across the mouth of the creek.

The final issue involves semi-wild pigs (figure 4-17). Pigs are an important source of income and food for community residents.[16] As one resident put it, " Pigs are worth money all year." Pigs have historically been raised in the seringal by giving them free range of the baboca.[17] In the baboca, the pigs find naturally growing foods such as fruits and nuts. In the past, free-range pigs were not a menace as there were less people and during the rubber period, less agriculture. Now these free-range pigs frequently find manioc or cornfields nearby and can eat prodigious amounts of these crops in a short time. A group of pigs can wipe out a field and imperil an entire family's subsistence needs. In figure 4-18 one can see that pigs owned by one resident range as far as the last house upstream. Pigs owned by another resident have gone wild and cause havoc in the fields of Vai-Quem-Quer. Vai-Quem-Quer must plant close to São Pedro because the majority of the land near their houses (houses in orange in figure 4-18) is várzea. Reactions to these invasions are varied. The people of Vai-Quem-Quer have begun to shoot these wild pigs in part to stop their predation on crops and in part because they

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[15] The creation of these rules was facilitated by PESACRE extensionist Cazuza Borges.
[16] This issue will be addressed at length in the following chapter.
[17] The baboca is seasonally flooded rainforest characterized by wet soils, a plethora of climbing vegetation and the presence of many palms.

Figure 4-17 A free-range pig waits for manioc scraps outside the front steps of a São Pedro house. Pigs are an important source of income for São Pedro residents and can live exclusively off of the nuts and fruits of the forest. However, an increase in annual crop production has made these semi-wild pigs more likely to invade and destroy local crops. UTM 18M E0694456 N9185275, July 25, 2000.

make good eating. The owner of the pigs is incensed by this killing but has no control over the animals. He talks about getting a neighbor and some dogs to capture the pigs and keep them penned.

This pig-raising resident originally came to the area twenty-five years ago. During that time period, residents on that stretch of the São Pedro lived on the north side of the river and let their pigs run wild on the south side. Now, however, the community of Vai-Quem-Quer cultivates the terra firme near São Pedro. These nearby crops are easy targets for the far-ranging bush pigs.

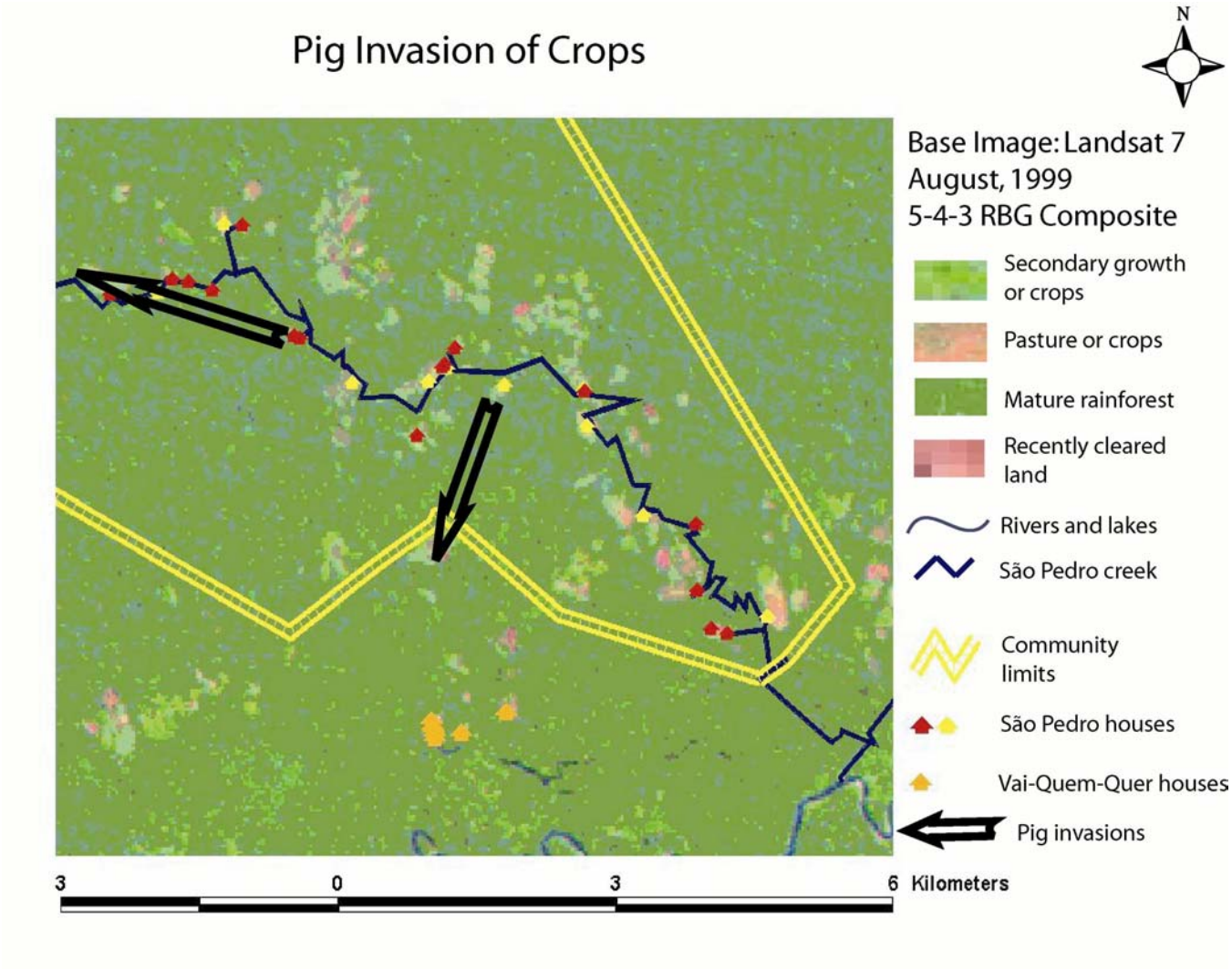

Figure 4-18 Map of pig invasions of crops in the São Pedro area.

Although Vai-Quem-Quer's response is to shoot the pigs, other strategies exist for invasions of crops by pigs. In São Pedro, one community member's pigs invaded and ate another community member's crops. The community member promptly sold his pigs and gave a portion of his own crops to the aggrieved party. This community member says that he will no longer raise pigs. Some community members raise pigs in pens, but this is much more labor intensive than the free-range model as 10 pigs can eat the fresh manioc equivalent of a 50kg sack of manioc flour in 8 days. Finally, one community member goes to the extreme of fencing in all of his crops to protect them from his own free-range pigs (figure 4-19). This resident also built a gigantic pen that the pigs return to after foraging (figure 4-20). Strategies are diverse, but a growing community population and continued pig raising signal that the conflict caused by free-range pigs that defy intra and inter-community boundaries is far from over.

The other shared boundary is that between São Pedro and Peri Peri Seringal. This boundary is complicated by the current incorrect boundary of the São Salvador project. Looking at figure 4-21 one can see that the official northeastern boundary of the project is defined by the official interpretation that the São Pedro Creek runs from the north. With the correct location of São Pedro Creek in mind, the official boundary has to adjust. The social center of Peri Peri lies clearly within the official boundary of the São Salvador project. If we consider that the Peri Peri Seringal begins at the edge of the São Pedro Creek, then that boundary becomes apparent. The eastern border between São Salvador (and São Pedro) and Peri Peri is less obvious. The interesting dynamic is that the westernmost resident of Peri Peri, a Peri Peri community leader, is the twin brother of the

Figure 4-19 São Pedro resident standing in front of his manioc field, which also contains papaya trees. He built the wall around the field to keep his free-range pigs from eating the manioc. The manioc variety pictured is known locally as fortaleza. UTM 18M E0697193 N9183727, August 2, 2000.

easternmost resident of São Pedro. Both grew up in São Pedro in house A (figure 4-21), they maintain good relations and it is they who know this area the best. The community of São Pedro relied on the São Pedro twin for the location of this border. He picked points dividing a large low-lying area as the division between his land and his brother's land.

Figure 4-20 São Pedro resident standing inside a pig pen built around a huge dead tree. His free-range pigs sleep inside this house at night and forage in the forest by day. UTM 18M E0697112 N9183453, August 2, 2000.

Conflicts concerning household boundaries within São Pedro have yet to become a major issue. However, the projected land-use and land-cover change described in the next chapter will bring family fields much closer to each other. The issues that have been raised so far surround the pig invasions described earlier and to a lesser extent, some timber extraction. The fuzzy boundaries currently in place may minimize conflict, but future expansion of cultivated areas and pasture may make the creation of fixed boundaries inevitable. The São Pedro families' decision to divide their land into lots will likely require precise household boundaries. These boundaries may be separated by communally owned várzea and baboca or may, in areas of terra firme, be side by side.

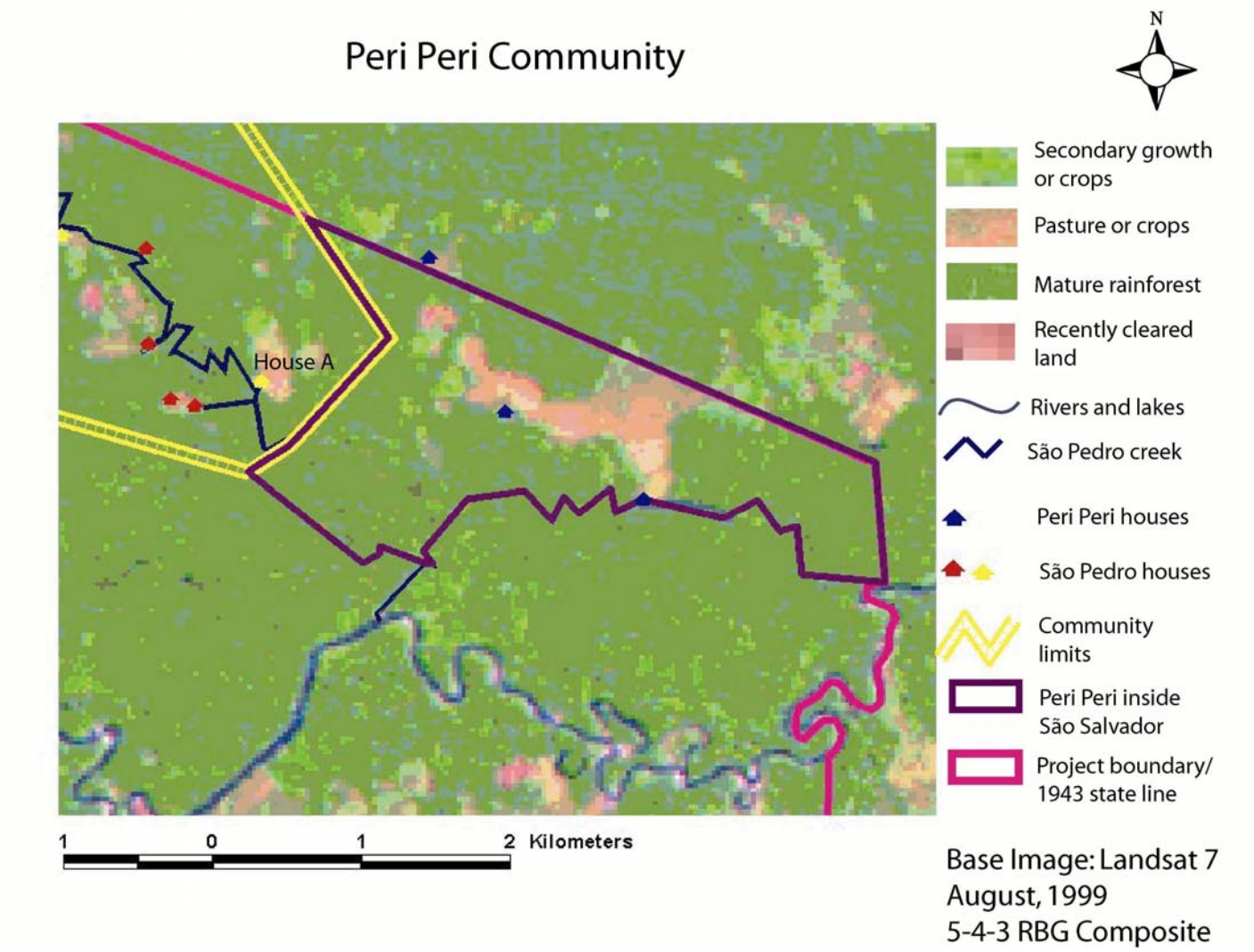

Figure 4-21 Map of the portion of Peri Peri within the MRSSP boundary.

Conclusion

This chapter demonstrates the utility of local knowledge of setting and boundary for the MRSSP. Talking to local people and georeferencing their knowledge has correctly identified the location of the São Pedro Creek and the community of São Pedro and correctly included them into the MRSSP. Local knowledge also helped identify the erroneous inclusion of the community of Peri Peri into the project, in addition to other discrepancies between community and project boundaries. In addition, local people shared knowledge of resource conflicts. This resource conflict information needs to be addressed for successful natural resource management. All of this knowledge is critical to the success of the MRSSP, especially in light of the existing errors in maps currently being used for management planning. INCRA's first approximation of the project's location, setting and boundaries is based on flawed RADAMBRASIL data, an inadequate scale and incorrect place names. Satellite imagery alone cannot solve these problems due to inadequate resolution and lack of accurate ground truthing. In this case, local geographic knowledge solved these problems. Given that these cartographic and remote sensing difficulties may be common in Amazonian conservation and development projects, I argue that local geographic knowledge should continue to be investigated as a means for improving management planning.

The community map of the São Pedro creek is clearly more accurate and much more appropriate for natural resource management and boundary establishment. This map's accurate representation of the São Pedro creek points out the necessary changes needed for a more appropriate boundary between São Salvador and Peri Peri. However, the larger issue of the uncertain Acre/Amazonas state line is more problematic. The state

line divides the households from their terra firme plots and hunting grounds. On the other hand, living inside the project boundaries will provide the secure land tenure eagerly awaited for by residents. Will residents be able to make a living on the land available within the project? The next chapter on land-use and land-cover change addresses this issue. Moving across the state line means less access to water and transportation.

São Pedro's resource management, land-use and interpretation of their boundaries clash with the official lines in the area (figure 4-22). Residents farm north of the 1943 line and hunt north of the 1988 line. The community's self-declared northern boundary extends far beyond both lines. Their use (both current and historical) of resources, the historical maps of the seringal and now their boundary map argue for continued use of the area. Expansion of the state to the 1988 line allows for more terra firme but still reduces community hunting grounds. The best course might be to use the culturally and ecologically grounded boundary of the watershed divide (roughly represented by the northern community boundary). This, however, may not be politically practical given the divide's location in Amazonas.

Figures 4-2, 4-4 and 4-5 show an historical northern seringal boundary similar to the community boundary of the watershed divide. The inclusion of this land into the project could be possible due to INCRA's status as a federal institution. It is likely that the people of São Pedro will continue to use the Amazonas side regardless. The opportunity to aggressively exploit resources on the Amazonas side while having secure land tenure on the Acre side might be tempting to community members. This could conceivably

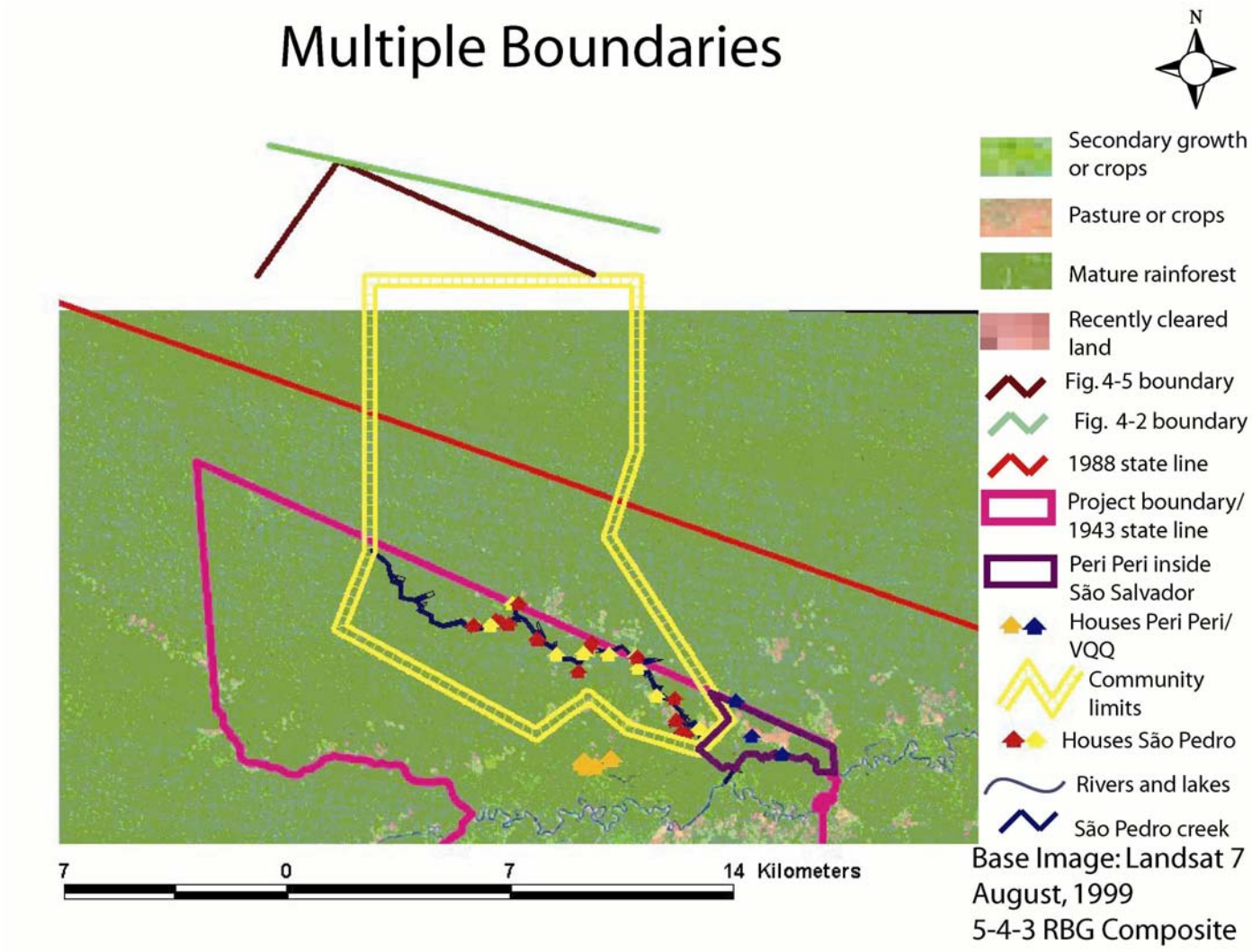

Figure 4-22 Map of the complexity of boundaries involving São Pedro.

create a landscape forested on the project side and denuded on the Amazonas side. Interestingly a fuzzy official boundary might prevent this dichotomy of land-cover. This uncertain northern boundary may even persist if INCRA decides to avoid the community conflict of marking the 1943 line and the state conflict of marking the 1988 line.

The sustainable management of the entire area is likely to be improved if the watershed divide is the northern boundary. On the other hand, the people of São Pedro may be happier and have improved livelihoods without the restrictions of a management plan and the annexation of the Amazonas side. If the 1943 line is the northern boundary future generations might opt to exploit the Amazonas side without restrictions while using family ports on the São Pedro to sell their goods in Acre. The formal or informal creation of this northern boundary should take place after further discussion with the people of São Pedro. Indeed, further discussion with local people needs to take place in this and other settlement projects. This case study demonstrates that local knowledge of setting and boundary can correct maps and thus potentially reduce conflict over resources and improve management planning. Combining georeferenced local knowledge with satellite imagery in a GIS bears continued investigation as a tool for natural resource management planning.

CHAPTER 5
MODELING LAND-USE AND LAND-COVER CHANGE IN THE SÃO PEDRO COMMUNITY

Introduction

The study of land-use and land-cover change (LULCC) is gaining more importance as the speed, spatial extent and magnitude of human alterations of the Earth's land surface continue to increase. Land-cover is defined here as, " the biophysical state of the earth's surface and immediate subsurface" (Turner II et al. 1995). Humans are the primary agents in land-cover change, thus making knowledge of land-use a prerequisite to understanding land-cover change (Allen & Barnes 1985; Turner II 1990; Whitby et al. 1992). Land-use "involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation- the purpose for which the land is used" (Turner II et al. 1995). The possible impacts of these alterations on the Earth's system are still largely speculative, although sophisticated models are being used for carbon cycle analysis and global change modeling. Local and regional data are also extremely important, as land-use and land-cover change are neither simple processes nor amenable to generalization.

Three dimensions of drivers: biophysical, socio-economic and proximate causes (such as land management or distance to town) are instrumental in land-use and land-cover change. However, incorporation of social, political and economic factors is hindered by a lack of spatially explicit data and by the methodological challenges of linking social and natural science data (Veldkamp & Lambin 2001). GIS technology can link spatially

explicit data with social and natural science data. Combining participatory methods with GPS technology provides the georeferenced local spatial, social and biophysical knowledge necessary to create a useful GIS for modeling LULCC and for natural resource management. If combined with relevant data from modern science knowledge sources, the GIS can become an even greater tool. This chapter is based around the LULCC analysis using a GIS constructed from georeferenced local knowledge.

The MRSSP strives to link social and natural data and create a sustainable management plan. Unfortunately, RADAMBRASIL does not provide the correct spatially explicit data needed. Despite this challenge, the project seeks to combine biophysical data concerning natural resources with socio-economic data on future residents to improve on past settlement initiatives (Valentim et al. 2000). One of this thesis' contributions to the project is improving the existing spatial knowledge while combining socio-economic data and biophysical data in a land-use land-cover change format. This LULCC case study of the community of São Pedro seeks to understand the past, present and future land-use and livelihood strategies of São Pedro residents. The study contributes directly to the MRSSP by providing detailed spatially explicit information relevant to the future management plan. In addition, the study provides a LULCC case study demonstrating the heterogeneity of the region. The study has potential linkages with regional LULCC dynamics. The regional focus is especially important in Acre due to the state government's efforts in Ecological and Economic Zoning (ZEE).

This chapter will describe the pattern of livelihood change and LULCC in the São Pedro area. The data demonstrate a transition from a rubber tapping past to a future

focused mainly on cattle production. This is a pattern that may be replicated or already in progress in other remote areas of Acre. The chapter is divided into five parts. The first three portions explain results of data collected on land-use and land-cover and income generating activities for the São Pedro area. The first section focuses on the area in 1990, the second in 2000 (the year the research was conducted) and the third section models a possible scenario for 2010. The next section, the discussion, explains the popularity of cattle and the possible ecological ramifications. The discussion also addresses possible impacts of pasture degradation, financing and population growth on the model. Finally, the conclusion discusses the relevance of the findings to various scales of inquiry.

1990 Results-Tapping Rubber and Raising Pigs in the Forest

The people in the São Pedro did not consider themselves a community in 1990. Rather, near the São Pedro Creek were houses and *colocações* related by geographic proximity, livelihood and/or family ties. In 1990 only 13 households resided along the São Pedro and Triunfo Creeks (figure 5-1). Six of these houses were *colocações* with rubber trails. Other nearby *colocações* cut by residents of the creek were Colocação Japonesa[1] to the north and the Colocação Vai-Quem-Quer[2] to the south. São Pedro had its own *aviador* who picked up goods from the actual *patrão* in what is now known as the community of São Salvador. This *patrão* was the father of household 4's head of household in 2000. As *aviador*, he supplied goods to the rubber tappers of the area in return for rubber. The year 1990 fell within a transitional livelihood period for many

[1] Japonesa had 5 rubber trails.
[2] Vai-Quem-Quer had 3 rubber trails.

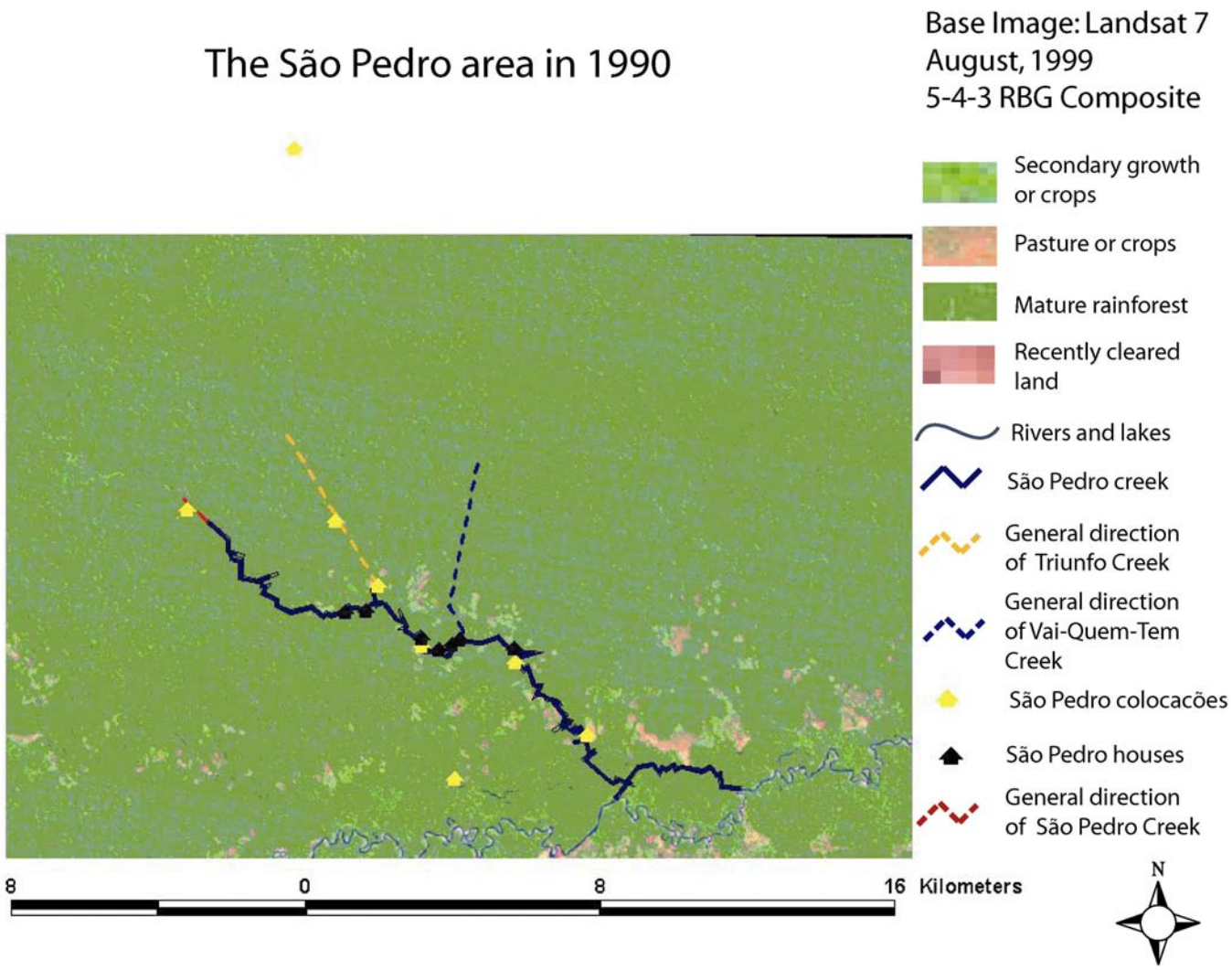

Figure 5-1 Map of location of houses and colocações in São Pedro area in 1990.

former tappers. Rubber prices in the region declined from U.S. $ 1.8 per kilogram in 1982 to U. S. $ 0.4 per kilogram in 1992 (Almeida & Menezes 1994). The Brazilian government caused this dramatic price decline when they discontinued protectionist policies in 1985.

Local tappers were moving away from rubber tapping during this period. Besides the falling price of rubber, the other important factor influencing a shift away from tapping was the historically poor rubber production of local rubber trees. Each local trail only yielded between four and five *frascos*[3] of liquid latex per day. In comparison, the rubber trails of the upper Juruá valley yielded between 7 and 38 *frascos* per day. The local population's lack of total reliance on rubber is demonstrated in figure 5-2.

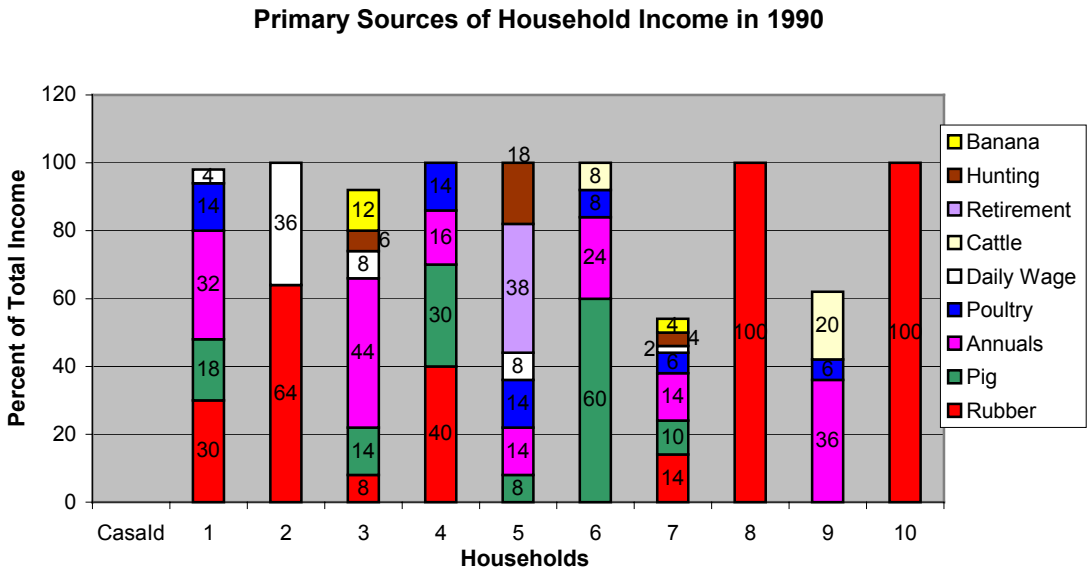

Figure 5-2 Chart of primary sources of household income in 1990 for São Pedro sample.

[3] Two-liter containers used in the collection of the rubber latex.

The chart in figure 5-2 shows the reported primary income generating activities in 1990 for the ten households studied. Households are designated a number from 1-10, and only the most important income generating activities are shown. Each activity is represented by a color. The number inside or next to the color bar denotes the percent of total income that the activity represents.

In 1990 only three of the area households had the same head of household as in 2000 (Households 5, 6 and 7). Two other household heads were minors living in their parents' house in 1990 (1 and 4). In these cases the household income shown in figure 5-2 is that of the parent's household in 1990.[4] Another 2000 household head lived in the same house in 1990 but as a laborer, not as the head (3).

Three families were distant from the area though they were in the Juruá Valley. As can be seen in figure 5-2, these distant households (2, 8 and 10) were almost exclusively dedicated to the extraction of rubber (shown in orange). This can be partly attributed to the improved rubber production in the areas they tapped. However, the continued decline of rubber prices eventually led them to São Pedro Creek. After the fall of rubber, each of these three households struggled in more urban situations before eventually coming to São Pedro after 1996. Household 9 had recently left the São Pedro area in 1990 and farmed and raised livestock in an INCRA planned agricultural community near Mâncio Lima. Families located in the São Pedro area in 1990 (Households 1,3,4,5,6,7) were less dependent on rubber for income (figure 5-2). Indeed, in 1990 none of the sample's families living along the São Pedro Creek had more than 40% of their income coming from rubber. The combination of limited production and low prices forced the local

[4] As estimated by the head of household in 2000.

residents to look elsewhere for sources of income. Most were moving away from rubber as a primary income source even before 1990.

Pigs (dark green in figure 5-2) and annual crops (violet) became the primary income sources after the decline of rubber. During the rubber tapping era the pigs were left to roam in the forest where they foraged for palm fruits and other forest foods. The *baboca*[5] has a high density of stands of buriti (*Mauritia flexuosa*), açai (*Euterpe oleracea*), bacaba (*Oenocarpus bacaba*) and patauá (*Oenocarpus bataua*) palms. São Pedro has an abundance of *baboca* along the margins of the creek. This area is ideal for pig raising because pigs thrive there and local people have little other utility for the habitat. The foraging ability of the pigs and presence of the *baboca* made pig raising a non-capital and non-labor intensive income generating activity. During this time annual crops, previously cultivated as subsistence foods, also were sold for income. Sweet manioc was the primary subsistence food in 1990, and became an income source through production of flour, along with rice and maize, when rubber prices plummeted. Currently, the manioc flour (*farinha*) of the region is the most prized manioc flour in the entire Brazilian Amazon.

Poultry (chickens and ducks) and cattle were not as important an income source for the community but they were present. Figure 5-2 shows income associated with poultry in purple, and cattle in cream. Three families had cattle, amounting to 32 total head. The young men in the area bought cattle with rubber. One household member talked of

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[5] The *baboca* or *babocal* is a particular type of environment found within palm forests. According to *seringueiros*, the *baboca* is only found in areas where soils are poorly drained and that permit an accumulation of water during the rainy season. Plants in the *baboca* are adapted to permanently soaked soils. Thus, some species found here also occur in the *várzea* (Silveira et al. 2001).

buying his first head at the age of 16 with money earned from rubber in 1990. That cow produced 9 offspring, and in 2000 he owned 18 head of cattle. Daily wages (shown in white) were also a source of income, with several of the informants working for others as haulers or cutters of timber.

The area was also in transition from a traditional *seringal* to one focused on timber extraction. The *patrão* led this effort in 1990. When the price of rubber fell, this *patrão*, who rented the *seringal* from the owner, began logging high-grade timber in all accessible regions to make up for the loss of income associated with rubber. This transition from the *aviamento* system to timber extraction is also documented elsewhere in the Juruá Valley (Almeida 1996;Almeida & Menezes 1994). The former rubber tappers paid off any debts they had accrued by cutting and hauling trees, and also received wages when debts had been paid.

Another income generating activity that followed the decline of rubber was commercial hunting (shown in black). The residents were used to spending large amounts of time in the forest and had shot game for food while tapping. These men began to actively search for the larger vertebrate game (tapir, peccary, deer and paca to name a few) in order to sell the meat in Mâncio Lima and Cruzeiro do Sul. During the rubber tapping era these families relied on game meat as their primary source of protein. This is also true today. Household number 5 relied in part (18% of family income in figure 5-2) on a son who hunted commercially in 1990.

In household 5 the retirement income (shown in lavender) of the household matriarch was 38% of her household's total income. Her husband was eighty-two in 1990. Brazil has a retirement law paying one or two minimum salaries if one is over 60 or physically

unable to work. This pension is accessible to those with proper documentation who also had either rural employment or had been employed as rubber tappers since youth (Almeida 1996). The minimum annual salary in 2000 was U.S.$ 81.1.[6]

Table 5-1 contrasts Almeida's 1991 data from the Upper Juruá Extractive Reserve with my data focused on 1990. The table reveals that income generating activities in São Pedro were similar to those in other areas of the Juruá Valley. Almeida shows the Juruá reserve's seven most important categories for income generation, forming 100 percent of income, although he acknowledges more income generating activities in the region. The

Table 5-1..A comparison of 1990 household income sources from São Pedro and 1991 household income sources from the Upper Juruá Extractive Reserve

	Percent of Income per Year		
	Data from São Pedro entire 2000 sample regardless of location in 1990	1991 Data from Alto Juruá	Data from São Pedro 2000 sample living in São Pedro in 1990
Manioc	7.8	8.3	9.3
Rubber	35.6	28.2	15.3
Poultry	6.2	5.3	9.4
Pigs	14	10.8	23.3
Cattle	2.8	5.2	1.3
Game	2.8	19.7	4.7
Pensions	3.8	22.4	6.3
Daily Wage	5.8		3.7
Rice	6.8		9
Corn	3.4		5.7
Banana	1.6		2.7
Total	90.6	100	90.7

Many products have been omitted from both data sources.
1991 portion of table from Almeida (1996)
More 1991 data available in Almeida et al. (1994)

[6] According to August 2000 rates of 1.862 reais to the dollar.

São Pedro data show 90% of the income generating activities, since the remaining 10% represented over 10 other activities, making the table excessively complex.

According to Table 5-1, the inhabitants of the reserve tapped more rubber in 1991 than residents of São Pedro in 1990. This probably is due to their more productive trees and the reserve's focus on extractivism. However, the table also shows greater reliance on rubber tapping among São Pedro households who were living elsewhere in 1990. Other major differences are the percentages that pigs, pensions and game represented in household income. The 1990 residents of São Pedro talked of pigs being an especially important income source during the transition from rubber. Pigs were important in the Alto Juruá (10.8% of income) but much less so than along the São Pedro Creek. Pensions were particularly important in the Alto Juruá, perhaps because the social structures in the more organized extractive reserve facilitated a process many illiterate elderly Amazonians found confusing. Hunting was more prevalent in the Alto Juruá, thus making it a more important source of income. Manioc, poultry and cattle income sources are more comparable in the table. In sum, table 5-1 indicates that in 1990 and 1991 rubber tappers throughout the Juruá Valley were probably not relying exclusively on rubber for income. Pigs, game, pensions, cattle and poultry were common sources of income in the region. In the Juruá Valley, the forest was no longer the sole income provider, although it was an important one, and some households continued to be totally focused on rubber extraction (Households 8 and 10 in figure 5-2).

In 1990, the forest supplied an important percentage of income through rubber, hunting, logging wages and free-range pig raising. Income was only one of the benefits that the forest provided as game meat and fish were considered their second and third

most important foods in 1990. Manioc was considered most important. The forest was also a source of fruits as the people ate and made drinks from many of the palm fruits. Timber was used for building houses and canoes, bark for lashing and vines for the making of brooms. Ten years later, the forest would continue to be important, but less for income than for subsistence needs and cultural tradition.

2000 Results-Small Animal Husbandry and Annual Cropping

In 2000, none of the ten households were extracting rubber latex. Instead, the primary income generator was the selling of manioc, rice and maize. The chart in figure 5-3 shows the sources of income in 2000 (annual crops noted in violet). Manioc was the most important of the three. Notice the chart's complete lack of income associated with rubber. Manioc has become more important with each 50 kilogram sack of manioc flour (*farinha*) worth U.S.$ 5.4-6.4[7] in 2000. These annuals were also a major source of food

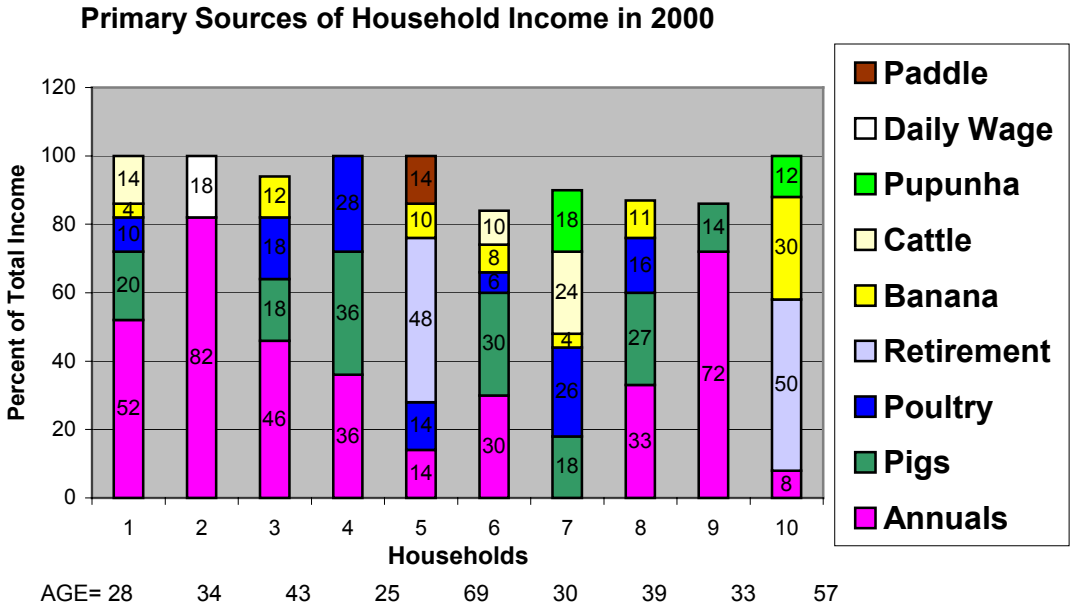

Figure 5-3 Chart of the primary sources of household income in 2000 for São Pedro sample.

[7] According to August 2000 rates of 1.862 reais to the dollar. 2000.

and animal feed. One family of eight ate a sack of farinha every three weeks. Ten pigs could eat the raw manioc equivalent of 45 sacks of farinha a year. Chickens also ate manioc: thirty chickens consumed the equivalent of 7 sacks of farinha a year with ducks eating even more than chickens (figure 5-4). Pigs, ducks and chickens also ate corn.

Figure 5-4 São Pedro resident chopping manioc for chickens and ducks outside his kitchen. Raw manioc is also used to feed pigs and goats. UTM 18M E0695296 N9185207, July 28, 2000

Pigs and poultry (shown in dark green and purple in figure 5-3) were also important income sources, although the raising of pigs was becoming more difficult with the increase in population and local extensive farming methods. Two of the participants (Households 8 and 9) talked of difficulties involving pigs getting into neighboring manioc fields.

Households 5 and 10 had half or close to half of their income generated by retirement (in lavender). Both of these households received the equivalent of two retirements a month. In household 5, the matriarch's husband was officially declared a soldado da borracha[8] in 1997 and earned double the agricultural workers pension of U.S.$ 81.1. A woman of 74 years of age (figure 5-5) lived in household 10 with her

Figure 5-5 São Pedro resident who received a monthly pension. Pensions are one of the main sources of cash in São Pedro. UTM 18M E0693821 N9185426, August 5, 2000.

[8] Rubber soldier- Individual brought into the forest by the Brazilian government to tap rubber during the WWII era allied rubber shortage. On the 28th of December, 1989, the Rubber Tapper Law was passed giving two minimum salaries to a retired rubber soldier or widow of a rubber soldier (Raissa Guerra personal communication).

mother of 98. Both earned a full agricultural worker's pension. These households were considered rich by the other residents because of their monthly access to ready cash.

Bananas (represented by yellow in figure 5-3) became more important economically by 2000, with seven out of ten families earning money from the fruit as opposed to only two families using bananas as an income source in 1990 (figure 5-6).

Figure 5-6 Two youngsters harvesting bananas in São Pedro. Bananas were an important source of food and income in the year 2000. UTM 18M E0695205 N9186034, August 27, 2000.

The three families not earning income from bananas in 2000 had been in the area less than two years or had recently returned to the area, and lost their banana orchard due to

secondary growth. The head of household 10 sold 30-60 boxes of bananas each month for U.S.$ 0.54 per box.

Five of the ten households raised cattle: accounting for 51 head of cattle in total. The three households with more than ten head were using the cattle as an income source while the households with four and three head were trying to increase their herd size. Beyond the ten households interviewed, only one community household had cattle. He had less than ten head and raised them on household 3's pasture.

Figure 5-7 indicates that despite cattle's relative lack of importance as an income generator (4.8% of the sample's income) pasture took up 71% of the 64.4 hectares of land

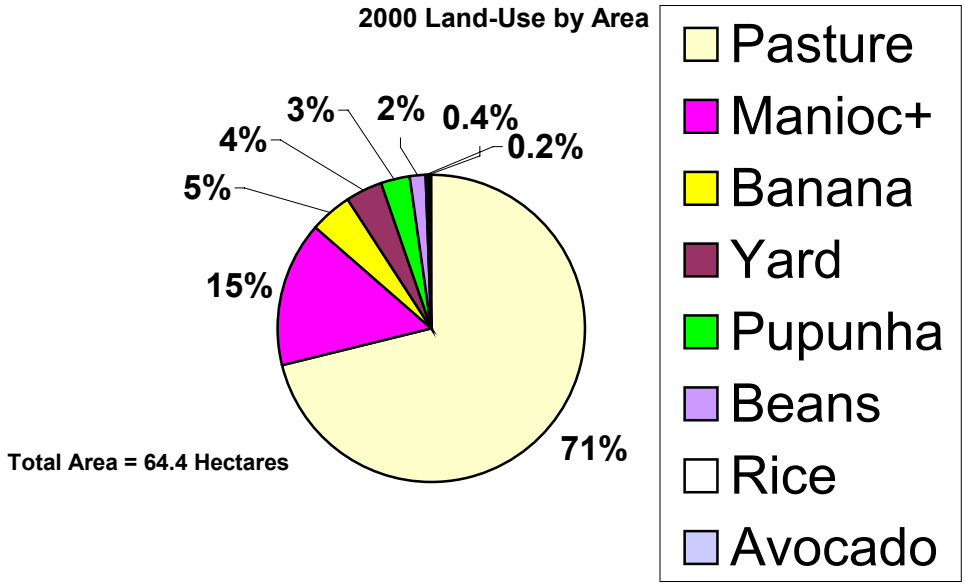

Figure 5-7 Chart of land-use by area for São Pedro sample in 2000.

in production. Manioc and other annual crops[9] (in violet) used less than 20% of the land in production and comprised 37% of the ten households' income.

[9] Rice and corn

The distribution of the land units in production throughout the community are shown in figure 5-8, while figures 5-9 and 5-10 focus on the western and eastern sides of the community. The dominant solid green areas in the image are comprised of mature rainforest,[10] only the light green and brown areas show the presence of fallows, crops, pasture or other uses.[11]

The ten families had 64.4 hectares in production. However, because land-unit measurements for households 1 and 5 also included measurements for a father's household and son's household respectively, 12 families' land units are effectively represented. The remaining 12 households in the community managed less land than those interviewed, but unfortunately measuring the exact amount was impossible due to time constraints. Many of the residents of these twelve families arrived within the last five years. If we assign to each of these households the minimum amount of land that any individual participating family managed (.59 hectares for household 2) then a very conservative estimate of the land amount in production for the rest of the community in 2000 is 7.1 hectares. Using this assumption, Table 5-2 demonstrates that all 24 households in the community would be using 71.5 hectares of land, only 1.0% of the community lands bounded by the 1988 state line if all land-units were actually within the line. If we consider the entire amount of land the community considers its own, then the

[10] Due to increasing knowledge of pre-contact anthropogenic impact on tropical forests, it has become difficult to call rainforest virgin, pristine or other adjectives used in the past. Here I use mature to define rainforest that appears to not have been impacted heavily by humans in the last 100 years.

[11] Not all light green, brown or red areas are anthropogenic. However, ground truthing during fieldwork verified the majority of larger areas as anthropogenic. Non-dark green areas two kilometers north of the São Pedro are likely to be tree fall gaps or natural clearings.

percentage drops from 1.0% to 0.6%. However, residents use much more land than these land-units for hunting, extractive activities and free-range pigs.

Table 5-2 Estimated areas relevant to São Pedro Community (in hectares)*

Entire São Pedro Comm. Area	São Pedro Area restricted by State Line of 1988	São Pedro Land in production in 2000
11,727.3	7,059.9	71.5

*Based on estimate of .59 ha for households not interviewed.

Other important income generating activities shown in Figure 5-3 included peach palm (*Bactris gasipaes*),[12] the making of paddles from mahogany and tropical cedar and also the earning of daily wages through clearing land. Household 10 sold 74 boxes of peach palm fruit in 1999 for U.S.$ 1.3 apiece. Each peach palm produces 5-6 boxes of fruit. Household 5 sold hand carved wooden paddles for U.S.$ 3.8 apiece if wood is provided. The forest also supplied protein through game meat. None of the community sold bush meat. Despite this, residents had noticed a decline in the quality and quantity of game near the houses, and during the fieldwork, community members created hunting rules outlawing the sale of meat and the use of dogs for hunting. The creek also continued to be an important source of food, although the participants noted a decrease in fish numbers and size. Community rules on fishing were also created with the facilitation of PESACRE. Finally, palm fruits continued to be abundant in the low lying areas and served people with food and drink while providing free-range pigs with feed.

[12] Known locally as *pupunha*.

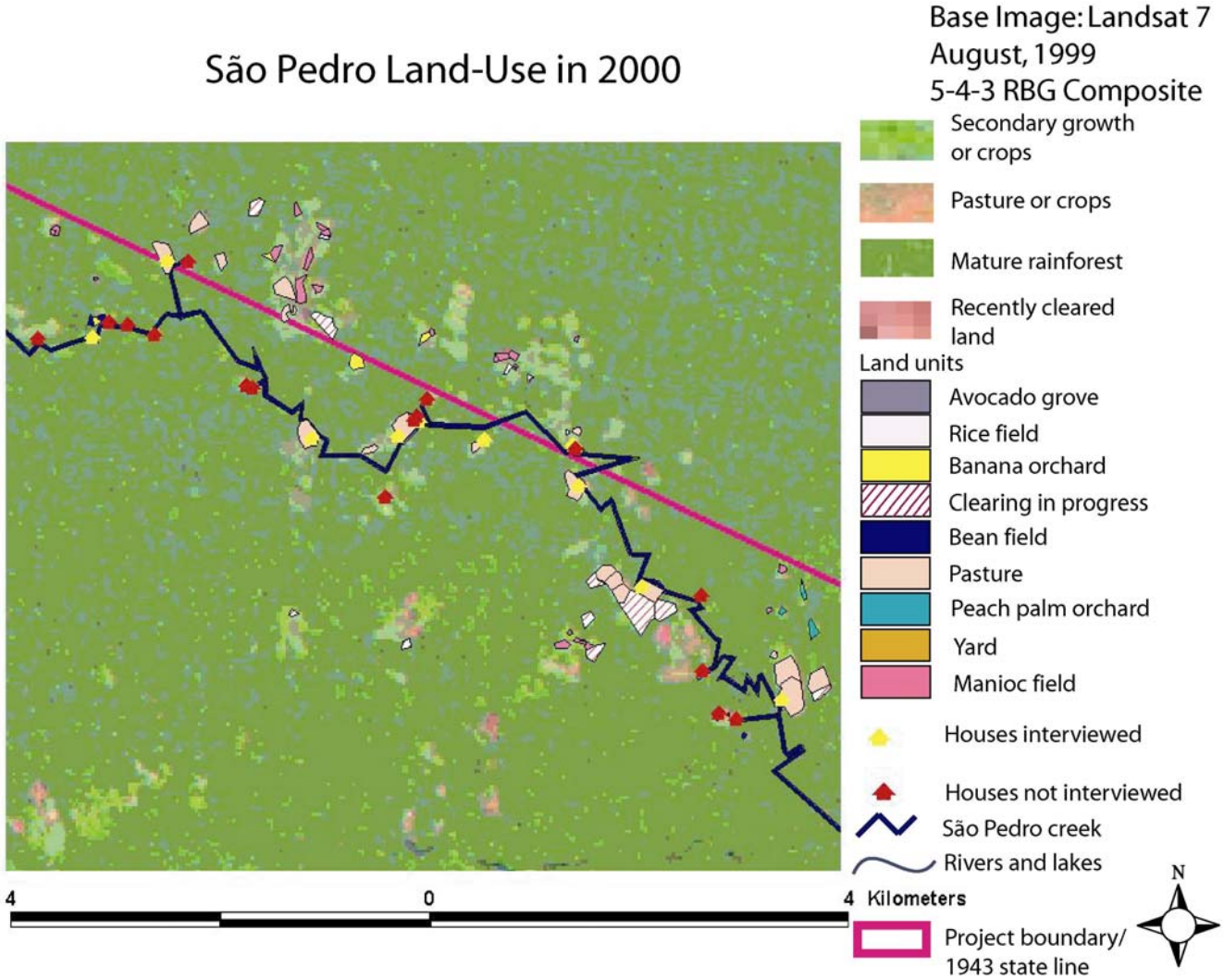

Figure 5-8 Map of land in production for São Pedro sample in 2000.

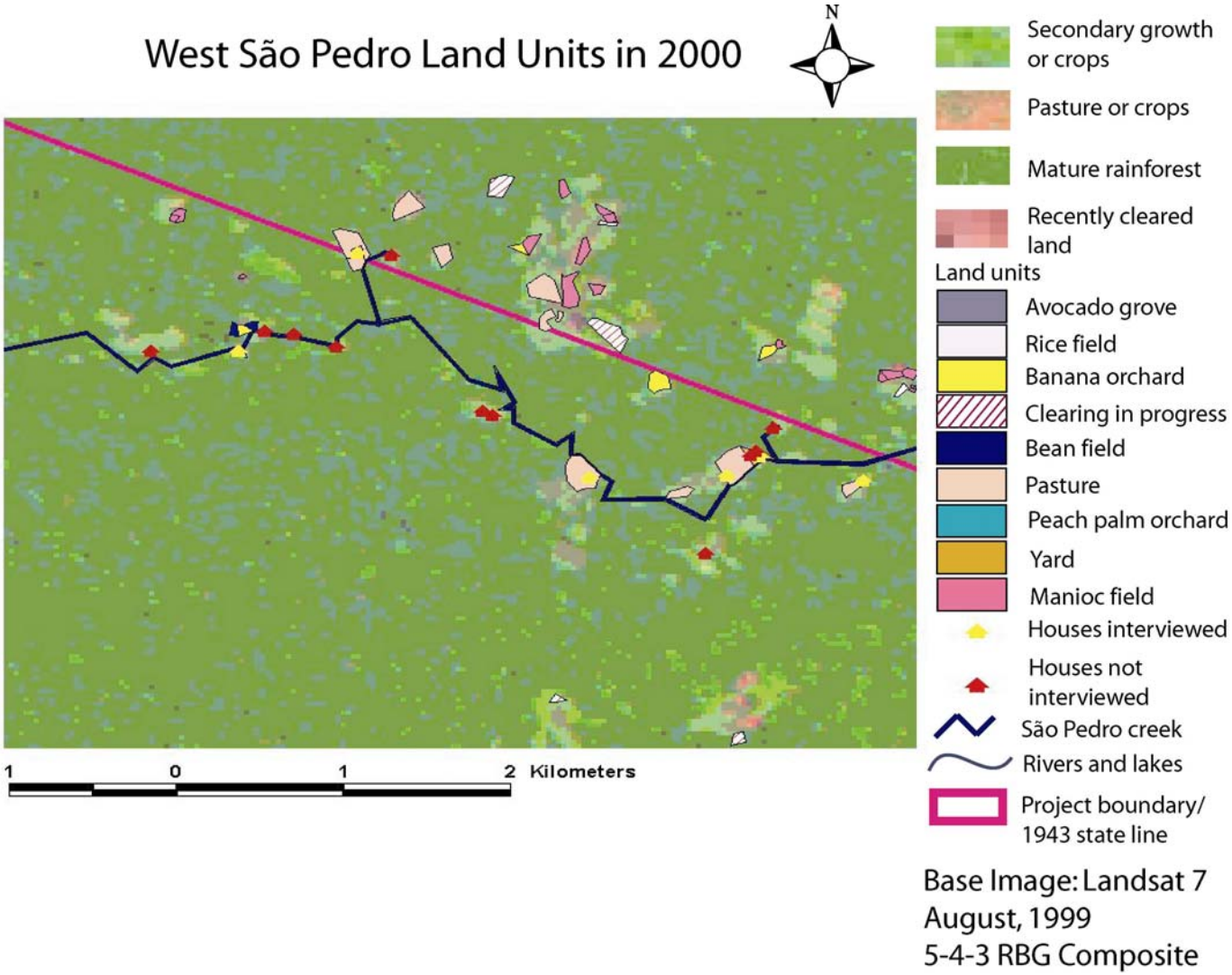

Figure 5-9 Map of the western land units for São Pedro sample in 2000.

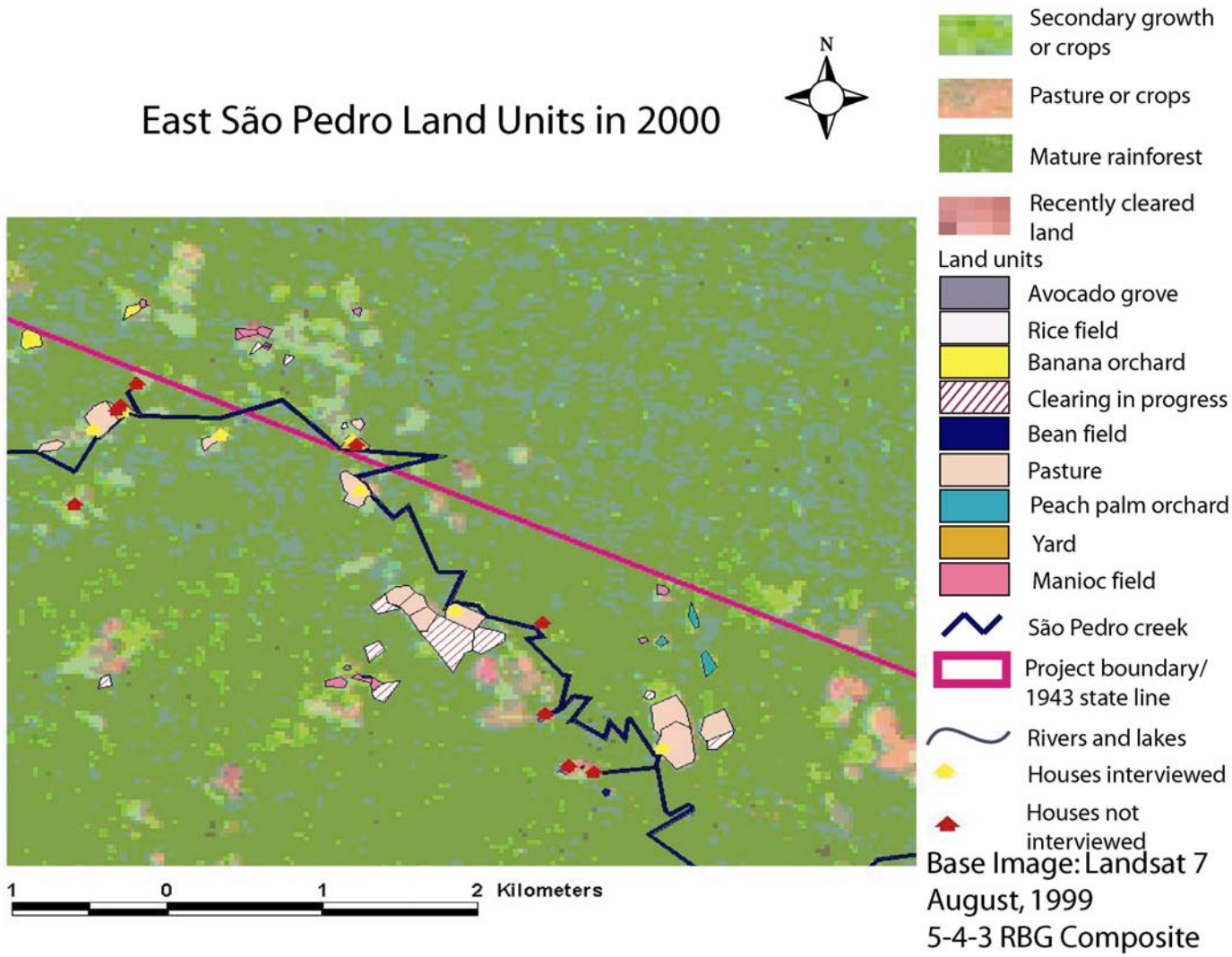

Figure 5-10 Map of eastern land units of São Pedro sample in 2000.

Results of Data Focused on 2010-A Future in Cattle Ranching

Figures 5-11, 5-12 and 5-13 model the land that the sample hoped to have in production in 2010 with figure 5-11 showing the entire sample and 5-12 and 5-13 showing more detail in the western and eastern sides of the sample. The maps model the desired future of the households presuming that they receive the land they want[13] and have the stability needed to increase both agricultural and livestock production. Since the data collection, the São Pedro community has elected to have individual land titles within the project. This request is likely to be fulfilled by the project. If lots are distributed according to household preference and current household land-units then this model may become reality. One important factor that could prevent the spatial distribution of land shown is the state line boundary (in violet in figures 5-11, 5-12 and 5-13). This line could restrict the amount of available terra firme north of the creek. However, the latest indications are that the project is going to proceed with the 1988 state line (in red) as the boundary. This move means that all land-units modeled would fall inside the project. The restrictions of the management plan remain to be seen. Figure 5-14 projects the distribution of the land that will be in production in 2010. Comparing Figure 5-7 to Figure 5-14, the amount of land in production for the sample will grow by over 600% from approximately 64.4 hectares to 466.5 hectares. However, the distribution of land among the two most prolific land uses, manioc and other annuals and pasture, remains more or less the same. The 2000 participating household with the least amount of land in production (household 2) becomes the one with the second least in

[13] In all cases the households asked for land that they were currently using.

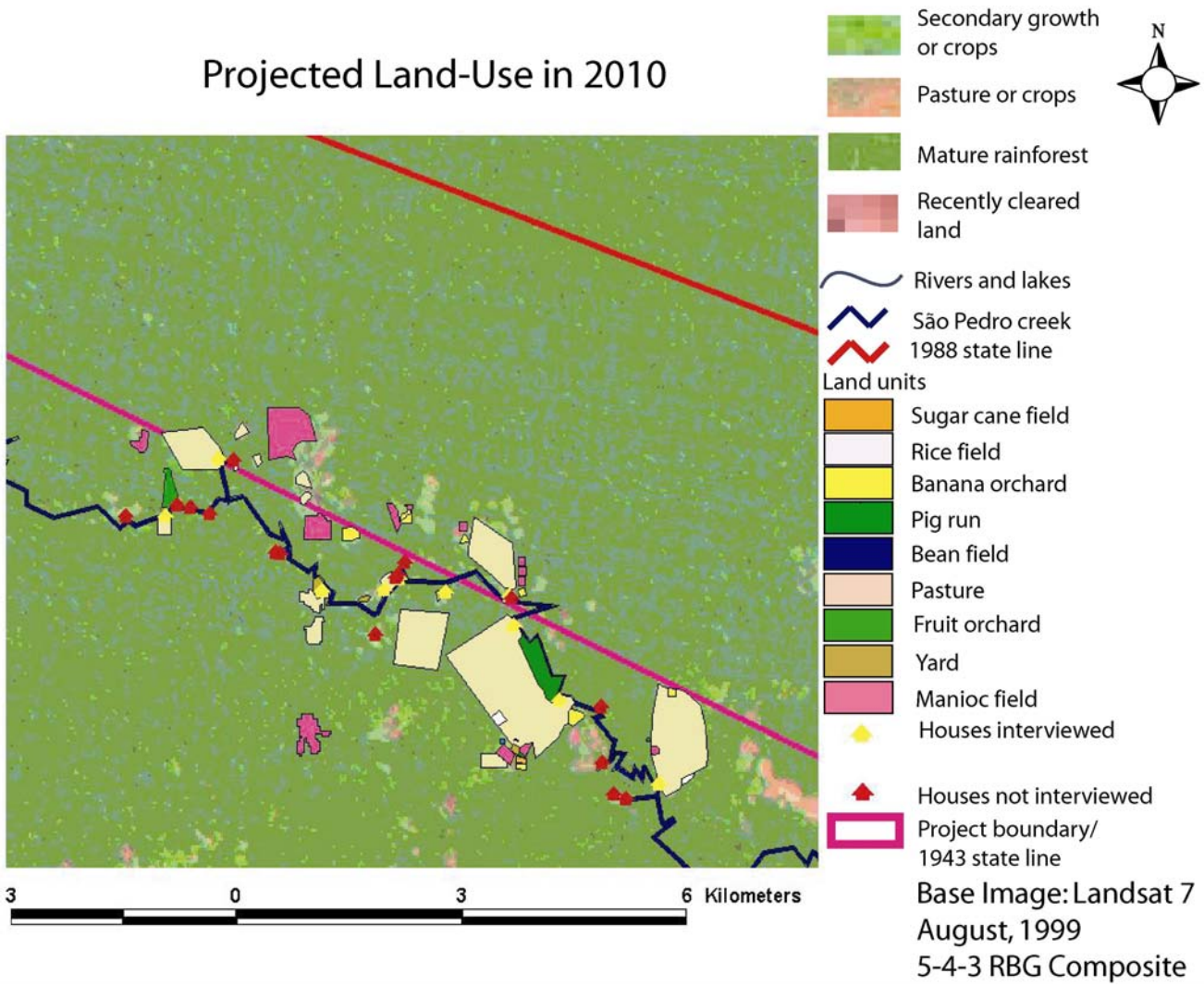

Figure 5-11 Map of projected land units of São Pedro sample in 2010.

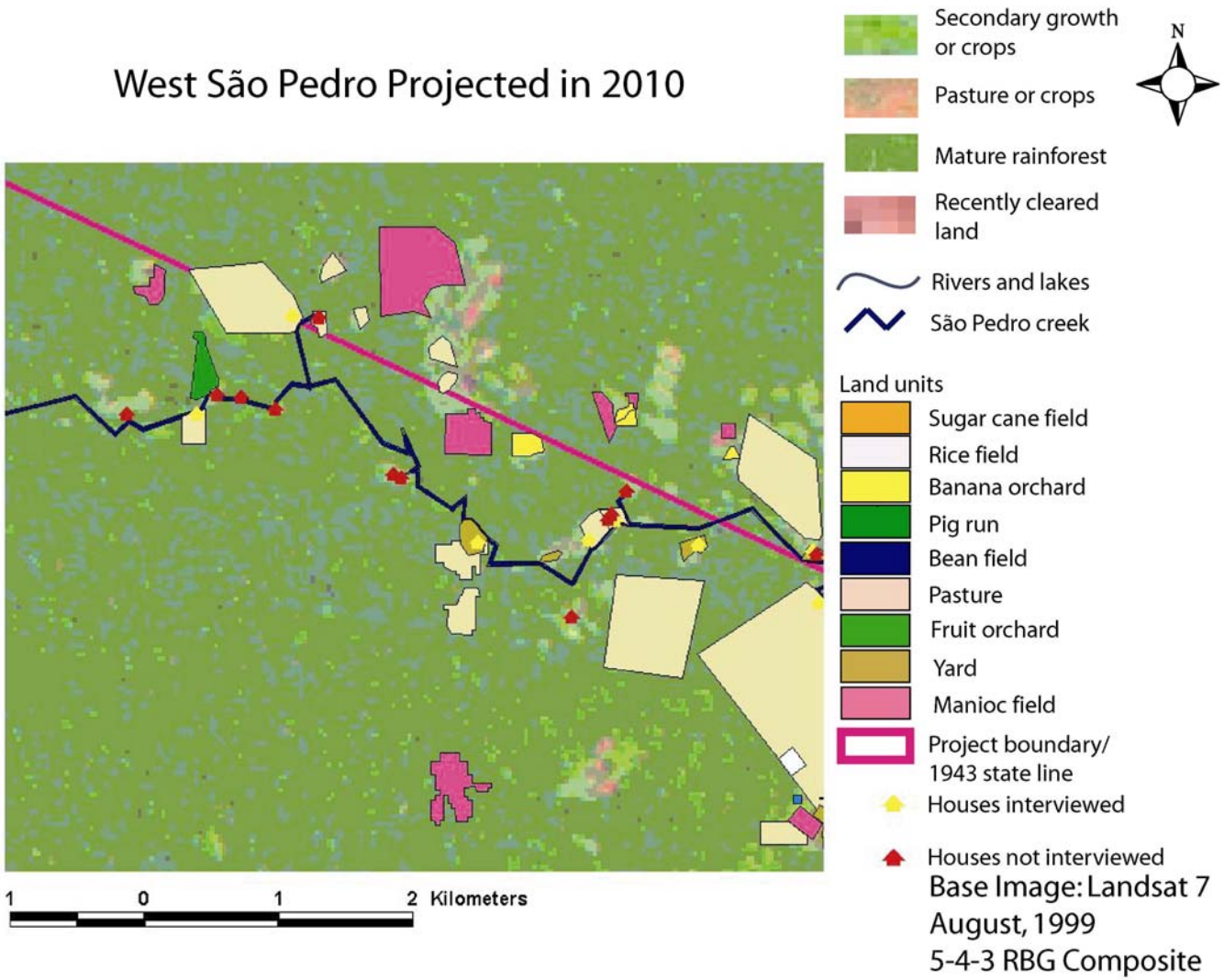

Figure 5-12 Map of projected land units for western side of São Pedro sample in 2010.

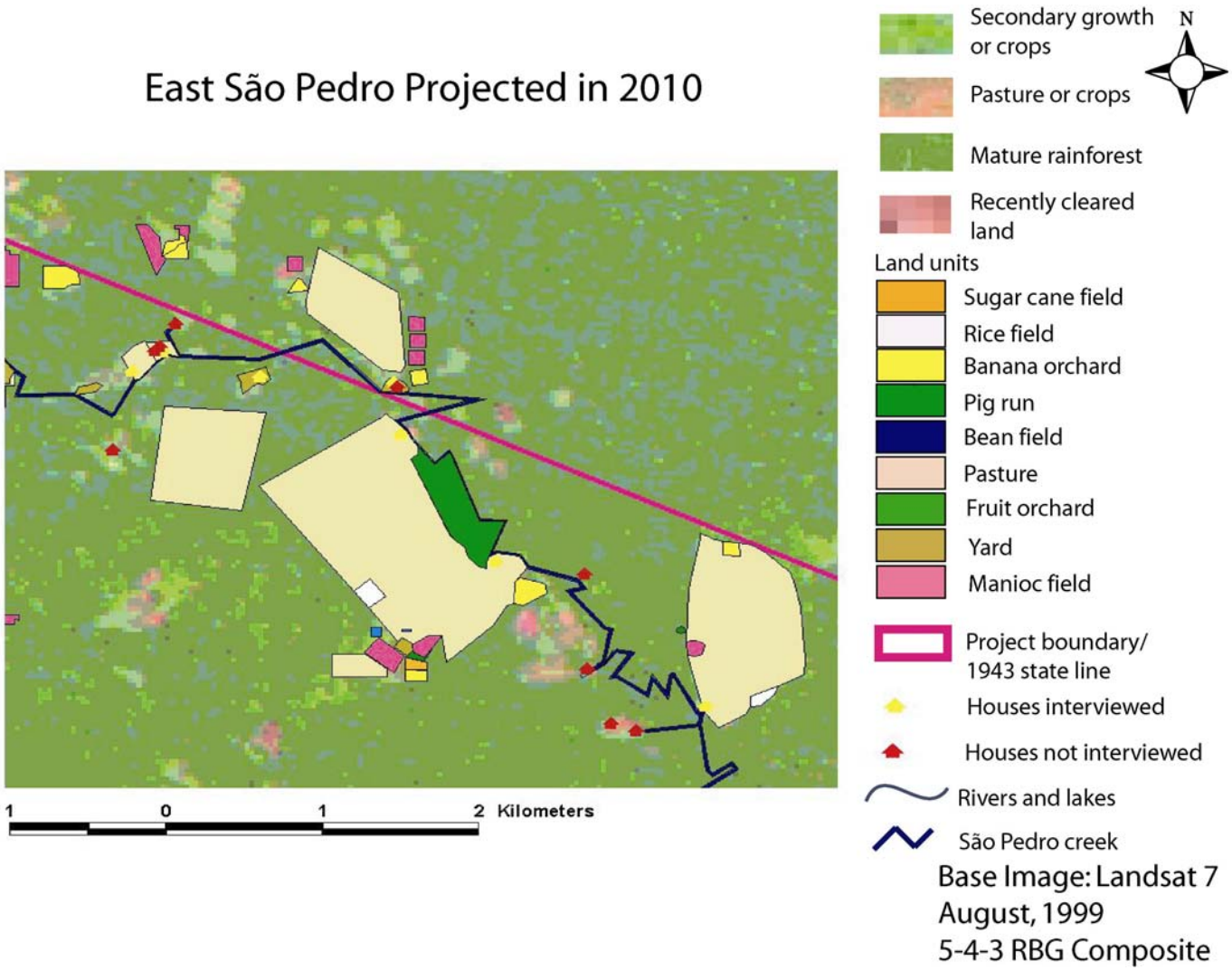

Figure 5-13 Map of projected land units for eastern side of São Pedro sample in 2010.

2010. If we conservatively project that household's production onto the 12 households unaccounted for in the community then we have a total of 611 hectares in production. This projection is appropriate because that household fits the newcomer profile of many

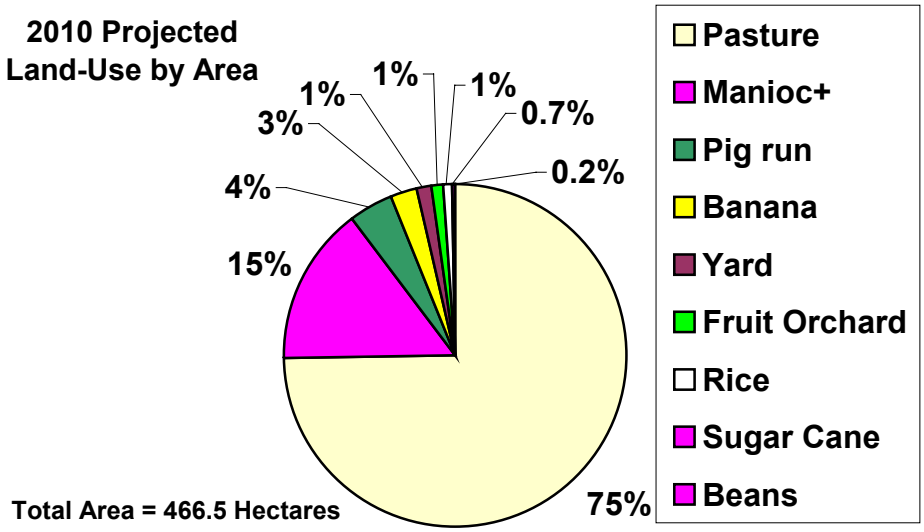

Figure 5-14 Chart of 2010 projected land-use for São Pedro sample.

of the non-participating households in the community, but still represents a conservative estimate.

Under this scenario, community land in production would make up 8.7% of the community area bounded by the 1988 interpretation of the state line and 5.2% of the entire community area. These percentages would be more relevant with accurate data on the distribution of terra firme, várzea, baboca and other natural land-covers restricting land-use. The conservative estimates also do not account for the new 2010 households that will form as children leave the home.

As in 2000, the projected sources of income in 2010 do not parallel the distribution of land in 2010. Figure 5-15 indicates that the main annual crops (manioc, rice and maize) remain the primary income generator, with cattle coming in second. Nine of the houses

plan to be gaining income through cattle, although all ten plan to have the animals. Household 2 wants only to increase herd size and does not plan to generate income through cattle. Only two households talked of generating income through milk or cheese production; the rest focused exclusively on beef cattle. The ten households plan

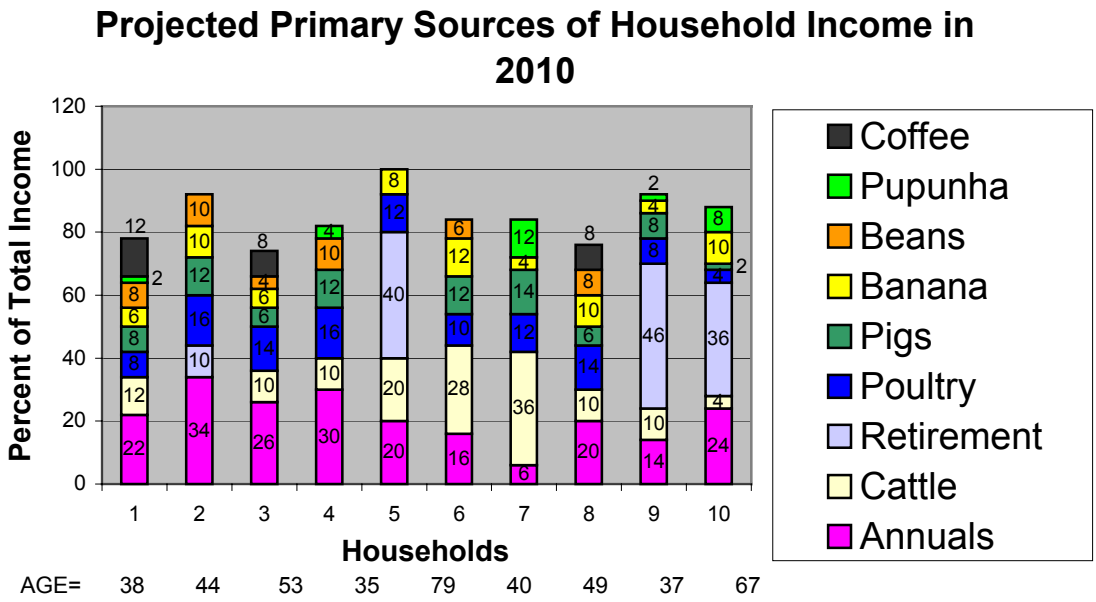

Figure 5-15 Chart of projected primary sources of household income for São Pedro sample in 2010.

on having a total of 466 head grazing on approximately 349 hectares of African grasses (*Brisantão*). Those 349 hectares of pasture are also expected to support 130 head of sheep and 90 head of goats, although goats do not necessarily require pasture to forage. Figure 5-16 shows the animal production per household for all 3 time periods of the research. The chart reveals a decrease in the number of domestic animals (ducks, sheep, goats, chickens and pigs) from 1990 to 2000 with the exception of cattle, which increased

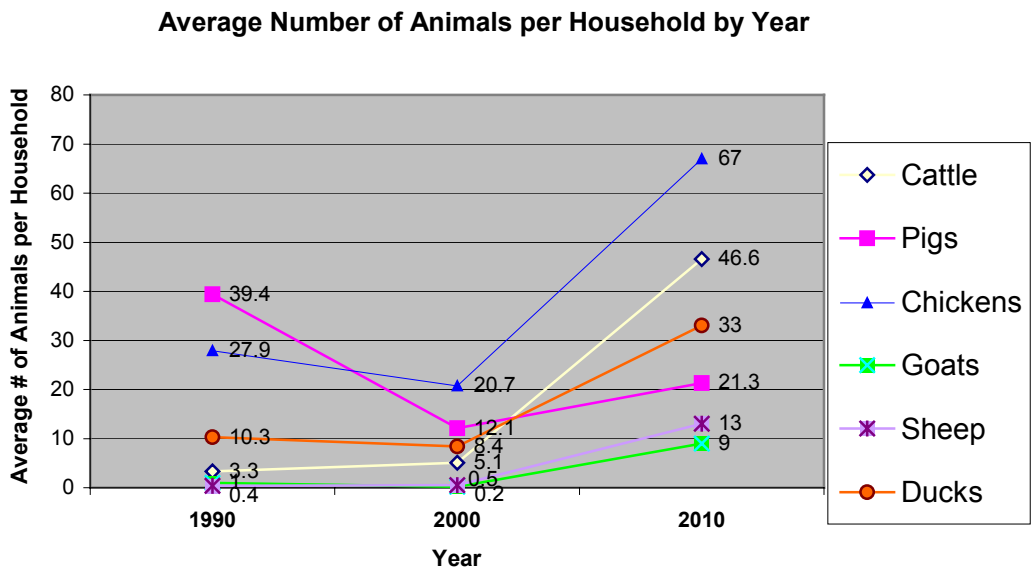

Figure 5-16 Chart of average number of animals per household by year.

from 3.3 to 5.1 a household (figure 5-17). This decrease is followed by a substantial increase in all animal numbers from 2000 to 2010.

Pigs are projected to increase in numbers from 2000, although not to the 1990 levels (figure 5-16). Most of the families interviewed talked of raising pigs in pens rather than free-range, due to the danger of crop invasions. This will make pig raising much more labor intensive through pen building, the daily roundup and increased manioc production for feed. Figure 5-16 suggests that even though pigs increase in numbers they will be a less important income source compared to years past.

Poultry, on the other hand, will continue to be an important income source and also grow in numbers as shown in Figure 5-16. Many of the families planned to raise up to 100 chickens. Ducks were less numerous than chickens in the model, as the families related the tendency of large numbers of ducks to travel far downstream and never return.

Figure 5-17 Cow grazing in African grasses (Brisantão) planted in a rainforest clearing in São Pedro. Similar pastures exist in the São Pedro area and many more are anticipated in 2010. The pasture has not been weeded recently and is less than ten years old. UTM 18M E0697371 N9183128, August 3, 2000.

Bananas, beans, peach palm and coffee round out the important income generating agricultural activities. In 2010 families planned to diversify their crop production as reflected in figure 5-15.

Pensions were also expected to be an important income generating income activity in 2010: four of the ten households planned to receive monies from the government. Three

households will have at least one person receiving a pension due to age, while household 2 plans to receive a pension due to an injury. The head of household 2 already has documentation authorizing receipt of a pension due to an accident with a chainsaw.

Discussion

The data in this chapter provide an analysis of changing livelihood systems and LULCC useful to natural resource management. This section will discuss the data and provide an understanding of the community's desire for cattle. Some of the ecological repercussions of this land-use will be addressed as well as the impacts of financing and population growth on cattle production. Finally, I will discuss the necessity of incorporating cattle into the management plan of the project.

The data presented demonstrate a livelihood progression from rubber tapping to small animal production and annual cropping, to a possible future of extensive cattle ranching. This transition has not been painless, although most participants argue that their lives in 2000 are improved over their lives in 1990. The 28-year-old head of household 1 in 2000 recalls putting away his rubber knife at 19 years of age after watching the price of rubber plummet over a four-month period, "We became sad. We did not know what to do. Manioc flour became worth selling only after the decline of rubber. At first life was harder, but now (in 2000) it is the same as the time of rubber." The head of household 8 in 2000 remembered the days of cutting rubber, "In the rubber era a guy suffered a lot. Now we don't have anything (goods) but we suffer less. In the rubber era we never lacked anything." His wife simply stated, "Things were better in the time of rubber." The matriarch of household 5 remembers, "When my son stopped cutting it got more difficult." However, her son later told me in private, " Not really, cutting was hard work.

You had to wake up early. I fell out of trees two different times. Once I broke my tailbone and the other time a stick went through my side" (figure 5-18).

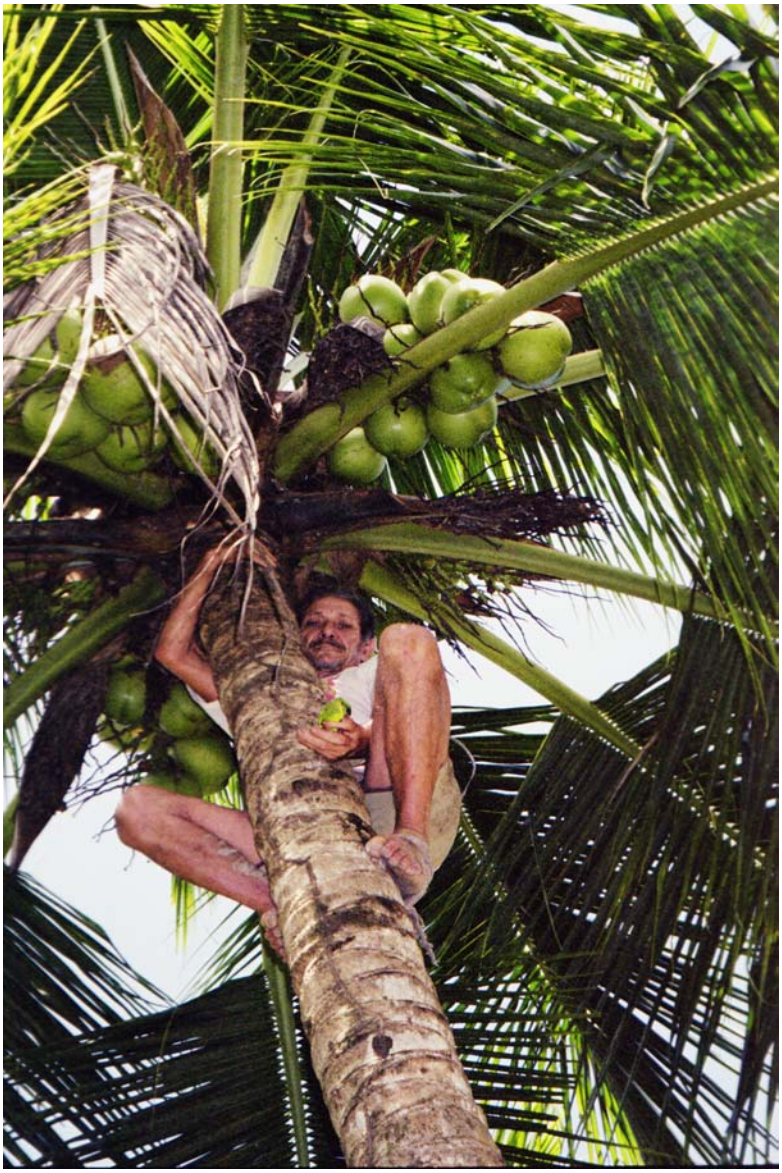

Figure 5-18 Sixty-year old São Pedro resident climbing a coconut tree. São Pedro residents often climb trees to harvest fruits and nuts. During the rubber tapping era residents would climb trees to tap high on the rubber trees in the *várzea*. UTM 18M E0693821 N9185426, July 7, 2000.

The head of household 7 in 2000 does not remember the rubber era fondly, "Each trail only gave 4-5 *frascos*. Life is better now. Nobody leaves to work in the middle of the night. I would do exactly what I am doing now if the price of rubber improved." The

price of rubber has improved with the Chico Mendes law and the state government's U.S. $ 0.4 per kilogram subsidy. However, the *aviamento* system that supplied many of the luxuries unaffordable to today's cash poor residents has not been reconstructed. The law has had no impact in São Pedro and the current interest in tapping is minimal.

Their new dreams lie with cattle. Household 5's head said that her nephew's greatest dream was to have cattle. Another household head when asked about cattle said, "Kid, I'm lucky with cattle." Later, he thought out loud, " two men can work 144 head with two horses[14]." He plans to buy horses to help manage his herd. Finally, he answered a question about land-use in 2020, " 20 years from now it will be bigger (the deforestation). I don't know if I will be alive but the children will struggle on and the deforestation will be greater." The quote's language displays a man-against-nature discourse. This can be juxtaposed with the state governments commitment to sustainable development through forest valuation. The sentiment of passing on an inheritance was also displayed by another older participant: "my idea is to gain a lot of land and livestock to give to my children when I die."

The evolution of land-use in São Pedro is moving towards a system where 75% of the land in production is devoted to the raising of cattle. This community is not unique, as other case studies in the Amazon document an increase of cattle production among small holders (Gomes 2001; Loker 1993; Murphy et al. 1997; Pichon 1996; Walker et al. 2000). The extensive nature of cattle ranching is already rapidly deforesting community lands.

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[14] Currently there are no horses in the entire Seringal São Salvador.

Furthermore, those interviewed rarely conform to recommended livestock to pasture ratios. In 2000, the ten families interviewed had 51 head of cattle on 45.7 ha of pasture or .9 ha per head of cattle. EMBRAPA-Acre's opinion is that no less than one hectare per head is sustainable (Judson Valentim personal communication), whereas respondents anticipated using ¾ of a hectare per head of cattle in 2010, in addition to the 130 head of sheep and 90 goats that will also graze on that land. One study indicates that Amazonian pasture may become entirely degraded by grazing in just seven years (Serrao & Toledo 1990). Therefore, the sample may have to extend their pastures faster than currently projected, given the amount of livestock production anticipated. Pasture degradation may mean that pasture in 2000 will be useless by 2010 and thus should not be counted towards the total amount of pasture projected by families. This would add at least another 45.7 hectares to the amount of pasture projected for 2010.

Degraded pastures may also become useless for most other purposes when grazed seven years and beyond. Some become bush fallows where the acidic soil is incapable of regenerating a diverse forest rapidly (Loker 1993). Loker estimates that successful recultivation of a plot of fallow requires accumulation of 60,000 kg/ha above ground biomass (Loker 1993). Uhl et al. anticipate 5,000 kg/ha/yr of biomass accumulation after what they term moderate grazing (Uhl et al. 1988). Therefore 13-14 years might pass before that fallow is suitable to be cultivated for traditional annual crops or converted back to pasture. This long layover time is likely to speed up the clearing of mature tropical forest, as the community member faced with large stretches of intact forest will continue to cut older growth rather than intensify and wait for the closer existing fallows to recover. The community is well prepared for this scenario; currently there are nine

chainsaws in São Pedro. As one participant said, pointing to his chainsaw, "This is our strong arm."

Clearly the study participants are moving into pasture extensification and cattle production even as the literature on cattle and the Amazon foreshadow a pessimistic outcome (Fearnside 1997; Hecht & Cockburn 1990; Loker 1993; Uhl et al.1988). The driving forces behind this land-use have been well documented and support the data here (Faminow 1998; Loker 1993). Loker identifies four principal reasons for small holders entering into cattle production: the "bank account/insurance" function; the high marketability of cattle; low labor input/ high return of cattle; and the dual purpose production due to milk and cheese (1993). All of the study sampled here talked of the first three of these four reasons as being instrumental in their desire for increased cattle production. Only two households, however, talked of milk and/or cheese production and/or consumption (3 and 8). The "insurance/bank account" function is the most powerful of the reasons. One participant said, " I want to have livestock. A guy who has livestock has cash in hand. I got sick and had to go down river twice with pigs in the canoe to pay for my medicine." The female head of household also cited security as a motivating factor, "I don't like beef and I don't like milk but cattle is the way to go. Sometimes you're in a tight spot and the vermin (cow) is worth more." This security function is demonstrated by the model's dramatic increase in cattle production and pasture extent from 2000 to 2010 without a corresponding increase in income through cattle and consumption of beef (figures 5-3, 5-8, 5-11, 5-15).

Financing is accelerating the move into cattle ranching. Currently, São Pedro residents have the opportunity to obtain financing through the state government's

PRORURAL program. The Secretariat of Rural Extension and Technical Assistance (SEATER)[15] is working with rural unions. The residents can obtain credit through membership in the Rural Workers Syndicate of Mâncio Lima (STR-Mâncio Lima).[16] During this fieldwork, half of the community households sent a representative to start the process in the main community of São Salvador. One resident had already taken out U.S.$ 4,237. The agreement stipulated that he must start paying it back in two years, then he has six years to pay it off. He immediately bought calves for future beef production and cleared 7.7 hectares of mature forest for pasture. Another participant later revealed that in order to fulfill his 2010 plan he will need financing. He thinks U.S.$ 10,741 will be needed to fence, buy wire[17] and hire help for clearing and fence-building.

Households 8 and 10 both amended their 2010 land-use estimates after learning about the possibility of financing. The head of household 8 put it this way, "With financing I will have 20 head of cattle, 20 sheep and 20 goats in 2010. This is good because now I have a house for processing manioc (casa de farinha) and manioc but I don't have the 10-15 reais[18] needed to make 200 reais.[19] Therefore it is good." The lack of cash to facilitate income generation is common in the community.[20] Household 8's new livestock estimates are an increase over the 6 cattle, 10 sheep and 10 goats recorded during the mapping process. Clearly he would expand on the 4-hectare pasture he was projecting for 2010 before financing. The head of household 10 also informed me on the

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[15] Secretaria de Assistência Técnica e Extensão Rural
[16] Sindicato de Trabalhadores de Mâncio Lima
[17] 36 U.S.$ per roll of 500 meters of wire.
[18] 5.4-8 U.S.$ in August of 2000.
[19] 107.4 U.S.$ in August of 2000.
[20] A household might need U.S.$ 5 to buy gasoline to process over U.S. $ 100 worth of manioc flour.

last day of fieldwork that he would be increasing his cattle production from his earlier 2010 estimates. He said, "with financing and a son to work by my side, I will have 20 head of cattle by 2010. I will buy a head every year." This is a 400% increase over the 4 head that he had anticipated having in our earlier conversations. It is also likely that he would expand on his earlier estimate of 1.2 hectares of pasture in 2010. Matching these two respondents' earlier pasture/cow ratios to the new amount of cattle would increase 2010 pasture totals for these two residents by 9.6 and 4.7 hectares respectively. Even if not all community residents proposed to buy cattle with financing (two residents were each interested in purchasing a large boat and a 5 horsepower outboard motor) this study shows an exponential effect of financing on future herd size.

Another factor that may contribute more pasture extensification is population growth. Tables 3 and 4 show the aging of the respondents from 2000 to 2010. Many of the young family members will be adults by 2010. More children are also likely to born in these families and some to these new young adults. Several of the household heads bought their first cow at the age of 16 and 17. In 2010, 6 of the male children will be over 20 years of age and 12 of female children will be 15 or older. Gomes has found a strong correlation between deforestation in eastern Acre and having sons to work the land (Gomes 2001) (figure 5-19). This correlation could also be true in the Juruá Valley. The preponderance of female children in the houses sampled appears to be a random occurrence. Fifteen is the age of the youngest wife in the sample and an age at which many local women marry. Some of these young adults will go to the city or to another seringal. However, many will also stay. It is beyond the scope of this research to predict

Table 5-3 Age of participating families in 2000

	Household Heads		Daughters					Sons				Elderly	
Hhlds	M	F	F	F	F	F	F	M	M	M	M	M	F
1	28	30	9	8	7	5			12	3			
2	34	29	13	7	5	4			11	1			
3	43	40	14	6	6				12	11	3		
4	25	15	5	4	3								
5		69							15	12			
6	30	27											
7	38	25	2						3				
8	27	27	3						2				
9	57	47											
10	60	74											98
11	60?	60?	9?										
13	45	19	.1										

Head of household 11 shares land with son- head of household 1.
Head of household 13 shares land with mother- head of household 5.

Table 5-4 Age of participating families in 2010

	Household Heads		Daughters					Sons				Elderly	
Hhlds	M	F	F	F	F	F	F	M	M	M	M	M	F
1	38	40	19	18	17	15			22	13			
2	44	39	23	17	15	14			21	11			
3	53	50	24	16	16				22	21	13		
4	35	25	15	14	13								
5		79							25	22			
6	40	37											
7	48	35	12						13				
8	37	37	13						12				
9	67	57											
10	70	84											108
11	70?	70?	19?										
13	55	29	1										

Head of household 11 shares land with son- head of household 1.
Head of household 13 shares land with mother- head of household 5.

the impact that this new generation might have, but preliminary indications are that they want to work with cattle.

Figure 5-19 Boys in São Pedro with a neighbor's cattle. Young men in São Pedro are learning to ranch and not to tap rubber. UTM 18M E0695957, N9183944, August 1, 2000.

These projections pose major challenges for the future of the MRSSP. The MRSSP states that the management plan will be created according to the needs and desires of each group within the project (Valentim 2000). Each community within the project will have input into their management plan. The São Pedro community desires cattle, which may not be perceived as sustainable. Given the energy they have already committed to this livelihood and the amount of energy that they want to commit further, cattle should be incorporated into the management plan. To deny or take away a community resident's cattle now would be very painful. Financing has made commitment to cattle even greater. A farmer in debt because of financing for cattle investment is not likely to back

off that income generating strategy. As one resident said, "If I can't raise cattle here then I will leave." Cattle provide many benefits directly: income for beef and milk, food from beef and milk, animal power and crop fertilization. Cattle's low labor input/ high return, marketability and insurance functions also explain small farmers' eagerness to begin cattle raising (Faminow 1998; Loker 1993). The marketability and mobility of cattle also make cows an ideal reward to family members leaving the home (Lena in Faminow 1998). Community members need the insurance function that only cattle apparently provide. The MRSSP must create a management plan balancing the community's need for cattle with the desire for a healthy forest. This balance will likely require forest-based alternative income generating strategies to diminish local reliance on cattle raising. The plan must also include plans for educating farmers on improving intensive methods for cattle ranching, realistic limits on the amount of cattle and pasture in the project, realistic monitoring strategies for local cattle production and enforceable repercussions if limits are not obeyed.

No forest product sold by São Pedro members has all of the positive properties of cattle. Rubber is no longer a viable income generator for the respondents. None of the households interviewed showed a desire to return to what most described as a life full of hardship. Can another product or group of products be found that provide a reasonable alternative to cattle production and extensive agriculture? This is the question that must be answered by the MRSSP to persuade the community's inhabitants to modify the direction of their current land use. If alternatives are not found, can a management plan be successfully forced on a community desiring other options of land use? The major income sources found in 1990, 2000 and 2010 data provide no ready solution to the

problem of finding value in the forest. The state government is committed to investing in the economic potential of the forest, a potential that has yet to be discovered in São Pedro.

Conclusion

The data suggest that São Pedro's cattle production is much more aggressive than what was previously thought about the area. The case study also provides a warning to the state of Acre, of former rubber tappers' shift of livelihoods from forest to pasture. The Southwestern Amazon Ecoregion, a region of high biodiversity and multiple protected areas, is also threatened by the expansion of cattle and pasture.

The MRSSP was aware that project residents had moved away from rubber tapping. The project knew that cattle ranching was present and desired, but did not fully realize the degree to which it constituted a future project for inhabitants. PESACRE noted in their socio-economic report that,

> The raising of cattle is recent in the seringal and not very common. It started about five years ago. Milk production for family subsistence is the dominant use. The number of head is 3 or 4, counting cows, calves and bulls, per producer… Beef production is even rarer and marketing of beef is sporadic… Although cattle raising is not common, it is frankly in expansion. Almost every community has areas of terra firme opening for cattle, and current producers reveal the desire to increase herd size while non-producers express an interest in starting production. (PESACRE 1999: 27).

The data in this chapter provide a more detailed view of the situation. Cattle raising in São Pedro has a history dating back to at least 1985. This detailed information allows PESACRE, EMBRAPA and INCRA to create a management plan with a more complete picture of local activities and desires.

The current and future land units described earlier also provide a spatial reference to facilitate the making of management plan maps. These land units show where the community members are working now and where they would like to work in the future. This can be used to reference the demarcation of individual household plots. In addition, the construction of the GIS can help for present and future management and monitoring of the project. However, the uncertainty of the Acre/Amazonas State Line will continue to make planning difficult until the issue is resolved. The adoption of the 1943 line, the 1988 line or the watershed divide provide vastly different possibilities to local land-use planning.

This study also contributes to regional work on LULCC. Hard evidence of the transition from tapping to cattle ranching is useful to the state government in their efforts to build sustainable livelihoods out of the forest. The former tappers' aggressive pursuit of the cattle raising livelihood underlines the difficulties that the state government faces in their quest to orient small holders towards forest-based livelihoods. The study underscores the threat to the forest while providing a case study in a remote and little studied portion of the Juruá Valley. More LULCC case studies at local scales might provide the detail and heterogeneity not represented in the Forest Government's 1:250,000 scale ZEE project.

The Southwestern Amazon Ecoregion can also benefit from the analysis. As a remote region with comparatively little recent human impact and a high level of biodiversity, the area is a conservation priority. Yet, smallholders similar to residents of São Pedro may be cutting forests to expand cattle production. The LULCC pattern demonstrated in this study is likely to be in progress throughout the ecoregion in Peru, Bolivia and Brazil.

CHAPTER 6
IMPROVING NATURAL RESOURCE MANAGEMENT WITH LOCAL PARTICIPATION AND GEOMATICS TECHNOLOGY

Summary

Many efforts are underway to integrate local knowledge into natural resource management. One method of including this knowledge into NRM is through the use of a GIS combining local and scientific knowledge. A GIS containing spatial, social and biophysical knowledge from local and scientific sources can improve NRM by providing ground-truthed base-line data relevant for management and monitoring strategies. Settlement projects in the Brazilian Amazon need to improve NRM to reduce land ownership turnover and deforestation. Incorporation of local knowledge of settlement projects through the GIS medium may help to accomplish these goals.

The thesis presents two different types of local knowledge relevant to natural resource management in the MRSSP. The first concerns a community's interpretation of setting and boundaries. Current RADAMBRASIL data of the São Pedro area is inadequate for the precise planning needed in the MRSSP management plan. Georeferencing local knowledge has corrected the flawed base maps of the region and improved outside knowledge of the landscape. The research has correctly located the São Pedro Creek and "discovered" that the São Pedro community is not divided by or outside the project map, but rather the largest community within the project.

This thesis has introduced a new map into the MRSSP. This action has both empowered and marginalized the community of São Pedro (Harris & Weiner 1998).

They are empowered by a more accurate representation of their setting and boundaries. This will allow all of the families to be part of the project and to reap the benefits of it. On the other hand, they have been identified by the map and are now subject to rules that they might previously have avoided through their anonymity. In addition, as the community members do not have GIS skills or equipment, their knowledge is in the hands of people and organizations like me, PESACRE, EMBRAPA and INCRA. Some have argued that GIS should contain community knowledge only when the community controls access and analysis of the GIS (Fox 1998). However, in this case, the community was in danger of being omitted and obscured. Thus, I argue that the creation of this participatory map is an improvement over being mapped from without and mapped incorrectly at that.

In São Pedro, local people have much to contribute concerning the placement of boundaries. Their own interpretation of boundaries may not fit with the official boundaries of conservation and development projects and, thus, they may not abide by boundaries made without an appreciation for the history, land-use and knowledge of the local people. Local boundaries are likely to be fuzzy, and if not may generally follow ecological boundaries.

The case of São Pedro also revealed an official fuzzy boundary. Multiple state lines and the mystery of their location could be substituted by the ecologically and culturally grounded boundary that is the watershed divide north of São Pedro. This would entail the cooperation of INCRA-Amazonas, but would be a more accurate representation of community and seringal limits. On the other hand, if the state boundary remains

uncertain due to political tensions, this might be better than a fixed boundary that painfully reduces São Pedro's territory.

Regardless of the uncertainty or future choice of project boundaries, the current boundary of the MRSSP incorrectly includes 469 hectares, including the political and social center, of Peri Peri Seringal. Within the project boundary, both location and selection of fuzzy or rigid intra- and inter-community boundaries will have important impacts on conflict over resources. This research has already found both real and potential conflicts over pig invasions, crop invasions and fishing net placement. Type and location of boundaries will be increasingly important in conflict management over resources as continued population growth strains resources in the Seringal.

The second type of local knowledge presented in the thesis concerns land-use and land-cover change. This knowledge is useful to NRM because it accurately represents what the local people are doing and where they are doing it. In addition, this study shows the residents' past activities, and models possible land-use and land-cover in 2010. Local people's future aspirations are particularly relevant to sustainable NRM. If a management plan is made that does not at least partially incorporate the wants of the local people, it is not likely to be obeyed.

This LULCC study demonstrates the shift from rubber tapping to a possible future of cattle ranching. Residents of São Pedro are largely enthusiastic about this transition, since cattle production has multiple benefits for community households. Despite some evidence that cattle production is unsustainable, this activity currently provides benefits unavailable from other resources. Until forest products provide significant and sustained income, cattle provide insurance in case of illness, injury or crop failure. Unfortunately,

this model shows residents relying on pasture extensification and aggressive rates of deforestation. This land-use trend appears exacerbated by financing and may increase more with population growth. However, knowing this tendency may help the MRSSP develop an intensive cattle production scheme that complements extractive activities. The model also shows the importance of the forest in providing food and other products, but legal income[1] from the forest is still rare.

Future Endeavors in the Amazon and Beyond

The local knowledge gained in this study is useful to the MRSSP and its natural resource management. However, this specific knowledge and the methods used can also contribute to other settlement projects or conservation and development initiatives. Growing demands for land and resources worldwide threaten forests and other natural areas important for biodiversity protection, carbon sequestration and regional and local climate maintenance. Combining local knowledge and modern technology and science may be the best path for sustainable natural resource management and the conservation of forests and other natural areas. Participatory methods may be particularly useful in eliciting local knowledge as they build human resources and improve the knowledge base for informed decision making. GIS combines the local and scientific knowledge and also has the ability to identify, organize and analyze the combined information for the management and monitoring purposes necessary in SNRM

SNRM initiatives can also benefit from more specific recommendations. As this thesis has demonstrated, geographic information on setting, boundaries and LULCC can improve SNRM initiatives. Local people can contribute valuable knowledge of

[1] Timber and game meat can be easily sold but are illegal activities.

landscape and boundaries while also participating to make wise selections of boundary type and location. In the Amazon, alternative income generating activities need to be identified and implemented to decrease reliance on cattle ranching and other less sustainable land-uses.

Projects such as the MRSSP need to have the best geographic information possible. Relying on incorrect maps delayed and confused the process used in this particular project. One of the first steps that any project undertakes should be the mapping of all watercourses and basic physical geography with local people and a GPS. In the Amazon or similar rainy/dry season environments, this mapping should be done at both peak wet and dry seasons. This allows the project to identify terra firme along with permanently and seasonally flooded areas. This information is not necessarily available or accurate on existing maps. These data could be further strengthened in combination with satellite imagery of the area during both the dry and wet seasons. This may be impossible due to cloud cover, but should be attempted nonetheless. Seasonal imagery would provide the detailed base maps needed for relevant NRM strategies. The input of local people is crucial, as they know more about the local area than outsiders. Without ground truthing, not even the most skilled cartographer with the best satellite technology available can match a long-term resident's knowledge of his area. Good maps require ground truthing, and nobody knows the true lay of the land as well as the people living on that land. GPS is also a tool that local people can learn to use. Peter Poole, Richard Smith, among others, have demonstrated the mapping potential existing in isolated rural populations (Poole 1995; Smith 1995).

Boundaries are another relevant subject that benefits from local people's input. There are many types of boundaries and many locations for them, according to whom one asks. In rural areas, the best boundary may be defined by the landscape and ideally would have a local history. These ecological boundaries may require no markers, and if already used by locals, may also be readily agreed upon.

Boundaries can be sources of conflict, and outside experts should try and recognize the type of boundary best suited to mitigate conflict over resources. This is best done with local participation. The option of fuzzy boundaries must be weighed with the choice of concrete boundaries. Whichever boundary is chosen should be accompanied by a clear discussion of possible future conflicts that could result from such a boundary. Local people can contribute to boundary creation, as it is they who often know the land and the existing boundaries and conflicts best.

Land-use and land-cover change studies promise to increase in magnitude as growing populations and limited space force more change on the environment and land-cover. This study shows ex-rubber tappers becoming cattle ranchers. The reality of the situation is that rubber tappers are an aging population. The daughters and sons of rubber tappers are not being raised into the same lifestyle and thus are not learning or interested in the same traditional skills. In the absence of rubber, this generation is gravitating towards cattle ranching. Raising cattle is not looked on with much favor by the current state government of Acre or international conservation and development organizations. Perhaps the state could increase incentives for forest-based activities instead of cattle. However, currently, no other activity has the positive qualities of cattle ranching. Cattle will continue to be an Amazonian reality until this changes.

To date cattle ranching has been a primarily male activity. This is likely to continue if cattle remain part of a smallholder's production. Women, on the other hand, could possibly be targeted for other income generating strategies that rely more on the forest. Women have already demonstrated ability in processing Brazil nuts in Acre (Campbell 1996). The state could provide incentives for forest-based activities in order to slow the interest in cattle ranching. Perhaps some of the many varieties of palms in the Juruá valley could produce fruits, nuts or fibers that women and female children could market successfully. This is a strategy that bears some investigation if conservation goals are to be reached in a future of Amazonian cattle ranching.

APPENDIX A
EXIT INTERVIEW QUESTIONS POSED TO OFFICIALS OF INCRA, EMBRAPA AND PESACRE

What is your title?

How many years have you worked for the organization?

How many years have you worked on the MRSSP?

What is the status of the project?

How big is the area that the project will cover?

What is the legal situation with the parts of São Salavador that lie in Amazonas state?

What is the legal situation of the Seringal Peri Peri?

How did you make the project boundaries currently in place?

Do you have a lot of confidence in the map you are using?

When will the project be demarcated?

How will it be demarcated? The perimeter? The communities? The households?

How is the land in the project being used?

How much land does each household have in agricultural production?

What will be the size and land-uses of agricultural production in 10 years?

What distance lies between the fields and the houses of individual families?

What type of animals are being raised? How many?

APPENDIX B
HOUSEHOLD MAPPING REFERENCE QUESTIONNAIRES

Reference Questionnaire Past

Passado 10 anos

Rio, Igarape, Lago?

Casa Distancia da água?

Onde era a terra que usava?

Estradas / Agricultura / Criação

onde terminou o seringal? N, Po, S, Nasc

Distancia?

Tinha Marcos?

Conhecia? Onde fica?

Paraná João Bezerra?

Peri Peri?

Japonesa?

Timbaúba das Bezerras?

Vai Quem Quer?

Onde moravam os vizinhos?

Dirreção / Distancia? Familia de alguem?

Tempo de Estar

você viu eles quantas vezes?

você tinha crédito, financiamento, dívida na época?

Terra

Dustancia á terra que usava? Pé?

Quando você chegou eraC, C~,M

Em que ano chegou?

Que produtos tinha lá?

Quantos anos atrais era mata bruta?

Tinha Arroz, milho, feijão?

Qualidades de roça?

Que produtos eram mais trabalho?

Tamanho de aréa que estava trabalhando num ano? Quadras?

Quantidade de __ que colheu?

Précio? Vendeu onde?

Como tirou?

Como levou a ML/ CZ?

O solo era que? Terra firme, baboca, baixo?

Sempre usou a mesma terra?

Brocou C, C~, M?

Queimou antes de plantar de novo?

Só uma vez ao ano? Menos?

Que tipos de problemas tinha a agricultura nessa época: preço baixo, crédito, transporte, mão de obra, invasão por animais de mata/criação?

Criação

Que criava? Quantos?

Soltos? Cercados?

Onde? Distancia da casa?

Tamanho de área?

Leva as animais a novo pasto cada?

Porque criu esses bichos?

Quando começou a criar: gado (leite/corte), porco, galinha, pato, ovelha, bode?

De que raza eram?

Comeu e Vendeu, comeu, vendeu?

Onde vendeu? Como levou a ML/CZ?

Précio?

Que era a comida para as animais?

Comprou?

Alguns dos animais andaram londe? Até onde?

Gostou da criação? Porque no?

Deu problemas a criação nessa época? Que tipos de problemas?

Tinha regras de criação?

gado de corte/ leite quanto leite?

Madeira

Tirou madeira?

Que qualidade de pau?

tinha motoserra? Machado?

Tirou para casa? Canoa?

Tem gente aqui que podem fazer canoa?

vendeu madeira?

Tirou de londe?

talbas, pranchas, árvores ao ano?

Produtos Não Madereiros

comia coisas como

buruti

patauá

bacaba

açai

pupunha

outros?

Vendiu?

Foi londe para tirar?

Era mais fácil or mais dificil tirar nessa época?

Caça?

A caça era melhor o pior nessa época?

Pesca

A pesca era melhor o pior nessa época?

Reference Questionnaire Present

Presente

Rio, Igarape, Lago?

Casa Distancia da água?

Onde está a terra que usa?

Estradas / Agricultura / Criação

onde termina a seringal/comunidade de SP agora? N, Po, S, Nasc

Distancia?

Marcos?

é importante que Sp tem limites?

Onde moram os vizinhos?

Dirreção / Distancia? Familia de alguem?

Tempo de Estar eles?

você vê eles quantas vezes?

Onde começa e termina a terra que é conhecida como a terra de você?

Como sabem eles que é de você?

Tinha algum problema com invasão de terra?

Você presta o divide terra com alguem?

Recibe alguma coisa por fazer isso?

Tem algum crédito, financiamento, dívida?

Terra

Distancia á terra que usa? Pé?

Quando você chegou eraC, C~,M Em que ano chegou?

Que produtos tem lá?

Quantos anos atrais era mata bruta?

Tem Arroz, milho, feijão, bananal, frutales na quintal –outros lugares?

Qualidades de roça?

Que produtos são mais trabalho?

Tamanho de aréa que esta trabalhando agora/ neste ano arroz? Quadras?

Quantidade de __ que colheu/vai colher?

Précio? Vende onde?

Como tira?

Como leva a ML/ CZ?

O solo é que? Terra firme, baboca, baixo?

Sempre usa a mesma terra?

Brocou C, C~, M?

Queima antes de plantar de novo?

Só uma vez ao ano? Menos?

Que tipos de problemas tem a agricultura: preço baixo, crédito, transporte, mão de obra, invasão por animais de mata/criação?

Criação

Que cria? Quantos?

Soltos? Cercados?

Onde? Distancia da casa?

Tamanho de área?

Leva as animais a novo pasto cada?

Porque cria esses bichos?

Quando começou a criar aqui: gado (leite/corte), porco, galinha, pato, ovelha, bode?

De que raza são?

Come e Vende, come, vende?

Onde vende? Como leva ML/CZ?

Précio?

Que é a comida para as animais?

Comprou/ onde planta a comida?

Alguns dos animais andam londe? Até onde?

Gosta da criação? Porque no?

Da problemas a criação? Que tipos de problemas?

gado de corte/ leite quanto leite?

galinha/pato ovos?

Madeira

Tira madeira?

Que qualidade de pau?

tem motoserra?

Tira para casa? Canoa?

Tem gente aqui que podem fazer canoa?

vende madeira?

Tira de londe?

talbas, pranchas, árvores ao ano?

Produtos Não Madeireiros

come coisas como

buruti

patauá

bacaba

açai

pupunha

outros?

Vende?

vai londe para tirar?

Caça

A caça é difícil o fácil?

Pesca

A pesca é difícil o fácil?

Trabalho agora ?

Diaria? Machado?

Motoserra? Frete?

Reference Questionnaire Future

Futuro, em 10 anos

Daqui em deiz anos onde está a terra que você pretende usar? Estradas/ Agricultura/

Criação?

Se você pudesse fazer os limites do comunidade onde ficariam? N, Po, S, Na PORQUE?

Você sonha permanecer na area? Si No

Se você pudesse escolhar seu terreno onde escolharia? _____

Porque?_____

No futuro quais são os recursos que você quer usar?

_____

De aqui a vinte anos qual tamanho de sua area você calcula estar desmatado?

_____

No futuro deveria ter regras de uso de terra e recursos naturais _____ Quais?

Caça_____

Pesca_____

Madeira_____

Extrativismo_____

Criação_____

Se tivesse financiamento no futuro como vai usar esse dinheiro

_____

Você quer que as vidas de seus filhos forem diferentes que as vida de você? Como?

_____

No futuros quais são as actividades que você acha os homens e mulheres vão estar fazendo? _____

No futuro que faria você se for uma regra de não ter gado dentro do seringal?

_____-

No futuro que faria você se for uma regra de não cortar madeira para vender?

_____

No futuro que faria você se for uma regra de não caçar?

_____

No futuro que faria você se for uma regra de não pescar nos lagos durante o tempo de inverno e de não usar mangas?

_____

No futuro que faria você se tinha um lote de 10 (30) quadras e não podia usar mais terra?

_____

Onde vão morar os vizinhos?

Dirreção / Distancia? Familia de alguem?

Você vai prestar o dividir terra com alguem?

Recibe alguma coisa por fazer isso?

Terra

Distancia á terra que vai usar? Pé?

Que produtos vai ter?

Quantas quadras vai precisar?

Vai ter Arroz, milho, feijão, bananal, frutales na quintal –outros lugares?

Qualidades de roça?

Tamanho de aréa que vai ter em producção num ano?

Quadras?

Quantidade de __ vai colher?

Précio? Vai vender onde?

Como vai tirar?

Como vai levar a ML/ CZ?

Sempre vai usar a mesma terra?

Brocou C, C~, M?

Vai queimar antes de plantar de novo?

Só vai queimar uma vez ao ano? Menos?

Vai ter problemas com a agricultura: preço baixo, crédito, transporte, mão de obra, invasão por animais de mata/criação?

Criação

Que vai criar? Quantos?

Soltos? Cercados?

Onde? Distancia da casa?

Tamanho de área?

Quantas quadras vai desmatar para criação?

Leva as animais a novo pasto cada?

Porque cria esses bichos?

Quando quer começar a criar eles: gado (leite/corte), porco, galinha, pato, ovelha, bode?

De que raza vai ser?

Vai comer e vender, comer, vender?

Onde vai vender? Como vai levar ML/CZ?

Précio no futuro?

Que vai ser a comida para as animais?

Vai comprar ou plantar a comida?

Alguns dos animais vão andar londe? Até onde?

Vai ter problemas na criação? Que tipos de problemas?

gado de corte/ leite quanto leite?

galinha/pato ovos?

Madeira

Vai tirar madeira?

Que qualidade de pau?

Vai ter motoserra?

Vai tirar para casa? Canoa?

Vai vender madeira?

Vai tirar de londe?

talbas, pranchas, árvores ao ano?

Produtos Não Madereiros

Vai comer coisas como

buruti

patauá

bacaba

açai

pupunha

outros?

Vai vender?

Vai ir londe para tirar?

Caça

A caça vai ser difícil o fácil?

Pesca

A pesca vai ser difícil o fácil?

APPENDIX C
TABLES FOR RECORDING MATRICES OF RESOURCES RESULTS

Past Matrix Table

PASSADO		quem trabalha					venda		dest. R			quem trabalha				
produto	renda	H	M	fo	fa		H	M	H	M	comida	H	M	fo	fa	
ovelha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
gado		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
galinha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pato		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
porco		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
bode		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
caça		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pesca		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
roça		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
arroz		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
feijão		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
banana		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
milho		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
mamão		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
café		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
cebola		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
abacaxi		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
melancia		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
gerimum Leit		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
inhame		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
cana de açuc.		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
urucu		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
abelha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
açai		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
bacaba		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
buriti		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
patauá		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pupunha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
coco		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
couve		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pimenta		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
limao		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
goiaba		H	M	fo	fa		H	M	H	M		H	M	fo	fa	

tangerina		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
laranja		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
biribá		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pupú		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
manga		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
graviola		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
madeira		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
seringa		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
aposentado		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
diaria		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
trab. de meia		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
frete		H	M	fo	fa		H	M	H	M		H	M	fo	fa	

Present Matrix Table

PRESENTE		quem trabalha					venda		dest. R			quem trabalha				
produto	renda	H	M	fo	fa		H	M	H	M	comida	H	M	fo	fa	
ovelha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
gado		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
galinha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pato		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
porco		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
bode		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
caça		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pesca		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
roça		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
arroz		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
feijão		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
banana		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
milho		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
mamão		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
café		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
cebola		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
abacaxi		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
melancia		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
gerimum Leit		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
inhame		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
cana de açuc.		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
urucu		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
abelha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
açai		H	M	fo	fa		H	M	H	M		H	M	fo	fa	

bacaba		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
buriti		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
patauá		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pupunha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
coco		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
couve		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pimenta		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
limao		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
goiaba		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
tangerina		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
laranja		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
biribá		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pupú		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
manga		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
graviola		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
madeira		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
seringa		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
aposentado		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
diaria		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
trab. de meia		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
frete		H	M	fo	fa		H	M	H	M		H	M	fo	fa	

Future Matrix Table

FUTURO		quem trabalha					venda		dest. R			quem trabalha				
produto	renda	H	M	fo	fa		H	M	H	M	comida	H	M	fo	fa	
ovelha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
gado		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
galinha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pato		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
porco		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
bode		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
caça		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pesca		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
roça		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
arroz		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
feijão		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
banana		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
milho		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
mamão		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
café		H	M	fo	fa		H	M	H	M		H	M	fo	fa	

cebola		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
abacaxi		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
melancia		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
gerimum Leit		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
inhame		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
cana de açuc.		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
urucu		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
abelha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
açai		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
bacaba		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
buriti		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
patauá		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pupunha		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
coco		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
couve		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pimenta		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
limao		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
goiaba		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
tangerina		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
laranja		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
biribá		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
pupú		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
manga		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
graviola		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
madeira		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
seringa		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
aposentado		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
diaria		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
trab. de meia		H	M	fo	fa		H	M	H	M		H	M	fo	fa	
frete		H	M	fo	fa		H	M	H	M		H	M	fo	fa	

APPENDIX D
TIMELINE QUESTIONS

Linha de Tempo

Borracha

Se criu onde?

Que faziam seus paes?

Morou em outros lugares, Quando?

Quando chegou aqui no SP? Sempre morou aqui mesmo?

Quando juntou/casou?

Quando nasceram os filhos?

Cortou seringa?

Onde cortou?

MAPA Quantas estradas?

Onde ficaram?

Quantas frascas de leite davam?

Quantas qualidades de árvores produziam borracha?

Era borracha boa?

O précio do frasco era quanto?

Quantos meses do ano produziam as árvores? Que fazia durante os outros meses?

Era bom viver asi? Problemas?

Quem era o patrao? Só um?

Ele ajudava você? Como? Crédito? Você devia alguma coisa na época?

Vendia alguma coisa ademais de cortar?

MAPA Tinha agricultura?

Quando começou a agricultura (roça, milho, arrox, feijão, bananal outro?)?

MAPA Criava alguma coisa?

Era importante a criação na época?

Quando começou a criar?

Gado (leite, corte), Porco, galinha, pato, ovelha, bode?

Quanta terra usava você quando estava cortando? Quadras?

Parou de cortar? A que edade?

Como / quando terminou a borracha? Como sabia que terminou?

Você mudou depois de terminar a borracha?

Que fazia depois de terminar a borracha? De que vivia? Roça, arroz, milho, caça, pesca, madeira?

Criação?

APPENDIX E
INTERVIEW GUIDE

Mora aqui o ano todo? ☐sim ☐não. Neste caso, indique

onde/quando:_____

Quanto tempo mora no local?

_____

Por que veio morar aqui?

_____

_____

_____

_____

Como consegui esta colocação?

☐ comprou ☐ trocou ☐ herdou ☐ abriu ☐ outros

QUAIS SÃO OS ULTIMOS LUGARES ONDE VOCÊ MOROU?

Local	Ano	Motivo da saída

Opinião do morador sobre aumento ou diminuição de moradores nas redondezas nos últimos anos: ☐aumentou ☐diminuiu ☐mesmo

Alguém da sua família já mudou? ☐ Sim ☐ Não

Por quê? _____

Tem parente morando próximo ? ☐ Sim ☐ Não

Onde ? _____

Grau de parentesco: _____

Gosta de morar aqui?

HOMEM

☐Sim.

Motivo:_____

☐Não.

Motivo:_____

MULHER

☐Sim.

Motivo:_____

☐Não.

Motivo:_____

FILHO

☐Sim.

Motivo:_____

☐Não.

Motivo:_____

FILHA

☐Sim.

Motivo:_____

☐Não.

Motivo:_____

O entrevistado ou alguém da casa pensa em se mudar?

☐sim ☐não

Motivo/Quem:_____

_____

Local de preferência para morar:

Onde:_____ Motivo:_____

Onde:_____Motivo:_____

Serviços Públicos

Utiliza água ☐ do rio ☐ da cacimba ☐ de poço

Tratamento de água ☐ não trata ☐ coa ☐ filtro ☐ hipoclorito ☐

Reuniões

Que tipos de reuniões que frequenta:

Homem: festas ☐ missa ☐ culto ☐ outro ☐ Onde?_____

Mulher: festas ☐ missa ☐ culto ☐ outro ☐ Onde?

Jovens: festas ☐ missa ☐ culto ☐ outro ☐ ONde?

Mobilidade

Frequência que baixa para cidade_____

Motivo_____

A frequência é satisfatória ou baixaria mais vezes? ☐Satisfatória ☐Baixaria mais vezes

Para fazer o quê?_____

Possui que tipo de transporte? ☐Canoa a remo ☐Canoa a motor ☐Carroça ☐

Outros: _____ ☐Nenhum

Caso não possua motor, paga para viajar? ☐ sim ☐ não

Quando vai para cidade fica: ☐ casa de parente ☐ casa de amigo ☐ igreja ☐ outro

QUEM TRABALHA EM CADA UMA DESTAS ATIVIDADES RELACIONADAS À AGRICULTURA?

ATIVIDADES	Homem (#)	Mulher (#)	Criança/ jovem (#)	Parentes/ Vizinhos (#)	Mutirão	Prestação/ serviços (#)
Preparo da área						
Escolha						
Plantio						
Limpeza						
Colheita						

Produtos não madereiros

Trabalha com extração de borracha? ☐ Sim ☐ Não

Nº de estradas de seringa, colocações_____

Porque mudou? ☐produtividade caiu ☐preços caíram ☐ está c/outra atividade ☐

outros: _____

Se os preços melhorassem voltaria ao extrativismo?

HOMEM ☐sim ☐não MULHER ☐sim ☐não JOVEM ☐sim ☐não

Limites Seringal/Estado:

Que são os velhos límites do seringal?

Poente_____

nascente _____

norte_____

sul_____

Tinha marcos? _____ Quais_____

Como foi dividido no passado?_____

Quais são os marcos/límites agora?_____

Como está dividido agora? _____

Onde estão morando pessoas agora? _____

_____

Em que estado mora você?_____

Você sabe em que direcção está o estado de Amazonas (Acre)? _____

Quanta distancia? _____

Tem marco o estado? Si No

Você acha importante vivir em um estado ou outro?_____

Você sabe se o outro (este) lado (Amazonas) tem proprietario? _____

Como está dividido a terra por este (ou outro lado)? _____

Você sabe o que é o linha cunha gomes?_____

Você sabe que é o Paraná João Bezerra? _____

Você sabe onde está Peri Perí? si no

Onde? _____

Você sabe onde está o local conhecido como japonesa? si no

Onde fica? _____

Você sabe onde está o Timbaúba dos Bezerras? si no

Onde fica? _____

Se você pudesse fazer ol límites do seringal onde ficariam? _____

Porque? _____

Que fazeria você se o terreno de você estivesse no estado de amazonas (acre)?_____

_____

_Que fazeria você se o linha cunha gomes era mais ao norte do igarapé SP? _____

_____

Limites comunidade/igarapé

Você mora numa comunidade? Si No Qual? _____

Quais são os límites de esta comunidade? _____

Tem marco(s)? Si No

Como sabe onde termina? poente _____

nascente _____

norte _____

sul _____

Que está ao outro lado do igarapé?_____

Onde está a comunidade Vai Quem Quer? _____

Em que direcção vai o igarapé? norte sul poente nascente

Onde termina? _____

Você divide recursos o terra com outros? _____

Com quem divide e onde?_____

_____

_____

Limites familia/roça

Você tem terreno aqui? si no

Como sabe que é de você (outro)?_____

onde termina o terreno? _____

Como sabe? _____

Tem outros moradores aqui? si no

QUAIS SÃO OS MORADORES PROSSIMOS?

nome	por que está	quanto tempo	distancia p/r	parente de?	vê # vez ano

Eles sabem qual é o terreno de você? Si No

Como sabem? _____

Você sabe que é o INCRA? si no Que fez o INCRA?

_____

Você sabe que o INCRA vai fazer um trabalho aqui no Seringal? si no

Como você gostaria que o INCRA trabalhe? _____

_____

Porque?

_____

_____

Você sonha permanecer na área? Si No

Se você pudesse escolhar seu terreno onde escolharia _____

Porque?_____

_____

No futuro quais são os recursos que você quer usar?_____

_____

De aqui a vinte anos qual tamanho de sua area você calcula estar desmatado?_____

_____

No futuro deveria ter regras de uso de terra e recursos naturais? _____ Quais?_____

caça, pesca, madeira, extrativismo, criação_____

_____

_____

No futuro tem recursos específicos que você quizer ter? _____

_____

Você quer que as vidas de seus filhos sejam forem diferentes que a vida de você?_____

Como? _____

_____

No futuro quais são as actividades que você acha os homens e mulheres vão estar fazendo?

No futuro que faria você se for uma regra de não ter gado dentro do seringal?_____

_____

No futuro que faria você se for uma regra de não cortar madeira para vender? _____

No futuro que faria você se for uma regra de não caçar?

_____

No futuro que faria você se for uma regra de não pescar nos lagos durante o tempo seco e de não usar mangas nunca? _____

_____

_____

No futuro que faria você se tinha um lote de 10 (30) quadras e não podia usar mais terra?_____

_____

Linha de tempo

Onde se criu? _____

Cortou seringue? Si No

Quando deixou de cortar seringue? _____

Quando se casou ? _____

APPENDIX F
LIST OF ACRONYMS

BASA	Bank of Amazonia
CNS	National Rubber Tappers Council
CONTAG	Brazilian Agricultural Workers National Confederation
EMBRAPA	Brazilian Institute of Agricultural Research
FUNTAC	Technology Foundation of the State of Acre
GETAT	The Executive Group for Lands in the Araguaia-Tocantins Basin
GIS	Geographical Information Systems
GPS	Global Positioning System
IBAMA	Brazilian Institute of Environment
IBGE	Brazilian National Institute of Geography and Statistics
IMAC	Environmental Institute of Acre
INCRA	National Institute of Colonization and Agrarian Reform
LK	Local Knowledge
LULCC	Land-Use and Land-Cover Change
MRSSP	Model Rural Sustainable Settlement Project
MST	Landless Rural Workers Movement
NGO	Non-Governmental Organization
NRM	Natural Resource Management
PAD	Directed Settlement Project
PAR	Rapid Settlement Project
PESACRE	The Acre Group for Agroforestry Research and Extension
PIC	Integrated Colonization Project
PNSD	Serra do Divisor National Park
PT	Workers' Party
PTD	Participatory Technology Development
RADAM	Radar Survey of the Brazilian Amazon Project
RADAMBRASIL	Radar Survey of the Brazilian Amazon Project
SEATER	Secretariat of Rural Extension and Technical Assistance
SNRM	Sustainable Natural Resource Management
STR	Rural Workers Syndicate
SUDAM	Superintendency of Amazonian Development
UTM	Universal Transverse Mercator
ZEE	Ecological Economic Zoning

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BIOGRAPHICAL SKETCH

David Salisbury was born in Pottsdam, NY, and raised in Columbia, SC. He attended high school at The Hill School in Pottstown, PA, graduating in 1989. In 1993 he graduated from Middlebury College in Middlebury, VT, with a Bachelor of Arts degree. He majored in Spanish and minored in sculpture. His third year of college was spent studying Spanish politics, history, art and literature in Madrid, Spain. He entered the U.S. Peace Corps in 1993 and spent over two years working on reforestation and organic gardening projects in Guatemala. Following Peace Corps, he taught Spanish and sculpture and coached soccer and basketball at Gilman School in Baltimore, MD. In 1999 he entered the Tropical Conservation and Development Program of the University of Florida's Center for Latin American Studies. His studies within the Center for Latin American Studies were funded by a Foreign Language and Area Studies Fellowship requiring the study of Brazilian Portuguese.

To complete this research, Mr. Salisbury received funding from the Charles Wagley Endowed Fellowship at the University of Florida. His interest in tropical conservation and development and geography brought him to the University of Texas in 2001 to study geography at the doctoral level. He plans to return to western Acre and investigate transboundary land-use along the border with Peru for his doctoral field work.