LAND USE AND LAND COVER IN IÑAPARI, PERU, AND ASSIS BRAZIL, BRAZIL, SOUTHWEST AMAZONIA

By

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To the people of the MAP region.

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The present thesis research has its roots in the growing field of land use and land cover change. It compares land use and land cover across space in two bordering areas: the district of Iñapari in Madre de Dios, Peru, and the município of Assis Brazil in Acre, Brazil. This study case has a micro-level approach that focuses on small farm households in this area know as the tri-national border Peru-Brazil-Bolivia.

The research analyzes the differences in land use and land cover in Assis Brazil and Iñapari and proposes an innovative integrative framework with roots on Political Ecology, Household Demography and Panarchy theories. The research also has an empirical component, the assessment of the proposed framework is done by modeling land use and land cover in both tows. The findings reveal the relevance of road infrastructure variables, market variables and background variables in explaining differences in land use and similarities in land cover outcomes. It also suggests that

further development of the proposed integrative framework may contribute to a better understanding of different level process that drive land use and land cover change.

CHAPTER 1
INTRODUCTION

The subject matter of this research has its roots in the growing field of land use and land cover change; however, differently from most studies it does not deal with changes across time. It compares land use and land cover across space in two bordering areas: the district of Iñapari in Madre de Dios, Peru and the município of Assis Brazil in Acre, Brazil.

The present document has been organized in four chapters. The chapter 1 briefly reviews the bases of the field of land use and land cover change, and presents the study area from a historical and current perspective observing its similarities and differences. The chapter 2 goes more in depth on relevant theories used to explain land use and land cover changes, and it ends by proposing an integrated theoretical framework for the present research. Chapter 3 describes the methods used to gather and analyze the data. It also presents and interprets the results obtained form the analysis. Chapter 4 presents a general discussion of the findings from Chapter 3 and elaborates general conclusions for the present research.

Land Use and Land Cover Change

It is only relatively recently that humans have taken a large role in modifying landscapes across the globe; although the process of massive change began in temperate areas, it is currently centered in the tropics (Ojima et al. 1994). Changes are so severe that when globally added they notably impinge on important Earth System functions (Lambin et al. 2001). Traditionally, research on human dimensions of global change has focused on two broad fields: industrial metabolism and land use and land cover change. The present research is framed within the latter. Land use and land cover change is recognized as an interdisciplinary research area. The land use component refers to the utilization of land, and it has been traditionally studied by social scientists, while the land cover component refers to the biotic and physical components of land surface, and has been traditionally studied by natural scientists (Meyer and Turner 1992).

Land cover changes occur in two ways: conversion and modification. Conversion implies change in land category and modification implies change within a category (Meyer and Turner 1992). Land cover conversion is usually related to land use changes in area, and land cover modification is usually related to land use changes in intensity. The majority of existing literature deals with land cover conversion, although land cover modifications are also widespread and probably as important as the former but more difficult to asses (Meyer and Turner 1992; Lambin et al. 2001).

Houghton (1994) explains that changes in land use have both intended and unintended consequences. The intended consequence is to increase area or productivity of a certain type of product, although some land uses have the opposite effect. The unintended consequence is to have a negative effect on global climate. Land use change has contributed to the enhancement of the greenhouse effect, 25% of human-caused emissions. Land use change rapidly changes ecosystems properties, regular inputs and exchanges of energy; water and nutrients in ecosystems are being severely changed and it may also create greater opportunities for exotic species invasion (Ojima et al. 1994). Well-recognized changes are trace-gas emissions, detriment of water quality, changes in water flows, and soil alteration and erosion.

Proximate Sources and Driving Forces of Change

Meyer and Turner (1992) differentiate between the proximate sources of change and the driving forces of change. Proximate sources are the human actions that alter the land cover, while driving forces are the underlying causes of proximate sources. At the global level, much research on driving forces has focused on human population pressure, but different changes may involve different driving forces, and the same changes may involve different driving forces in different areas of the world (Meyer and Turner 1992). According to Lambin et al. (2001) poverty and population growth are not the major causes of land cover change at the global scale. Significant correlations between land cover conversion and population were found only when the research area possessed similar social and environmental characteristics (Meyer and Turner 1992). The role of political, cultural and other demographic factors in land use decisions are gradually taking more relevance in the effort to understand global change (Ojima et al. 1994). Relationships are complex; the current higher rates of change in the so called developing areas may be explained by the demand from developed countries, since international trade is often an important land use change driver (Houghton 1994).

Tropical deforestation has been a central concern among other land cover conversions. In general agricultural expansion is considered to be the main proximate source (Barbier 2001) and has been found to be driven by changing economic factors that are associated to institutional factors like social and political changes (Hecht 1985; Lambin et al. 2001). On average, 50% of the forest area lost in the tropics per year is used to replace agricultural areas that are no longer productive and were abandoned. Therefore only 50% goes to actually increase the area in agriculture (Houghton 1994). Data on past land use and land cover are not enough to improve current models of land use and land cover change. Data should be accompanied by a better understanding of the causes of land use and land cover change (Lambin et al. 2001).

Barbier (2001) reported a list of factors that play an important role in tropical deforestation. Among those listed at the cross-country and country level are factors like income, population growth and density, agricultural prices and returns, agricultural yields, logging prices and returns, roads and road building and institutional factors. In general changes in markets, credit and roads are associated with changes in land cover, and therefore we will review them in more detail in the following chapter.

Assis Brazil and Iñapari

Comparison studies in land use and land cover change are rare. One of the main constraints is to adequately address differences at the land use driver level. Socioeconomic and biophysical drivers may interact in ways that are difficult to understand when trying to make comparisons. To assess the role of biophysical land use drivers one would like to compare populations with very similar socioeconomic characteristics that are located in different landscapes. In a similar way, to assess the role of socioeconomic land use drivers one would like to compare populations that are in the same biophysical landscape that have different socioeconomic characteristics. The latter is precisely the case I expect to make for Assis Brazil and Iñapari in this section.

Both towns, due to their proximity, are located in very similar biophysical landscapes. This fact will allow us to compare the effect of socioeconomic land use drivers. Socioeconomic land use drivers are especially interesting in this bi-national context since they largely result from different development policies applied by Peruvian and Brazilian governments since this area was first reached by the white man in the early 1900s.

Site Description

General differences between Brazil and Peru are very evident at national levels. Brazil is larger in size and population (Table 1-1). However when we look at the lower administration levels, obvious differences diminish. The município of Assis Brazil has 2884.2 km^2 while the district of Iñapari has 3,793.9 km^2. In the year 2000, Assis had a population of 3,490 persons. In 1993 Iñapari had a population of 841; the population of Iñapari had changed little by the year 2000, due to internal migration to bigger cities in Peru.

Table 1-1. Comparisons of land area and population from the country level to the Municipio of Assis Brazil and the District of Iñapari

Variable	Brazil	Peru
Government	Federative Republic 26 states 5 regions	Constitutional Republic 24 departments 12 regions
Land area km^2	8.5 million	1.3 million
Population	172.6 million	26.1 million
	State: Acre	**Department: Madre de Dios**
Land area km^2	153,149.9[1]	85,182.6[2]
Administration	5 Development regions	3 Provinces
	Município: Assis Brasil	**District: Iñapari**
Land area km^2	2,884.2[3]	3,793.9[4]
Population	3490[6] (2000)	841[5] (1993)
	Municipal Seat: Assis Brasil	District capital: Iñapari

[1] Governo do Estado do Acre - GEA (2000a), [2]Insituto Nacional de Estadística e Informática - INEI (1997), [3] GEA (2000a), [4]Instituto Nacional de Recursos Naturales - INRENA (1998), [5]INEI (2002), [6]Instituto Brasileiro de Geografia e Estatística IBGE (2002).

The study sites are located in what is called Southwest Amazonia. Assis Brazil is a municipal seat in the state of Acre in Brazil and Iñapari is a district capital in the department of Madre de Dios in Peru. The area of study consists of the Município of Assis Brazil and the District of Iñapari (Figure 1-1).

In geomorphologic terms, the area is quite similar on both sides of the border, and results from the interaction of tectonic, climatic, and erosive factors that have shaped its surface. The climate is the same: hot and tropical, seasonally humid, and with abundant rains and a short dry season that usually lasts from June to August.

There are some initiatives that cross the international border between Peru and Brazil such as the “Development Program for the Peruvian-Brazilian Border Communities”, a bi-national program led by the ministers of foreign affairs of Peru and Brazil with the assistance of the General Secretariat of the Organization of American States (GS/OAS). The Brazilian area covers the Município of Assis Brazil and the Peruvian side covers the Province of Tahuamanu; the district of Iñapari is located within this province (SUDAM and INADE 1998). Since 2000 there have been annual meetings known as MAP (Madre de Dios-Acre-Pando) that bring together academic institutions, international cooperation agencies, non-governmental organizations, and local, state and national governments committed to sustainable development and conservation in the MAP area.

According to the document elaborated by the SUDAM and INADE (1998), cities in the area are mainly rural, work on farms being the principal economic activities. Assis Brazil and Iñapari are the main centers with urban characteristics. Both are small towns cut by a road. Table 1-2 presents a general time line for both towns making a comparison of the different events that should explain land cover differences.

Assis Brazil and Acre in Context

Acre was the traditional territory of different indigenous groups that fled, were killed or were forced to move by the “correrias” when the white man arrived looking for rubber (*Hevea brasiliensis*). No missions or indigenous slavery existed in the area during the colonial period (GEA 2000b).

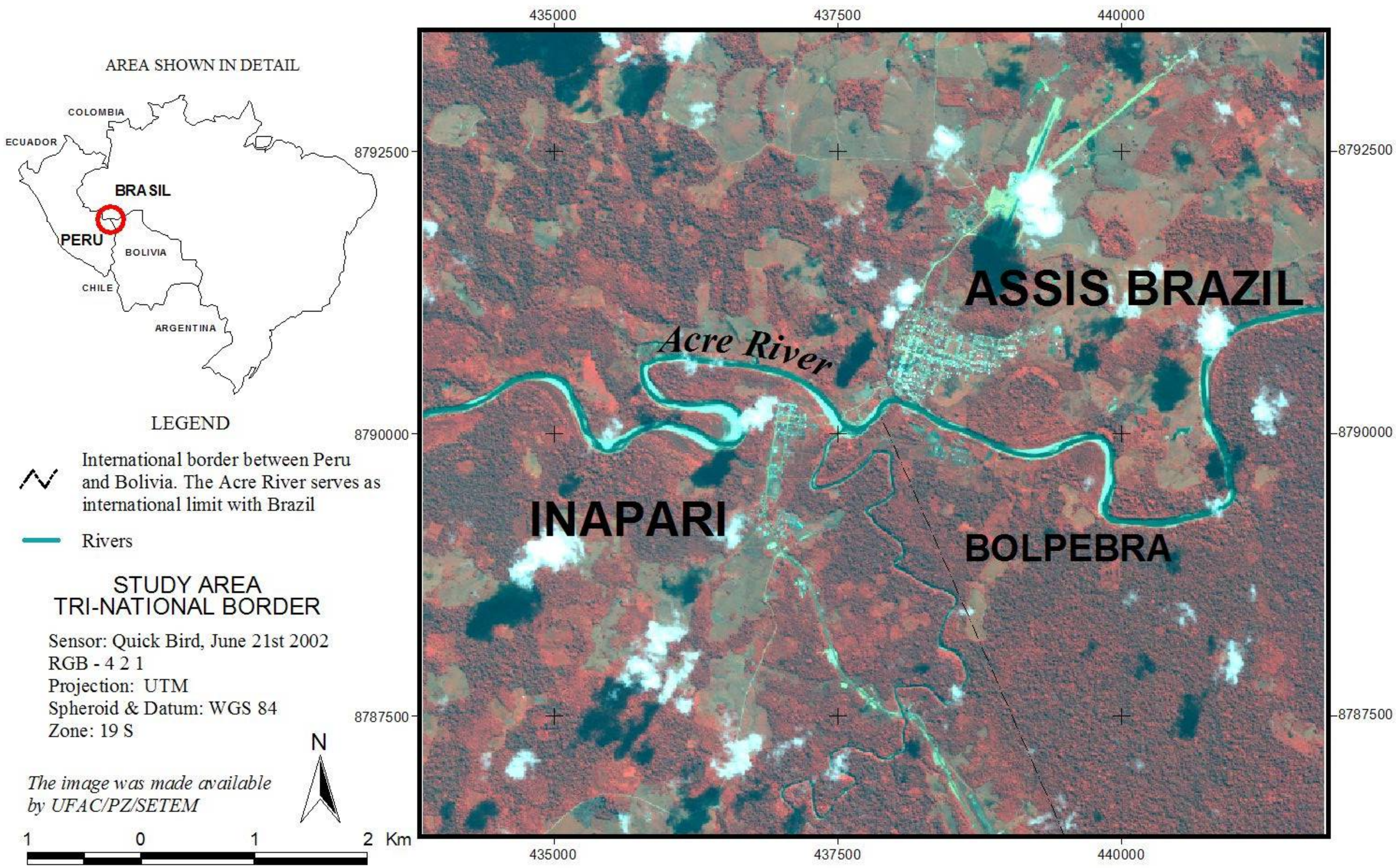

Figure 1-1. Study Area: Tri-national border Iñapari (Peru), Assis Brazil (Brazil) and Bolpebra (Bolivia)

Table 1-2. Comparing historical processess for the Município of Assis Brazil and the District of Iñapari

Year	Iñapari	Assis Brazil
1900s	Indigenous territory	
1900-13	Rubber boom until plantations in Asia took over rubber production	
1914-50	Migration to Puerto Maldonado and Cuzco	Tire industry and World War II maintain rubber tapping in Acre
		Seringa
1950s	Banco de Fomento Agropecuario	
1960s	Unpaved main roads are built	
1970s	Agrarian Bank is established	Operation Amazonia
1980s	Directed Settlement	Conflicts over land
1990s	Agrarian Bank is closed	Secondary roads are built
2000s	Main road is improved	Main road is paved Credit programs are established

Acre was settled when rubber extraction expanded beyond Belém and Manaus; between 1850 and 1870, suppliers spread their network westward to the Madeira and Purus rivers (Schmink and Wood 1992). This was Bolivian territory, incorporated to Brazil in 1903 after a war, with the signing of the Petropolis Treaty (GEA 2000a).

Population composition

Household productive structures in Acre are classified in the following categories (GEA 2000b):

Ribeirinhos. The first settlements in Acre were reached by river; along their banks are found most of the municipal seats. The riparian populations established communities based on family productive activities. They had a diversified subsistence production, adapted to the Amazonian environment, without large-scale shifting cultivation practices (GEA 2000b).

Seringueiros. Migrants from the northeast, nordestinos, were the labor force for rubber extraction. However, English plantations in Asia took over world production of rubber after 1913, giving origin to the rubber crisis in Brazil. In the 1920s in areas endowed with dense stands of the castanheira tree (Bertholletia excelsa), Brazil nuts became an especially important export item (Schmink and Wood 1992). During World War II the North American and Brazilian governments coordinated to stimulate rubber extraction in Brazil (Batalha da Borracha) with a second nordestino migration to Acre. After the armed forces took control of the Brazilian government in 1964, the Operation Amazonia (Wood and Schmink 1993) began in 1966, and many landlords from the south and Southeast moved into Acre stimulated by federal incentives on cattle, logging and mining. This generated major land conflicts in the mid 1970s that resulted in the institutionalization of Extractivist Settlement Projects in 1987 (Projetos de Assentamento Extrativista - PAEs under Instituto Nacional de Colonização e Reforma Agrária - INCRA administration) and Extractive Reserves in 1990 (Reservas Extrativistas - RESEX, under Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis - IBAMA administration). Due to the decline in rubber price, many families now migrate to agricultural settlements, ranches and urban peripheries. Families that remain in PAE and RESEX areas move from extractive to farming, cattle and logging activities (GEA 2000b).

Colonos. Farming families are located in the Directed Settlement Projects (Projeto de Assentamento Dirigido - PAD) and Colonization Projects of INCRA. Traditional state models of rural settlement in Acre present many problems; for example, family plots may be designed without considering soil quality, topography or water courses. Their main farming activities are corn, rice and beans, coffee, papaya, passion fruit, banana and pineapple. Extractive activities may be directed to wood, brazil nut, açaí and game (GEA

2000b). There is also a strong tendency to establish cattle for milk and meat, with consequences in the increase of deforested areas.

Pecuaristas. The first expansion phase of cattle raising occurred in the 1960s-70s, when the military regime began the Amazonian Operation, offering incentives for cattle raising. Prior to this they had cut financial help to rubber traders who were forced to sell their lands at low prices to the landlords from the South. In the 1970s both the federal and state governments wanted to convert Acre into a major meat producer. The second phase (1979-1989) was marked by an increase in degraded areas, mainly because of a pest that thrived in established pastures. At the same time new pasture species adapted to tropical weather were introduced, as well as better cattle management practices. The third phase was initiated in 1989 by the federal government prohibition on the use of official credit for development activities that result in deforestation in the Amazonia. The development of environmental laws, the increase in environmental control and the availability of new technologies and pressures on tropical forest conservation made pecuaristas adopt strategies to recover deforested areas. But it is clear that there is a strong tendency to increase cattle raising areas in households of all kinds and size (GEA 2000b).

Natural protected areas

Acre has two Indirect Use Conservation Units (Unidade de Conservação de Uso Indireto - UCUI), the Serra do Divisor National Park and the Acre River Ecological Station, both are under the administration of IBAMA. The latter is located in the southeast, distributed in the municípios of Assis Brasil and Sena Madureira. It was created in 1981 by the federal government. The Ecological Station also borders two Indigenous Lands (Terras Indigenas - TIs under the administration of Fundação Nacional do Índio - FUNAI). The TI Cabeceira Do Rio Acre covers 78.513 ha, and has 134 persons, from the Jaminawa ethnic group. Environment conflicts in the Ecological Station and TIs are caused by the proximity to Assis Brazil, which increases logging and game activities by poachers (GEA 2000b).

Transportation and highways

The oldest transportation system in Acre is the rivers, the Madeira River being the most important as it is the cheapest way to get to Manaus. The Acre River is also important during the rainy season. There is aerial domestic transportation from Rio Branco (flights from Rio Branco to Puerto Maldonado are offered in a less consistent manner). Finally there is a network of federal and state highways, municipal roads and INCRA's secondary roads.

The federal government during the military dictatorship, seekign to promote Brazil's industrialization, gave priority to the construction of highways. In the case of Acre they were: BR-364 (Rio Branco - Peruvian border), BR-317 (Lábrea/AM - Assis Brasil/AC - Peruvian border), BR- 307 (Marechal Tahumaturgo/AC - Benjamin Constant/AM - Venezuelan border) and BR-409 (Feijó - Santa Rosa).

Brazil's transport authority (BR) is the responsibility of the National Highway Department (Departamento Nacional de Estras e Rodagem – DNER), which delegated some highways to the Army, some of which were sub-delegated to the State Highway Department (Departamento de Estradas e Rodagem – DERACRE). INCRA secondary roads (to settlement projects, colonization and others) are under its responsibility, some of which were also transferred to DERACRE.

The most recent infrastructure development in Acre, part of the Avança Brasil Program, is precisely the paving the BR-317/AC - Brasiléia - Assis Brasil. This has meant the paving of 110 km with the purpose of integrating the Southwest of Acre with the national highway system and to promote relations with Peru, making it possible to access the Pacific Ocean (Ministerio do Planejamento 2003).

Iñapari and Madre de Dios in Context

The era of rubber extraction (1895 - 1940) marked the beginning of the non-indigenous settlement of Madre de Dios. During this period international companies brought the immigration of large numbers of peasants. Thus, the area of the Acre and Manuripe rivers has the highest number of towns in the department. Between 1900 - 1924 peasants from Cajamarca, La Libertad, Arequipa and Loreto, as well as European and Japanese immigrants also came to the area, and due to concern about land tenure, the Peruvian government created the city of Puerto Maldonado in 1902 (INRENA 1998).

The decline in rubber prices first, and then the Cuzco - Puerto Maldonado road constructed in 1961, stimulated migration to Puerto Maldonado and Cuzco. The remaining population in the Iberia - Iñapari area were based on a subsistence economy (INRENA 1998). In the 1960s the government of Feranado Belaunde provided the first incentives to cattle ranching in Madre de Dios. The government Office for Agricultural Research (Servicios de Promoción e Investigación Agraria - SIPA) established a cattle ranch in Madre de Dios to expand cattle raising, and encouraged the genetic improvement of herds (Jorge Coronel cited by Varese 1999).

Gold mining also is an important activity in Madre de Dios. It is practiced in three main forms: manual, in distant locations as a family activity or with peons; with pumps, in the Inambari, Madre de Dios, Malinosky and Colorado rivers; and with heavy machinery, in the Caychihue, Huaypethue, Madre de Dios and Malinosky rivers (Arbex 1997).

Logging is a major activity in Madre de Dios, though since December 6, 1999 the Ministry of Agriculture outlawed all industrial or commercial logging in the region; after that the President declared a ban on cedar and mahogany logging in Madre de Dios, effective from January 1st 2000. Until 2001 the Peruvian Forestry law only authorized the granting of logging contracts for areas less than 1000 ha, and for less than two years. Within Madre de Dios such logging was permitted only in the Tambopata province and in the Tahuamanu district (AIDA and SPDA 2002). A major change in logging activities was brought with the new Forestry Law (*Ley Forestal Y De Fauna Silvestre* 2000) and its regulations (*Reglamento De La Ley Forestal Y De Fauna Silvestre* 2001) that give forest concessions for longer periods and over larger areas.

During the 1980s and 1990s the Government carried out two Directed Colonization Programs in the district of Iñapari, the Proyecto Especial Madre de Dios in Primavera and Chilina, both of which failed: desertion of the colony in Chilina is around 56%, and in Primavera it is around 80% (INRENA 1998).

A study on land use was conducted in the Iberia - Iñapari area in 1997 covering 204,550 ha. The area with permanent crops was 0.1%; banana was the main species, and papaya, pineapple, coffee, and cacao were also present, usually for subsistence. Families also had small areas with tomatoes, onions, garlic, lettuce and subsistence crops. Farming activities were carried out along main roads and rivers. Pastures represented 3.3% of the area, both abandoned and productive. Forests covered 92.7% of the area (INRENA 1998). According to the study made by the Brazilian Superintendency for Development of Amazonia (Super Intendência de Desenvolvimento da Amazônia - SUDAM) and the Peruvian National Development Institute (Instituto Nacional de Desarrollo - INADE), after the Agrarian Bank of Peru (Banco Agrario del Peru - BAP) and the National Rice Commercialization Enterprise (Empresa Comercializadora de Arroz - ECASA) were deactivated in 1991 crop production has mainly had subsistence purposes (SUDAM and INADE 1998).

Natural protected areas and indigenous communities

At present Madre de Dios is renowned worldwide for its outstanding biological diversity, and it has been a place of extensive research. As a result there are four areas of strict protection: Pampas del Heath National Sanctuary; Bahuaja Sonene National Park; Manu National Park; and the Tambopata-Candamo National Reserve. All of these are under INRENA administration.

Madre de Dios has a low population density and is home to diverse indigenous peoples. The valleys of the Piedras, Yaco, Chandles and Alto Manu rivers are the ancestral territories of indigenous communities from the Pano family; these indigenous populations live in the floodplains in the Iñapari and Iberia provinces. The native community Belgica (Arawak) is located in the district of Iñapari. According to the 1991 census, they included 151 persons, but their right to the land they use was not legally recognized (INRENA 1998).

Transportations and highways

In Madre de Dios the Tambopata and Madre de Dios rivers are important and inexpensive transportation. Domestic flights are available in the city of Puerto Maldonado, and sometimes flights to Rio Branco are available. The transportation network is made up of what is now called the Pacific highway. Starting at the coast of Peru the route is Matarani - Juliaca - Puerto Maldonado - Iberia - Iñapari. The road is not paved, and is difficult to transit during the rainy season in its Andean and Amazon portions. From Puerto Maldonado there is also a road that connects with Cuzco and from there to Lima. In Peru usually the Transportation Ministry takes care of roads and highways; however this task is often given to Special Development Projects (Proyectos Especiales), regional and local governments.

In the District of Iñapari the main transportation is the road to Iberia, a 50km unpaved road with some secondary roads, usually in bad shape. This is the road that was built by the *Proyecto Especial Madre de Dios* between 1998 and 2000. Iñapari also has a small airport that has hardly been used.

The Case for Comparing Iñapari and Assis Brazil

This section looks more in depth at certain factors that are usually recognized as land use drivers and that are also different in nature in Assis Brazil and in Iñapari. The discussion is centered on road infrastructure, market and credit.

The Role of Roads

Both towns were traditionally isolated from the rest of their respective countries until recent years. From the 1960s to the late 1990s they were linked to the rest of their countries by a dirt road suitable for a walk or to make a trip in a tractor for three days to get to the closest town. Difficulties were mentioned, especially in cases of health problems. Infrastructure development in Peru and Brazil towards the construction of the Pacific highway changed the roads on both sides. There is a general sense among settlers that the roads are the best thing the government has done for the people living in this area so far.

In the case of Iñapari, the unpaved road that links it to the town of Iberia and to the city of Puerto Maldonado was built in many phases by the *Proyecto Especial Madre de Dios*. Its last portion was declared finished in October 21st, 2000. This road, although not paved yet, is described by the engineers in the *Proyecto Especial* as ready to be paved. Most farms are located along this road and there are only two secondary roads in the district.

In the case of Assis Brazil, the road that links it to the city of Brasiléia (BR-317) was paved in its final portion in 2002, within the frame of the Avança Brazil Program, and for the formal inauguration presidents of both countries got together in December 2002 in Assis Brazil. There are also many secondary roads that connect to the different farmlands in the Município, usually in bad shape during the rainy season.

There is a difference in the process here: both sites had very difficult dirt roads that could only be passed by 4 x 4 trucks, referred to as "*Toyota",* during the rainy season; while in 2000 after a long process an unpaved road passable all year reached Iñapari, in the case of Assis Brazil in 2002 the road was upgraded to a paved road in a process that took less than two years.

The next step in the building of the Pacific highway is the construction of a bridge over the Acre Rive; initial work is already going on and the 175m bridge, that will cost US$7 million should be completed by the end of 2004. After that, the paving of the roads on the Peruvian side should start, although funds are not available yet. One of the issues that is taking time and effort from the local authorities is whether the Pacific highway should cross through the center of the towns or if it should go around the towns. It is apparent that most people would like the highway to cross the towns, for fear of not getting any benefits if it does not.

The Importance of Markets

Throughout history, from the elders' references, both towns were closely related. In terms of trading, in the beginning it was Iñapari who was at an advantage, meaning that settlers from Assis Brazil would buy goods on the Peruvian side, first things like soap and candles and later manufactured goods. Although no one could pinpoint when the reverse process started, the current scene shows a different picture. In 2000, my first visit to the area, the presence of the “J.B” grocery store (like a small supermarket) in Assis Brazil was unexpected; in 2003 with the new paved road I found at least two more of these stores in town selling manufactured goods that came from different parts of Brazil. Prices are so low compared to prices in Madre de Dios that not only people from Iñapari but also those from Iberia and Puerto Maldonado make the trip and cross the border to do some shopping. But these stores not only sell goods they brought from other parts of Brazil, they also buy a small amount of products from some local farmers like rice, beans and fruits. So, from time to time, one can see the peculiar scene of a big ox with its wooden cart being discharged of farm products and loaded with manufactured goods at the front door of the grocery store. But while these markets are the places where most people on both sides of the borders buy manufactured goods, the stores buy only a small part from local farms in Assis Brazil.

The market for the agricultural products in both towns is much reduced, and farmers produce mainly for subsistence. On both sides, complaints from producers are the same: the local market demand is not enough to consume all that is produced in the area, and transportation cost is the main restrictive factor to take the products to other places, to Iberia in the case of Iñapari and to Brasiléia in the case of Assis Brazil. For small animals like chickens, ducks and pigs, the market is usually Puerto Maldonado, even for the Brazilian livestock that is not supposed to cross the border without a permit from the

Peruvian National Service for Animal and Plant Health (Servicio Nacional de Sanidad Agropecuaria - SENASA) office in Iñapari.

But the most successful market is the market for beef; buyers from Puerto Maldonado and from Rio Branco, respectively, go all the way to the farmlands with trucks that may fit up to 8 -12 animals, depending on their size. Settlers do not take their own cattle to the city; it is suggested that a "cattle mafia" arrived with the roads. They buy cattle at your door, and with cash money, usually young bulls that are taken to fields near the cities to be fed, processed and their meat sold. Before the road, the only way to get the cattle to the cities was by walking them for 4 days, which was usually done by the cattle owners.

Timber, however, has a different story in each town. To begin with, logging is not allowed in Assis Brazil, and permits are officially necessary if one wants to use timber from one's own land for construction. In Iñapari, logging has been banned since 1977, but logging activities were traditional carried out by local small loggers. Although no farmer or settler says that logging is their only economic activity, it is certainly an important part of the livelihood strategies for some of them. Logging became an important source of conflict since 1999, when illegal logging permits were given to a Peruvian logging company called Empresa Industrial Maderera Tahuamanu EIRL, who had a joint venture with Newman Lumber Company of Mississippi. The venture installed the first big sawmill with foreign capital, and a 100km extraction road was opened with the purpose of extracting mahogany that was directly exported to the U.S. (Caillaux and Chirinos 2003; AIDA and SPDA 2002). The conflict over timber led to many legal battles between the National Institute for Natural Resources (Instituto Nacional de

Recursos Naturales – INRENA) and the Newman Lumber companyover a three-year period, as well explained by Calliux and Chirinos (2003). Almost at the same time in 2000, the new Forestry Law was approved (*Ley Forestal Y De Fauna Silvestre* 2000) and in 2001 despite all the street protests that took place in Puerto Maldonado, the first forest concession competition took place, and a total of 99 000 ha, two of the three areas that were available in the district of Iñapari, were given in concession to two local small loggers associations.

Existence and Inexistence of Credit

Credit in Iñapari has existed since the 1950s with the Banco de Fomento Agropecuario, whose name was changed afterwards to Banco Agrario del Peru (BAP) by the Gobierno MIitar Revolucionario of Gral. Juan Velazco Alvarado in the early 1970s. It provided credit first for rubber, and then in materials and/or cash for agriculture and cattle, from theearly 1980s until 1991, when the bank was closed under President Fujimori's regime. The people who were in Iñapari in *los tiempos del banco* remember having received credit for agriculture, for cattle and for small animals. Since the Banco Agrario there is not a single type of credit available to rural small farmers.

In Assis Brazil, however, the Constitutional Fund for the North (Fundo Constitucional de Financiamento do Norte - FNO) and the National Program for the Strengthening of Family Agriculture (Programa Nacional de Fortalecimento da Agricultura Familiar - PRONAF) are currently available, at least for some of the farmers and until 2001 there was also a fund available for cattle ranching.

Roads, Markets and Credits as Land Use Drivers

From Figure 1-1 to the last section, the present chapter provided the base information to establish the first hypothesis:

H1: Access to markets, credit and road infrastructure drove more deforestation by households in Assis Brazil than in Iñapari.

By observing Figure 1-1 one can see that there is a bigger area deforested in the Municipo of Assis Brazil than in the District of Iñapari. This comparative study will therefore focus on key differences in drivers of deforestation that may explain this difference in land cover in the two sites.

From the information available for both sites it is apparent that there is better road infrastructure and a better market in Assis Brazil. Credit, however, has different timings: it was available in the are of Iñapari for nearly 30 years until 1992, and it is currently available in Assis Brazil since 1999. There is also a population difference: Assis Brazil has a higher population than Iñapari. In order to control for that difference, a household level approach will be better than a Município or District approach.

CHAPTER 2
THEORETICAL APPROACH

Introduction

In an effort to improve current understanding of land use and land cover change drivers, different analytical and empirical approaches have considered different temporal and spatial scales. More recently, research has been conducted in Amazonia, focusing on household level land use practices, as they are often pointed as to being responsible for deforestation. The present chapter looks into the factors considered to be important land use drivers, precisely into the ones that are of interest for the present research: markets, credit and road infrastructure. Then it explores the relevant theories used in explaining deforestation since this sort of land cover change has been the center of many studies in the field of land use and land cover change. It finally reviews in more detail three theoretical frameworks, and concludes by proposing an integrated theoretical framework.

Land Use Drivers and Deforestation

Markets and Credit

The socioeconomic matrix of deforestation for Amazonia elaborated by Schmink (1994) explains deforestation as an outcome of social processes, and locates markets in the global and national contexts. At the global level important variables are the demand for Amazon products (e.g. timber, rubber) and foreign investment (e.g. oil, mining, timber). At the national level the variables considered are transportation and export orientation. Schmink (1994) describes international and national markets as an important factor for the expansion into remote forest areas.

The debate of how economic development impacts the environment includes the roles of markets in the use of natural resources (Godoy et al. 1997b). The topic has been extensively researched in the case of traditional populations; however, the basic principles may apply to any group. According to Godoy et al. (1997b) there are three main positions in regard to market: the market works to the detriment of conservation; the market increases conservation, if land rights are secure; and the market has ambiguous effects on deforestation.

Households integrate into markets by selling crops, labor, or both. If integration is achieved by selling crops, increase in market demand will increase deforestation, unless intensification occurs. If integration is achieved by selling labor, increase in market demand will reduce deforestation since there will be less time to work the land (Godoy et al. 1997b). Therefore integration into both markets usually has nonlinear effects.

In their review of models of deforestation at the household level, Kaimowitz and Angelsen (1998) include transportation costs which show an inverse relation between market access costs and deforestation. They also find that an increase in off-farm income sources typically decreases the pressure on forests. However, increased participation in market oriented activities does not always have a positive impact (Schmink 2004). Market dependency is in many cases not desirable since it leaves little room for subsistence activities, making the producer vulnerable to changes in demand, and price (Schmink 2004). Market integration deserves special attention in the case of traditional groups with little market experience since some of the features of market economy, like profit, may erode their cultural ties (Smith 1995). Increase in market demand may also put more pressure on forest resources (Schmink 2004), resulting in increased deforestation. Furthermore, social justice and equity are not expected outcomes from market participation (Schmink 2004).

Government subsidies are one way of addressing the local producer disadvantages (Schmink 2004). In the case of the Brazilian Amazon subsidies include a combination of road building, colonization projects, and taxes and credits that have helped to foster the frontier expansion process (Wood and Schmink 1993).

Roads Driving Land Use

Access has been recognized as the main factor in the spatial distribution and rate of deforestation (Soares-Filho et al. 2002). Historically, rivers and roads have provided easy access to tropical forests, but roads are especially associated with deforestation and social conflicts (Schmink and Wood 1992). However, road improvement is an important priority in many Amazonian countries (Mäki et al. 2001) and transportation plays a important role in development (Leinbach 2000). In most cases it is necessary, but not sufficient for development. Local social and environmental characteristics have an important effect in the way roads influence economic and social changes. Moreover, roads do not always help to alleviate poverty; development will depend on the local and regional economies' capacity to reallocate resources (Leinbach 2000).

In their review of models of tropical deforestation Kaimowitz and Angelsen (1998) found that roads, rivers, railroads, and low gas prices provide greater access to forests. Roads usually lead to more deforestation when there is also access to markets, especially in areas of good soil with commercial agriculture. However, the relation is not always direct; in some cases roads are built in previously settled and cleared areas, or settlement and roads may be influenced by other variables.

Alves (2002) made an analysis of the geographical distribution of the deforested areas in the Brazilian Legal Amazon. His results show that deforestation is concentrated around major roads and pioneer settlements. Three quarters of the deforestation between 1978 and 1994 were within 50 km (on each side) of major roads.

The Brazilian Development Program Advance Brazil (Avança Brasil) effective since 2000, and projected to be active until 2007, involves the paving of 6000 km of roads (Minísterio de Planejamento e Orçamento 1999). Some of the roads to be paved will provide access to 31 indigenous lands and 26 conservation units and remote forest regions (Nepstad et al. 2000). This project has brought the issue of road paving and its relation to deforestation to the front line and different scientific teams have worked in developing deforestation scenarios for the Legal Amazon.

In modeling past deforestation, Laurance et al. (2001) found that paved roads have more far-reaching effects than unpaved roads. On average, areas further than 25 km from an unpaved road have less than 15% forest loss, but for paved roads average forest loss is 15% for areas between 26 and 50 km from the paved road. Nepstad et al. (2001) found that 29-58% was deforested within 50km from paved roads and 0-9% for unpaved roads.

Paved roads produce three vicious cycles: the first is related to the cycle of cattle ranching, annual crops and its reinforcement by the use of fire; the second is related to conventional logging and its implications for wildfire during severe droughts; and the third is related to rain inhibition due to the former cycles (Nepstad et al. 2000; Nepstad et al. 2001). Investments in forest management and perennial crops would decrease the use of fire, aswould the establishment of rules in the use of fire, and the incorporation of fire prevention incentives in currently available credit lines (Nepstad et al. 2001).

In economic terms the opening of new frontiers increases land supply, reducing the land value in the older frontiers. It also represents more work for the government to monitor natural resources use, as well as to provide health, education, and technical assistance (Nepstad et al. 2000; Carvalho et al. 2001). In general, it will encourage colonization and forest clearing that the government does not have the capacity to control (Laurance et al. 2001).

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The proposed alternative is to promote old frontier areas through local road networks that allow producers to reach trading areas, with technical assistance, and with health and education programs (Nepstad et al. 2000). Therefore, roads where settlements already exist are desirable like Altamira-Marabá and Brasiléia-Assis Brasil, and roads that open new frontiers like Santarém-Cuibá and Humaitá-Manaus are not (Nepstad et al. 2001; Nepstad et al. 2000; Carvalho et al. 2001). The most important issue is that priorities for transport policy in rural areas must meet the necessities of the poor population and not those of elite groups (Leinbach 2000), like has happened in the past (Schmink and Wood 1992; Wood and Schmink 1993).The increase of governance in frontier areas through strengthening of existing management institutions, adequate land use planning and enforcement of the existing environmental legislation is recognized as a very much needed measure to control land conversion following road paving (Nepstad et al. 2002; Mäki et al. 2001).

Approaches to Explain Deforestation

To analyze the effect of different land use drivers it is necessary to pay special attention to the specific scale and place of research in order to make the appropriate assumptions. In general, most studies have been made at the country or cross country level in tropical areas. Four of the most important approaches for deforestation analysis were reviewed by Barbier (2001): the Environmental Kuznets Curve (EKC), competing land use models, forest land conversion models and institutional models. The EKC hypothesizes that environmental problems (like deforestation) decrease as the per capita income of a country rises. For Latin America and Africa the per capita income level at which deforestation equals zero is two to four times higher than the current average (Cropper and Griffiths 1994).

Competing land use models hypothesize that deforestation results from competing land use, mainly between forests and agriculture. Therefore an opportunity cost is calculated for agricultural conversion versus potential timber and environmental services from forests. An important consideration is that very often agricultural conversion follows timber extraction (Barbier 2001). Forest land conversion models assume that households use their own labor or hire labor for land conversion, the level of cleared land is hypothesized to be a function of output and input prices, but these data are usually difficult to obtain. Institutional models, on the other hand, are centered on factors like ownership and political stability.

Kaimowitz and Angelsen's (1998) more extensive review of economic models of tropical deforestation identified three primary levels: household and firm, regional and national and macro models. Household and firm level models, the relevant level for the present research, were divided into three categories: analytical open economy (e.g. Angelsen 1999), analytical subsistence and Chayanovian (e.g. Angelsen 1999), and empirical and simulation models (e.g. Godoy et al. 1997a). Analytical models are theoretical constructs; they allow researchers to examine the implications of their assumptions. Empirical models quantify the relationships between variables using statistical methods, and simulation models use parameters to assess scenarios under different circumstances. Open economy models assume that households' and firms' actions have no impact on prices, and that market prices (including labor) fully determine how they value their resources. In this way household production is analyzed as profit maximization oriented. Subsistence and Chayanovian models assume imperfect markets (particularly labor) and that household consumption does matter in production decisions. The household goal is to maximize utility. Empirical and simulation models require time consuming surveys for data collection. For these models, common independent variables are transportation costs, farmer's background, credit access, input and output prices, and tenure security (Kaimowitz and Angelsen 1998). The different assumptions and methods in each category show different results. The summary of findings for the analytical models are presented in Table 2-1.

Site specific characteristics may play an important role in land use decisions, which may result in different land cover outcomes. That is precisely why empirical research is important and limited at the same time. While it provides site specific insights, findings should not be extrapolated without serious considerations and reservations.

Table 2-1. Models of deforestation showing predicted effect of key variables

Variable	Analytical Model		
	Subsistence	Chayanovian	Open economy
Higher agricultural prices	Reduce	Indeterminate	Increase
Population growth	Increase	Increase	No effect
Lower transport costs	No effect or reduce	Increase	Increase
Higher agricultural productivity	Reduce	Indeterminate	Increase
Higher wages	NA (reduce)	NA (reduce)	Reduce
Higher land prices			Reduce
Higher interest rates			Reduce

Adapted from: Kaimowitz and Angelsen (1998)

To situate the present research within the categories at the household level set out by Kaimowitz and Angelsen (1998) we may say that the present research is analytical and empirical. It proposes an analytical integrated framework and uses survey data to quantify the relationships between land use and land cover outcomes and variables commonly perceived as land use drivers from open economy models, and household demographic variables from chayanovian models.

Empirical models of land use that incorporate demographic variables at the household level were reviewed by Perz (2001). His revision is specific to the Amazon and to the Neotropical Americas. Table 2-2 is an updated version from Perz (2001). General observations from his results show that the age of the household, length of residence, family size, and number of family members all influence land use in terms of area deforested, in old or secondary growth forest, as well as household agricultural decisions, among many factors.

Table 2-2. Household demographic variables used in land use modeling for Amazonian areas.

Variable	Demographic variables				
	Age of household head	Length of residence	Family size	Adults (males, females)b	Children
	(1)	(2)	(3)	(4)	(5)
Alston et al. (1993)					
% area annuals	+ns c	+ns	-ns		
% area perennials	-ns	+ns	-ns		
% area pasture	-ns	+ns	+ns		
Rudel and Horowitz (1993)					
% land deforested			-**		
Ozório and Campari (1995)					
Ha deforested since arrival	-ns	+ns			
Ha deforested in 1991	+ns	+ns			
Sydenstricker and Vosti (1993)					
Ha deforested				+**, +*	
Jones et al. (1995)					
Cleared ha per year					
Total cleared ha		+ns			
Alston et al. (1996)					
% area crops or pasture	+ns c	-ns			
Godoy et al. (1997a)					
Ha old growth forest	+ns c	-ns -ns			
Godoy et al. (1997b)					
Prob. Of cutting old growth forest					
Mojeno			+ns	-ns	
Yurucare			+*		
Chimane			+ns	-ns	
Pichón (1997)					
% land in annuals		-ns	+**		
% land in perennials		+ns	+**		
% land in pasture		+**	+ns		
% land in forest		-**	-**		
Godoy et al (1998a)					
Ha primary forest cut	-**	+**		+**, +ns	+ns
Godoy et al (1998b)					
Ha old growth forest cut	+ns	+**	-ns		
Godoy et al (1998c)					
Ha primary forest cut	-ns	+ns	+ns		
McCraken et al (1999)					
Annual deforestation 1988-1991		-*			
Ha forested in 1991		-*			

Source: Perz 2001. Authors appear in chronological order. A "+" indicated a positive or direct effect, and a "-" indicates a negative or inverse effect. A "ns" indicates not significant at $p > 0.10$, * indicates significance $p < 0.10$, and ** indicates significance at $p < 0.05$.

Table 2-2. Continued

Variable	Age of household head (1)	Length of residence (2)	Family size (3)	Adults (males, females)b (4)	Children (5)
Wood and Walker (2000)					
Ha deforested on arrival		+*		+*	
Ha deforested at interview		+*		+*	
Cocoa		+*		+*	
Coffee		-ns		+*	
Ha pasture		+ns		+ns	
Head cattle		+ns		+*	
Reforestation		+*		+ns	
Gomes (2001)					
Area deforested		+ns		+**, +ns	
Pasture size		+ns			
Head of cattle		+ns			
Perz (2001)					
Annuals	+ns	-ns		+ns	+ns
Perennials	+ns	+**		+**	+ns
Pasture size	-ns	+**		+**	-ns
Cattle	+ns	+**		+**	-ns
Reforestation	+ns	+ns		+ns	+ns
Perz (2002a)					
Area in forest		-ns		+ns	-**
Area in cropland		-ns		+**	+**
Area in pasture		-ns		+ns	-ns
Area in secondary growth		+**		+ns	+**
Perz and Walker (2002) tobit 1,2,3					
Secondary forest growth under fallow		+ns, +**, +**		na, +ns, +ns	na, +**, +**

Source: Perz 2001. Authors appear in chronological order. A "+" indicated a positive or direct effect, and a "-" indicates a negative or inverse effect. A "ns" indicates not significant at $p > 0.10$, * indicates significance $p < 0.10$, and ** indicates significance at $p < 0.05$.

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Integrated Theories

While a good understanding of the effect of individual land use drivers that are relevant for this study, as well as an overview of the existing theories that intend to explain deforestation reveals limitations in the tools available to adequately address land use and land cover change issues when dealing with a complex reality. That is the primary reason for the existence of integrated theories that intend to provide a better explanation for changes in land use and land cover.

The framework used in this study comes from the integration of three frameworks drawing on three different integrative theories. The first is a hierarchical framework drawn from the bases of political ecology theory. The second looks at household transformations from demography theory. These two frameworks explain land use at different levels. The third framework provides the elements to link the previous ones and to make them more flexible; it is drawn from panarchy theory

These three integrated frameworks were chosen for various reasons,. First, political ecology and demography or Chayanovian theories have been used in explaining land use and land cover changes in frontier areas in the Amazon region. Political ecology is explicit in linking global and local events; it brings in the spatial dimension, and it is preferred over open economy theories because their assumptions of perfect markets and information are far from real in the Amazon frontier. Demography or Chayanovian theories provide a tool to work at the household level, as required by this research, and bring in a temporal factor by looking at household composition over time. Panarchy presents an innovative opportunity to link political ecology and Chayanovian theories, since it has explicit temporal and spatial dimensions and has its origins in natural resource use.

The purpose of integration is to show that biophysical and socioeconomic drivers of land use and land cover change do not have a linear or constant influence on households and their land use systems (farming, ranching, logging, etc). Instead, much depends on the stage that the household and the productive system occupy in terms of life cycles.

All components of theory are linked together in a coherent conceptual structure named a theoretical framework. Integration is the union of existing theory, perspectives, approaches, models or data that are apparently disparate (Kuchka 2001). It is important to find out how paradigms, theories and theoretical practices themselves limit integration and how those constraints may be overcome; theoretical understanding changes through integration (Kuchka 2001).

Integration is a difficult task. Some of the procedures and circumstances necessary for successful theoretical integration include (Kuchka 2001):

1. Domain: the domain of the related theories must be clearly stated, to make the development of linkages between theories more feasible.

2. Concepts: the meanings and subjects of concepts should be clear; this enables the asking of new questions that may further integration and the development of theory.

3. Scale and level: it should be clear if the theories are answering questions across levels of organization or particular adjacent levels of a given scale.

For the particular research question of this study, it is my intention to integrate frameworks from three different integrative theories: (1) Political Ecology, (2) Demography, and (3) Panarchy. I will begin by reviewing some of their basic components:

1. Basic conceptual devices (assumptions, definitions and concepts)
2. Framework and structure (framework and domain)

Political Ecology

Political ecology has its origins as a new research field in the 1970's. It was a reflection of a need for 'an analytical approach integrating environmental and political understanding' given the increase in environmental problems in the Third World (Bryant 1992; Bryant and Bailey 1997). In its first phase from the late 1970s to the mid 1980s political ecology was mainly a critique of neo-Malthusian and cultural ecology, and had its theoretical base in neo-Marxism. In its second phase from the late 1980s to the 1990s; it was mainly a critique of deterministic neo-Marxism and had its theoretical base in neo-Weberianism, social movement and household/feminist theories.

Empirical analysis in this field has been favored; this has resulted in a research field 'grounded less in a coherent theory than in similar areas of inquiry' (Peet and Watts 1996; Bryant and Bailey 1997). These areas of inquiry are only generally similar since different scholars have adopted different approaches to the same issues. Political ecologists have sought to explain Third World environmental change and conflict in terms of key environmental problems, concepts, socioeconomic characteristics, actors and regions, or they have used various combinations of these approaches (Bryant and Bailey 1997).

Political ecology is in part based on the assumptions and ideas of political economy theory (Bryant and Bailey 1997). Blackie and Brookfield (1987) stated that political ecology considers ecology concerns within a broadly defined political economy. In general political ecologists agree on two basic points: first, the environmental forces facing the Third World are not simply a reflection of policy or market failures, but rather are a manifestation of broader political and economic forces associated with the worldwide spread of capitalism. Second, there is a need for changes to local, regional and global political-economic processes (Peet and Watts 1996).

Political ecology addresses the political, economic, and cultural factors underlying human use of natural resources and the complex interrelations among people and groups at different scales, from local to global (Blaikie and Brookfield 1987; Schmink and Wood 1987). Elemental political issues of structural relations of power and domination over environmental resources have been seen by a variety of scholars as critical to understanding the relationship of social, political, and environmental processes (Scoones 1999). The view of resources as socially and politically constructed has been central to this discussion and has resulted in important work on how perspectives in environmental change must be gauged from the view points of different actors (Blaikie 1995).

The perception of an unequal relationship between politics and ecology explains in part the fact that political ecologist tend to favor consideration of the political over the ecological (also because of the social science background of most political ecologists). But they should not overlook advances in the understanding of ecological processes derived from the New Ecology since, in doing so they might miss an important part of the explanation of human-environmental interaction (Scoones 1999; Bryant and Bailey 1997).

According to Bryant and Bailey (1997) there are five main approaches or similar areas of inquiry in Third World Political Ecology, although many times they are combined. These approaches are the following:

In the first approach the explanation centers around a specific environmental problem or set of problems such as soil erosion, tropical deforestation, water pollution or land degradation. This approach constitutes in many respects a ‘traditional’ geographical research theme associated with understanding the human impact on the physical environment (Goudie 1993), but with a distinctive political-economy twist.

The second approach focuses on a concept that is perceived as having important links to political-ecology questions. To understand the latter is partly to appreciate the way in which ideas are developed and understood by different actors, and how attendant discourses are developed to facilitate or block the promotion of a specific actor's interest (Escobar 1996).

Third, inter-linked political and ecological problems are examined within the context of a specific geographical region. 'Regional political ecology' has reflected a concern to take into account environmental variability and the spatial variations in resilience and sensitivity of the land, as well as 'theories of regional growth or decline' (Blaikie and Brookfield 1987).

Fourth, political-ecological questions are explored in light of socio-economic characteristics such as class, ethnicity or gender.

A final focus is on the interests, characteristics and actions of different types of actors in understanding political-ecology conflicts. An actor-oriented approach seeks to understand such conflicts (cooperation too) as an outcome of the interaction of different actors pursuing often quite distinctive aims and interests (Long and Long 1992).

The present research will use a combination of the first and third approaches, focusing on a particular environmental problem (deforestation) from a regional perspective. It will center on land use and land cover outcomes driven by market, infrastructure and credit availability.

Household Demography

The theoretical foundation of the role of household life cycle in land use was established by Chayanov (1966). His study of peasant farming practices in Russia, in the first half of last century, serves as a reference mainly because the October Revolution in Russia created conditions of land abundance similar to agricultural frontiers in the Amazon region (Walker et al. 2002). His theory explains differences in farm size and surplus production in relation to household structure. Chayanov distinguished households according to the ratio of consumers/workers. This relation led him to describe the household life cycle, where young households with many children have low labor power, and mature households with high labor power have larger holdings (Walker et al. 2002; Perz 2001).

The basis of Chayanov's theory is that the drudgery of labor increases exponentially as work is done, while on the other hand the marginal utility of goods decreases as they are acquired; the household production level determined by the intersection of these curves. Marginal utility is determined by the standard of living, which consists of: the amount necessary to support one consumer; the number of consumers each worker has to support (the consumer/worker ratio); the amount that has to be reinvested in the farm to maintain its production; and any other factors that require part of the farm's production. Drudgery is a measure of the noxiousness of labor and is inversely related to productivity. The more productive a technique is, the greater is the output of per unit of labor, and the lower the drudgery (Tannenbaum, 1984).

While Chayanov's theory provides the basis for demographic theory related to land use, some assumptions about peasants do not apply directly to Amazonia. The theory does not address the issue of migration, an important feature in frontier Amazonia where many peasants migrated from places with a different landscape. It assumes closed household life cycles, while in Amazonia households are not always detached from labor or products markets, but rather have different assets. Chayanov assumed the existence of relatively homogeneous farming practices among households, something that doesn't necessarily happen in Amazonia where, besides farming, cattle ranching and forestry also are land use options (Perz 2001).

At this point it becomes important to make a distinction among household assets. Ellis (Ellis 2000) considers household assets are resources owned, controlled or claimed by the household. These assets mediate the way in which households become involved in production and labor markets, and participate in exchanges within their community. Assets can be understood as capital or resource stocks that may be used for household survival. In a general way, assets are divided in five classes. Natural capital comprises land and water. Physical capitals are buildings, machines and roads. Human capital is the labor available, including education, skills, and health. Financial capital is money as savings and/or credits, while social capital is kinship and community networks (Ellis 2000).

Household demography has its focus on human capital assets; however, according to the specific case other assets should be considered. For the purposes of this study some aspects of natural, physical and financial capitals will be included.

Panarchy Theory

Theories like Panarchy intend to explain not what is, but what might be. They will not predict the details of future possibilities, but might help to identify the conditions for future possibilities (Holling et al. 2002a). Their objective is to enable the understanding of economic, ecological and institutional systems and their interactions. The cross-scale, interdisciplinary, and dynamic nature of the theory gives it its name. Its essential focus is to rationalize the interplay between change and persistence, between the predictable and unpredictable (Holling et al. 2002a).

According to this theory, the stabilization of target variables leads to slow change in other ecological, social, and cultural components, and those changes may lead to the collapse of the entire system (Holling et al. 2002a). Decline in variability and diversity creates conditions that cause a system to flip into an irreversible (typically degraded) state controlled by unfamiliar processes. The magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behavior is named *ecosystem resilience* (Holling and Gunderson 2002).

According to Holling and Gunderson (2002) resilience has three defining characteristics: The first is the amount of change a system can undergo (and, therefore, the amount of stress it can sustain) and still retain the same controls on function and structure (still be in the same configuration—within the same domain of attraction). The second is the degree to which the system is capable of self-organization. When managers control certain variables in a system, they create inter-variable feedbacks that would not be there without their intervention. The more "self-organizing" the system, the fewer feedbacks need to be introduced by managers. And third, is the degree to which the system expresses capacity for learning and adaptation.

Semi-autonomous levels are formed from the interactions among a set of variables that share similar speeds. The organizations and functions we now see embracing biological, ecological, and human systems are therefore ones that contain a nested set of the four-phase adaptive cycles, in which opportunities for periodic reshuffling within levels maintain adaptive opportunity, and the simple interactions across levels maintain integrity (Holling et al. 2002a).

Integrated Frameworks

In this section I will try to integrate three frameworks from the three integrative theories we reviewed in the preceding section. The frameworks are the following:

1. The conceptual framework that uses a three-tiered hierarchical approach to depict the socioeconomic and biophysical drivers that led to deforestation, elaborated by Wood (2002) which comes from a Political Ecology view.
2. A conceptual framework of household transformations, land use and environmental change (McCracken et al. 2002), which comes from Demographic theory
3. The 'Adaptive cycle' elaborated by Holling and Gunderson (Holling and Gunderson 2002) which is within Panarchy theory.

The Three-Tired Hierarchical Approach

This framework treats land cover outcomes as the direct effect of the land use decisions made by rural households whose decisions are embedded in contexts that operate at higher levels of the system. The higher level contexts consist of the proximate, intermediate and distant drivers that comprise the socioeconomic and biophysical subsystems. The analytical focus is on the relationships that take place within each level, as well as the cross-level dynamics that link one level to another (Wood 2002).

This model considers socioeconomic, as well as biophysical drivers. To depict the driver forces hierarchy, it presents the proximate, intermediate, and distant scales. The model assumes that land use decisions made by firms and households in rural areas are the result of interactions of a large number of variables acting at different scales within the social and natural system. They are located at the center and within community and kinship networks, meaning that networks at the local level may influence land use decisions. The model also considers the feedback effect that land cover may have in the socioeconomic and biophysical drivers (Wood 2002) (Figure 2-1).

Each land use/land cover outcome is associated with different kinds of economic activity, and therefore with different social groups. Rubber tappers, farmers, ranchers and loggers all engage in clearing the forest cover, but they do so in varying degrees depending on their respective objectives, resources, and decisions (Wood 2002). Outcomes can be arranged in five main categories: undisturbed forest, harvest of non-timber products, selectively logged forest, cleared (annual crops, perennial crops, pasture, mining), and regrowth (managed fallow, abandoned plots).

Household Transformations Land Use And Environmental Change

This approach is based on Chayanovian theory and on the work of the Centro Agro-Ambiental do Tocantins (1992 cited by Walker et al. 2002), Walker and Homma (1996) and McCraken et al.(1999). It emphasizes the role of household labor in land use decisions in agricultural frontiers (McCracken et al. 2002; Perz 2002b; Brondizio et al. 2002) . It is seen as a complement, not an alternative, to models focusing on environmental and economic factors, like the different drivers presented by Wood (2002).

It was Walker and Homma (1996) who placed households in a context of labor and product markets, capital availability, and land use differentiation in Amazonia (Perz 2001). According to this framework, as the household looks for its consolidation, different stages of land use are linked to different household life cycle stages.

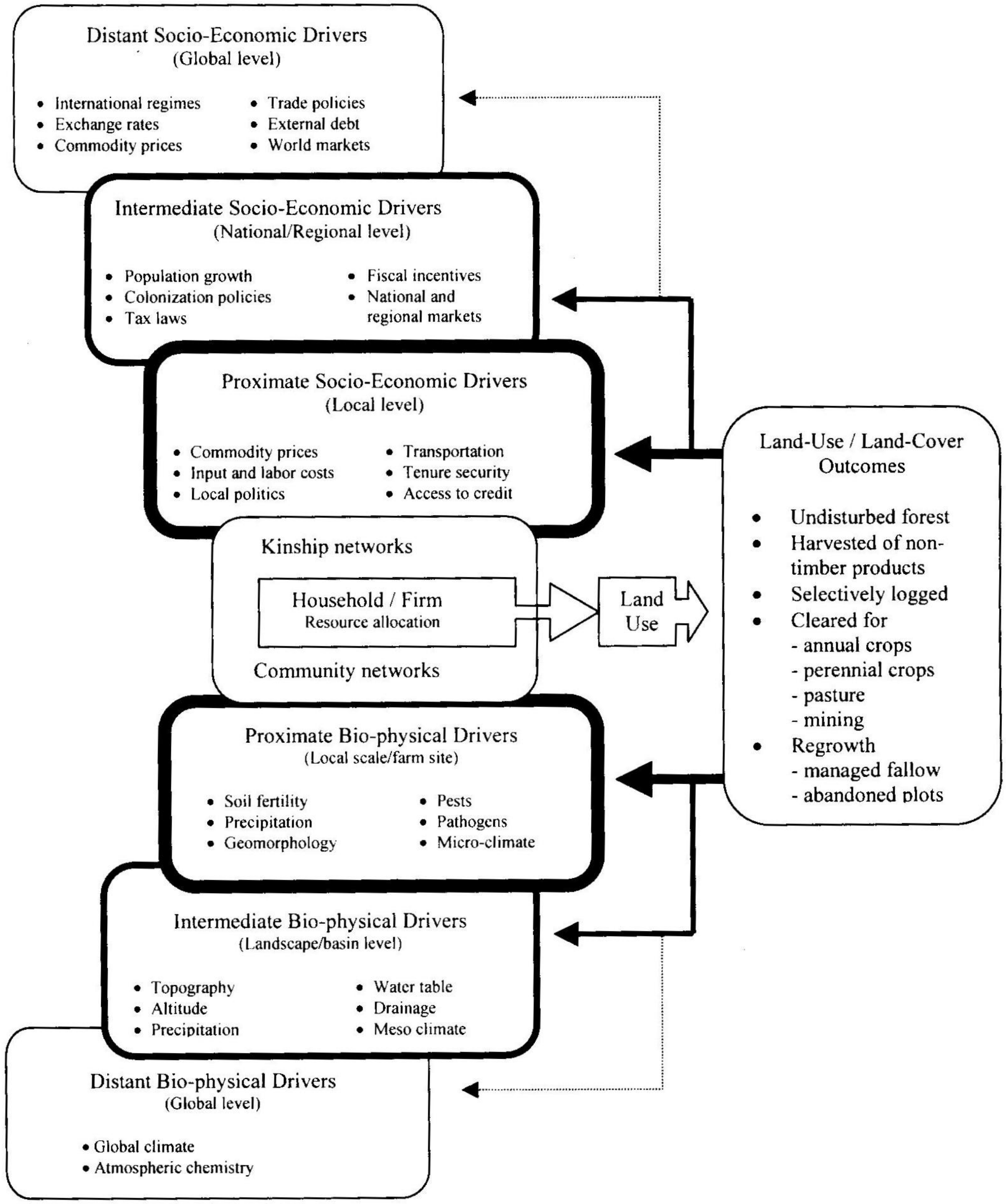


Figure 2-1. The three-tiered hierarchical approach. Socioeconomic and biophysical drivers of land use are classified in: distant, intermediate and proximate. Land cover outcomes are direct effect of the land use decisions made by rural households and firms. Feedback intensity is represented by the varying thickness of return arrows.

Recent settler families in a frontier are assumed to be small young nuclear households, with a head couple and a few young children. Due to small requirements in land and capital, and the low level of risk, they first clear small areas of forest to cultivate annual crops (Perz 2001). These are mainly for consumption and local markets. As the family grows in age and size, additional site knowledge increases and more household labor is available, more areas are cleared, and previous plots are left uncultivated, formed into pasture, or planted in perennial crops, causing a decline in deforestation rates (McCracken et al. 2002). This change is slow, and involves high initial capital and labor cost.

Economic gains from cattle and perennial crops will be perceived in future years. While perennial crops in general will not provide any returns for three to five years, acquiring cattle may be an important capital-saving strategy because it can be quickly purchased or sold. Perennial crops are also more labor intensive than cattle raising, one reason why older households with less labor usually shift into pastures (Perz 2001; McCracken et al. 2002). Access to resources like good soil, water, capital / credit, markets, technical support and household labor affect the shift to either perennial crops or raising cattle, or the decision to remain in annual cash crop activities. It is assumed that in the first household stages most families exhaust their initial capital reserves. Thus, labor of adolescent and teenage children may be a determining factor along with credit possibilities for furthering farm investments (McCracken et al. 2002; Brondizio et al. 2002).

Finally, as Perz (2001) indicates, an important final land use is reforestation. When children become adults, at the point of inheriting their parent’s land the family may plant trees for long-term timber production. Reforestation initially requires capital and labor, but after the establishment of the plantation, little attention is required.

The schematic representation of McCracken et al. (2002) presented in Figure 2-2 defines five stages of a household life cycle, each one linked to a particular time of residence in the area, demographic composition, and land use practices.

Early farm consolidation is associated with credit, capital, and large supply of household labor. Troubles in farm consolidation are associated to reliance on annual crops and restricted supply of household labor (McCracken et al. 2002).

The Adaptive Cycle

In case examples of regional development and ecosystem management, it has been found that three properties seemed to shape the future responses of the ecosystem, agencies, and people (Gunderson et al. 1995; Holling and Gunderson 2002):

1. the potential available for change, since that determines the range of possible options;
2. the degree of connectedness between internal controlling variables and processes, a measure that reflects the degree of flexibility or rigidity of such controls,
3. and the resilience of the systems, as a measure of their vulnerability to unexpected or unpredictable shocks.

Potential, connectedness and resilience

The framework is partly based on the traditional view of ecosystem succession seen as being controlled by two functions. The first is *exploitation*, in which rapid colonization of recently disturbed areas is emphasized. The second is *conservation*, in which slow accumulation and storage of energy and material are emphasized. In ecology, species of the exploitive phase are named r-strategists and in the conservation phase k-strategists (Holling and Gunderson 2002).

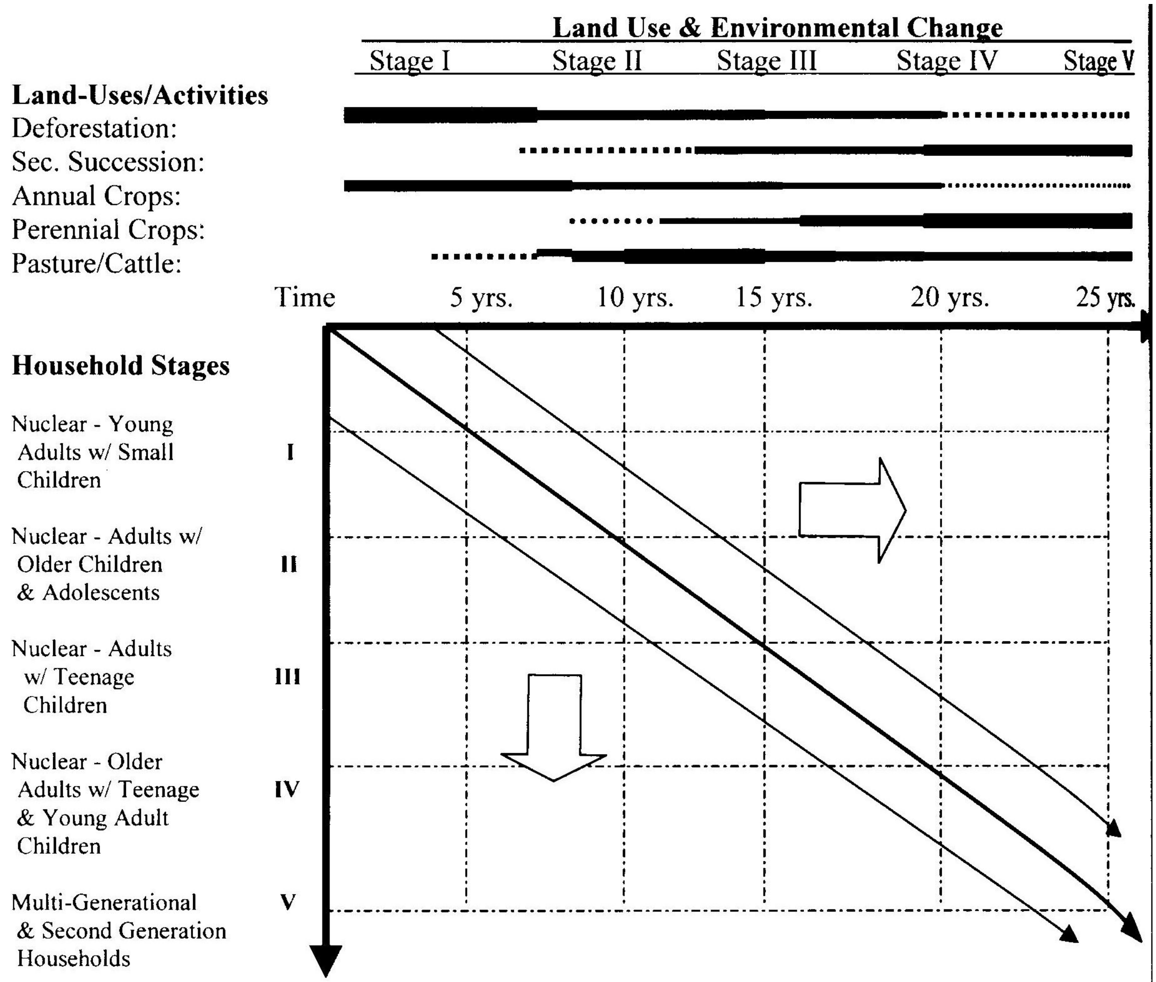


Figure 2-2. Household transformations, land use and environmental change. This framework highlights the role of household labor over the domestic life course. In the upper section it suggests a pattern of land use. The thickness of each line represents the level of activity for each land use. Land use stages (x-axis) are linked to different household stages (y-axis). The diagonal from the upper left to the lower right represents a general course of farm formation and domestic life. Deviations to the right are associated to early farm consolidation linked to credit, capital and larger supply of household labor. Deviations downward are associated with difficulties in farm consolidation linked to greater reliance on annual crops and a restricted supply of labor.

Later understanding in ecology indicates that two additional functions are needed. The first is *release* or “creative destruction”, in which the tight-bound accumulation of biomass and nutrients becomes increasingly fragile until suddenly released. This is named the omega (Ω) phase. The second function is *reorganization*, in which the remaining elements after the omega (Ω) phase are rearranged; this is known as the alpha (α) phase (Holling and Gunderson 2002).

During this cycle, as shown in Figure 4, biological time flows unevenly. The progression in the ecosystem cycle proceeds from exploitation (r), slowly to conservation (K), very rapidly to release (Ω), rapidly to reorganization (α), and rapidly back to exploitation (Holling and Gunderson 2002).

The cycle reflects changes in two properties: (1) Y-axis: the potential that is inherent in the accumulated capital of biomass and nutrients. (2) X axis: the degree of connectedness among variables (see figure 3). As the system goes from exploitation to conservation, connectedness and potential increase (Holling and Gunderson 2002). For resilience, as the system goes from exploitation to conservation, resilience shrinks; and it expands as the system goes into reorganization.

Hierarchies and panarchies

There are many possible interactions among phases at one level and phases at another level. Two are considered specially important. These are the connections named “Revolt” and “Remember”; these connections become important at times of change in the adaptive cycles (Holling et al. 2002b).

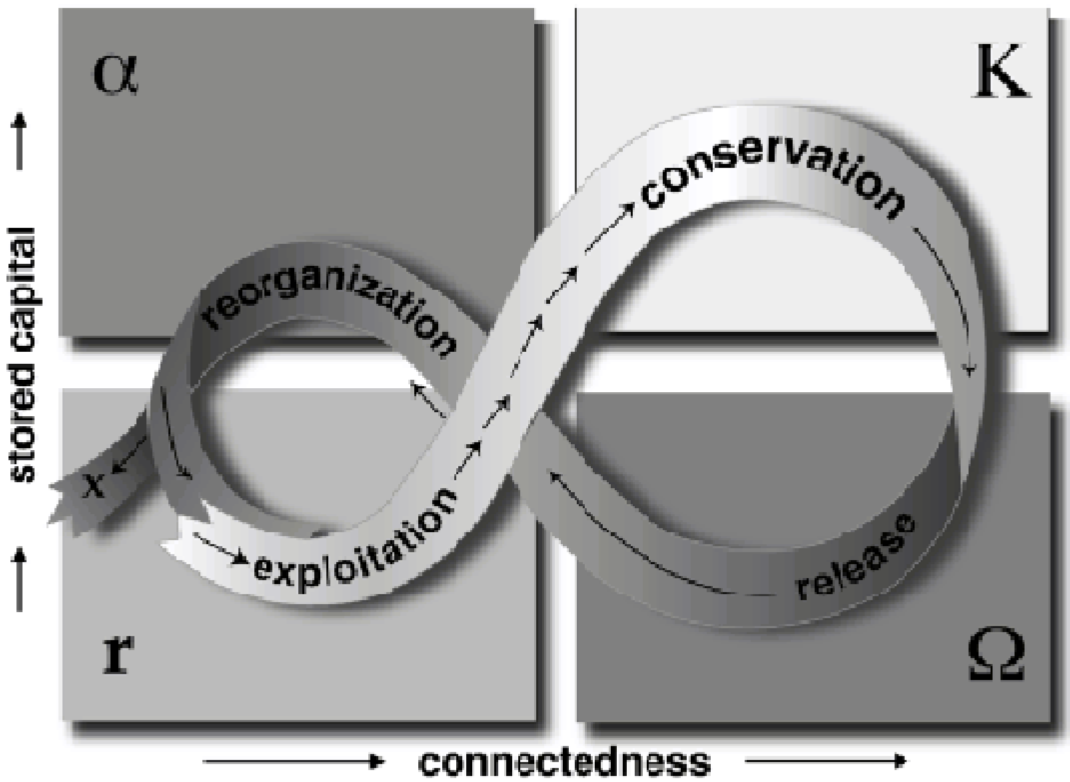


Figure 2-3. The adaptive cycle, the four ecosystem functions (r, K, Ω,α) and the flow of events among them. The arrows show the speed of that flow in the cycle, where short, closely spaced arrows indicate a slowly changing situation and long arrows indicate a rapidly changing situation. The cycle reflects changes in two properties, (1) Y-axis: the potential that is inherent in the accumulated capital of biomass and nutrients. (2) X axis: the degree of connectedness among variables. The exit from the cycle indicated at the left of the figure suggests the stage where the potential can leak away and where a flip is most likely into a different system.

When a level in the panarchy enters its omega phase and experiences a collapse, that collapse can cascade up to the next level by triggering a crisis, particularly if that (higher) level is at the K phase where resilience is low. This is termed “Revolt”. When a level enters its omega phase, the opportunities and constraints for the renewal of the cycle are strongly organized by the K phase of the next higher and slower level. This is termed “Remember” (Holling et al. 2002b).

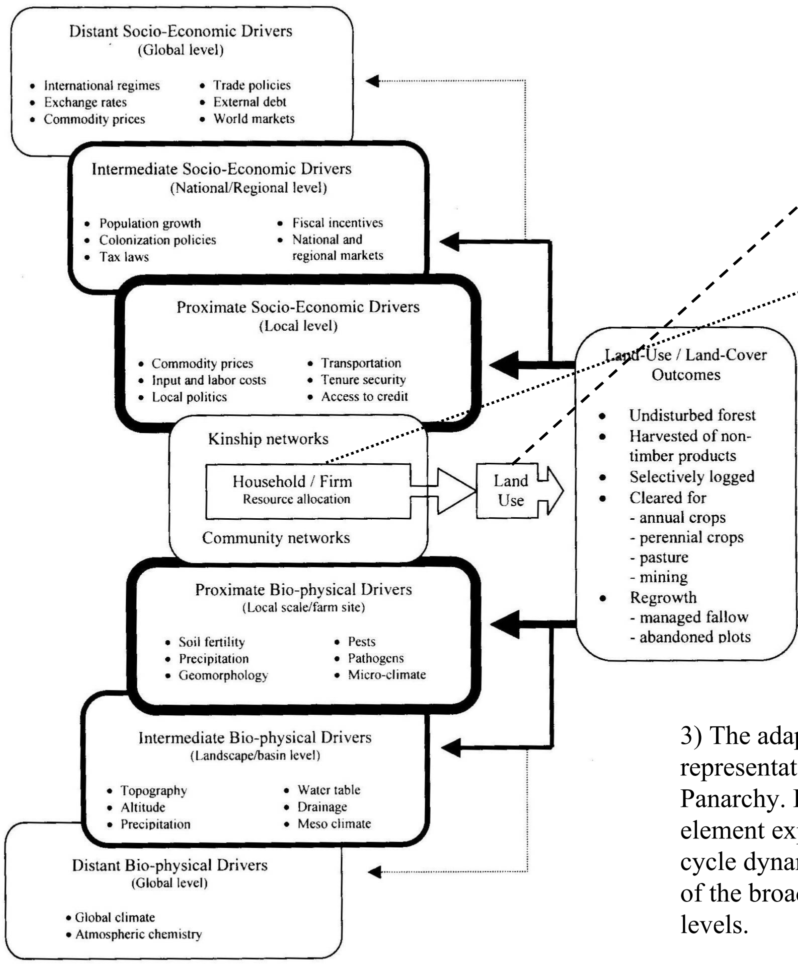
There are two distinctions between panarchy representation and traditional hierarchies. The first is the importance of the adaptive cycle, and the alpha phase as the engine of variety and generator of new experiments within each level. The second is the connections between levels. The levels of a panarchy could therefore be drawn as a nested set of adaptive cycles (Holling et al. 2002b).

Framework Integration

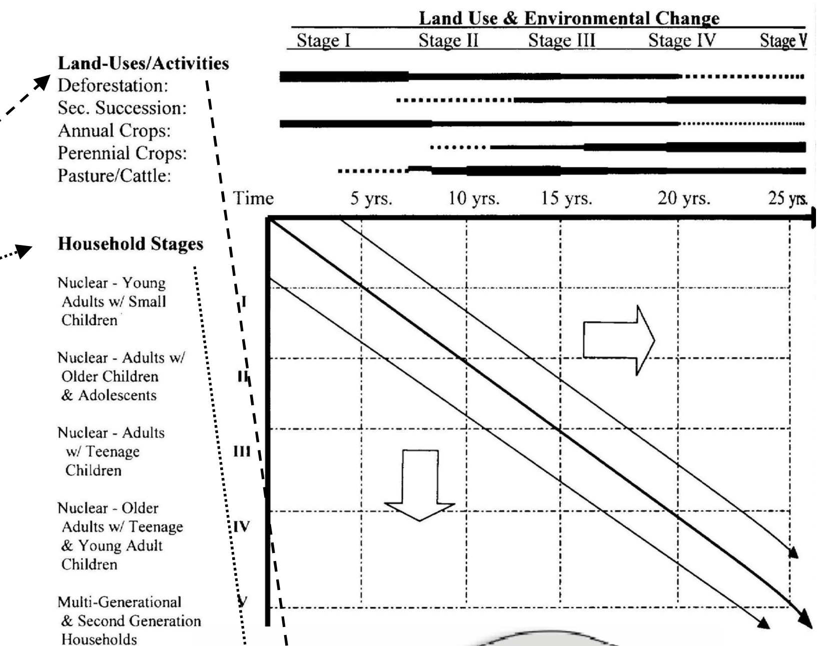
Now that the information on the theories and on the specific frameworks we are interested in has been reviewed the next step is to bring them together in order integrate the three frameworks. In that way it may be possible to incorporate the different levels of land use drivers proposed by the three-tiered hierarchical approach, the household dynamics from the household transformations approach, and finally to better understand the spatial and temporal interactions by adapting the panarchy approach. Figure 2-4 provides an initial vision.

In Figure 2-4 there are no arrows linking the three-tiered hierarchical framework to the panarchy framework; there is, however, a direct link. The adaptive cycle may be applied to all hierarchical levels (household, local, proximate, intermediate and distant) to make up a nested set of adaptive cycles, a panarchy. Looking at Figure 2-5 one can imagine having adaptive cycles at each level and for each land use driver. However, in this chapter the integration will be centered at the household and land use activity levels. This is mainly for practical and methodological reasons, since information at these faster levels may be gathered in an easier and more direct way, and examples will be easier to understand. The logic remains the same for the higher levels and will be applied in the next chapter when explaining the results from data analysis.

1) The three-tiered hierarchical approach, socioeconomic and biophysical drivers of land use are classified in: distant, intermediate and proximate. Land cover outcomes are direct effect of the land use decisions made by rural households and firms. Feedback intensity is represented by the varying thickness of return arrows.



2) Household transformations, land use and environmental change. The thickness of each line represents the level of activity for each land use. Land use stages (x-axis) are linked to different household stages (y-axis). The diagonal from the upper left to the lower right represents a general course of farm formation and domestic life.



3) The adaptive cycle, a schematic representation of two levels in a Panarchy. Each level or structural element experiences its own adaptive cycle dynamics, within the constraints of the broader, slower hierarchical levels.

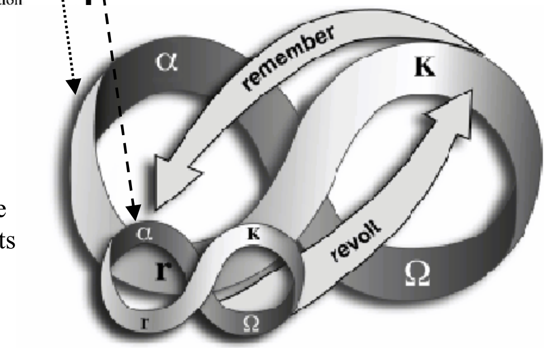


Figure 2-4. Framework integration, the three-tiered hierarchical approach, household transformations approach and the panarchy approach.

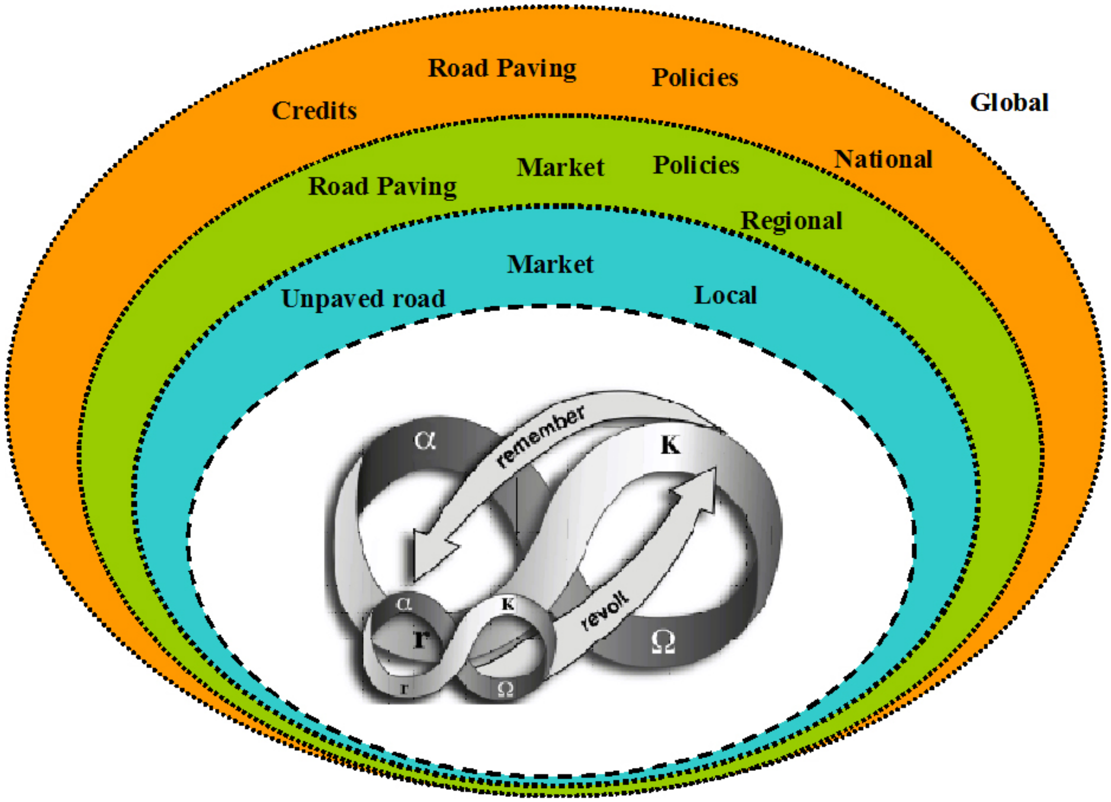


Figure 2-5. Levels of interaction in a nested set of adaptive cycles. In the white area the bigger cycle represents the household and the smaller cycle represents the land use activities. Similar cycles exist at the local, regional national and global levels.

Looking at the household and its activities as adaptive cycles

The most obvious link between the three-tiered hierarchical approach proposed by Wood (2002) and the household transformations through time framework proposed by McCracken et al. (2002) is, of course, the household (as shown in Figure 2-4), our center of analysis. While the first framework classifies the land use drivers that are external to the household, the second framework classifies the household according to five stages in its life cycle according to its effect on land use decisions. In that way one can imagine that proximate, intermediate and distant socioeconomic and biophysical drivers of land use may have a different effect depending on the household life cycle stage.

This effect is expressed in different land use activities. At the same time, but at a faster pace, each productive activity has its own transformations through time. In order to make this idea clear we can look at the household's land use activities as an adaptive cycle. Let's take the example of a cash crop in the Amazonia (see Figure 2-6). The cycle may be seen as follows:

4. r: cash crops establishment
5. k: crops are established and producing
6. Ω: due to soil depletion or a fall in market prices, crops are not in production any more
7. α: depending on the cause for the Ω phase, and on household transformations the options may be;
    a. change to different cash crops (reorganization within the same cycle),
    b. change the farm place (reorganization into a different cycle) or,
    c. change its productive activity (reorganization into a different cycle)
    d. mix farming with other productive activities (special case, as we will see later).

In the same way, we can look at the household itself as an adaptive cycle. Returning to the schematic representation of McCracken et al. (2002) presented in Figure 2-2; it defines five stages of a household life cycle, each one linked to a particular time of residence in the area, demographic composition and land use practices. We may say that the cycle is as follows (see Figure 2-6):

1. r: this is represented by stage I, when a young couple with small children arrive to a frontier area in Amazonia.
2. k: this will be stages II, III, and IV. The family grows from having adolescent children to have adult children. At the end all household members are available labor force.

3. Ω: this stage in the cycle corresponds to stage V. The original family turns into multigenerational or second generational households. Small children are present again.

4. α: depending on the assets available, the second generation young family may:

   a. remain in the original farm place (reorganization within the same cycle),

   b. move to start their own farm (reorganization into a different cycle) or,

   c. change from farming to another productive activity (reorganization into a different cycle)

   d. mix the farm with wage activities.

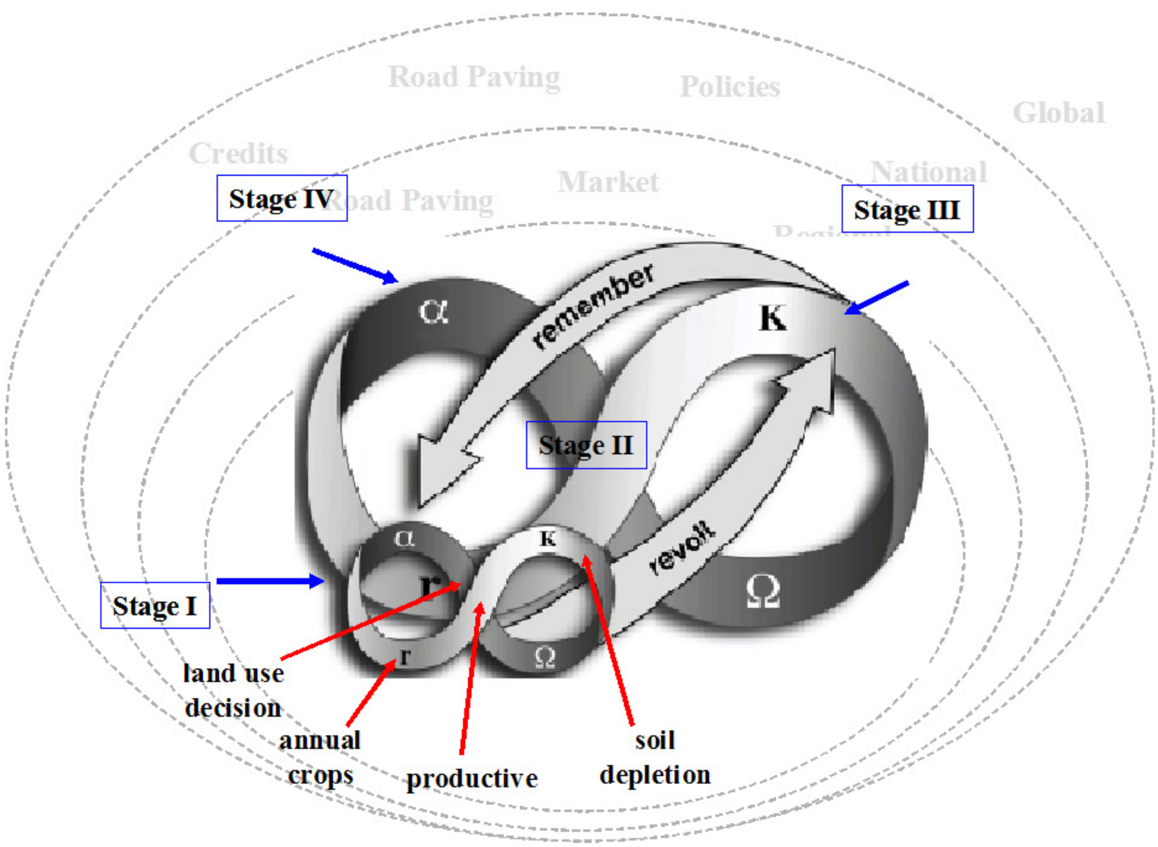


Figure 2-6. Looking at the household and its land use activities as adaptive cycles. the bigger cycle represents the household and its four stages according to the household transformations approach. The smaller cycle represents one of the household land use activities (annual crops). The information in the background represents the other levels from the three-tiered hierarchical approach

Nonlinear effect of land use drivers

This chapter has provided an integrated framework to be used in the present research. And it has also provided a strong basis for the formulation of the second hypothesis:

H2: Land use drivers do not have a linear influence on households, and land use systems; instead, much depends on the phase they occupy in their life cycle.

Now that we see the household and its activities as adaptive cycles, it should be clear that in general the household has a slower adaptive cycle than its agricultural land use activities. Taking this figure further, the complex interplay can be seen as the interaction of the household adaptive cycle with other adaptive cycles within a nested set of the four-phase adaptive cycles (see Figure 2-6). Now I will try to engage with the next slower adaptive cycle, the household's town; in our example this is Iñapari and Assis Brazil. At this scale we have direct effects of the proximate and intermediate land use drivers. Every driver has its own adaptive cycle, so we will have as many adaptive cycles as drivers of land use determined for this particular town; of interest to us are markets, credit, and road infrastructure.

Panarchy theory considers potentially multiple connections between phases at one level and phases at another level, but as explained earlier, "Revolt" and "Remember" connections become important at times of change in the adaptive cycles (Holling, Gunderson & Peterson 2002). When the soil cycle enters its omega phase, and experiences a collapse, that collapse can cascade up to the household cycle by triggering a crisis, particularly if it is at the K phase (stage IV in household lifecycle) where resilience is low: that is called revolt. The same thing happens when the household enters its omega phase and experiences a collapse; that collapse can cascade up to the proximate driver cycle by triggering a crisis, particularly if it is at the K phase where resilience is low.

When the household enters its alpha phase, the opportunities and constraints for the renewal of the cycle are strongly organized by the K phase of the proximate driver cycle, which is called remember.

Considerations Regarding the Framework

The main objective of this section was the development of a framework to analyze land use in Amazonia through the integration of three frameworks. The integration allows us to see the different levels that may affect land use decisions and its interactions: distant, intermediate and proximate drivers, household assets, and its land use activities (productive systems). While the adaptive cycle may be applied to all levels, it is applied in this study at the household and its land use activities level.

A main consideration should be mentioned: the time line. Ideally information taken in at least two different points in time is desirable. In that way more accurate cycles may be described. However it was possible to explore the issue with a single time data collection by asking what future decisions regarding land use will be taken in the face of anticipated changes that may include road infrastructure, and credits. Questions also probed about key changes in land use and land cover in the past.

Work needs to be done in regard to some more specific issues. For example, some of the resources that are considered to be household assets in one framework are considered as proximate drivers in the three-tiered hierarchical approach (e.g. access to credit). A second consideration is that we focused on only two of the many different levels of interaction in the complex processes of land use decisions. The role played by drivers/assets will vary according to different conditions, becoming more or less important in different cases.

The nature of land use drivers is also an important fact to be considered; for example, changes in markets at the national level may have an immediate effect on household land use decisions, while changes in policy at the national level may not have a direct effect, usually because environmental laws are poorly implemented. This is an important consideration since it appears to be a contradiction to the panarchy framework where cycles at the same level are considered to have the same speed.

Another important consideration is the nature of the land use activity. From the example that was given in this chapter on agriculture it is obvious that annual crops have faster cycles than households; however, other agricultural systems may have slower cycles, like vineyards or other long lived perennial crops. That will also be the case for rubber tapping and Brazil nuts.

CHAPTER 3
LAND USE AND LAND COVER

Introduction

In methodological terms, the research conducted in Assis Brazil and in Iñapari was a natural experiment. It was not an experiment conducted by a researcher; it was evaluated through research (Bernard 2002).

The two former chapters provided a strong base for establishing the hypotheses to be tested:

- H1: Access to markets, credit and road infrastructure drove more deforestation in Assis Brazil than in Iñapari.
- H2: Land use drivers do not have a linear influence on households, and land use systems; instead, much depends on the phase they occupy in their life cycle

The present chapter deals with the methodology followed to gather the data in the field and its analysis. Data gathering included two different steps followed in Iñapari and in Assis Brazil, first interviews and then questionnaires. Analysis of both qualitative and quantitative data was performed in order to test the hypotheses set out in the first two chapters.

Data analysis included four steps: first, the operationalization of the variables and the presentation of descriptive statistics; second, the comparison of the means for the data found in Assis Brazil and in Iñapari; third, correlation analysis to observe the relationships among variables; and fourth, multivariate modeling to observe the role of the group of independent variables in determining land uses and land covers.

Fieldwork Methods in Iñapari and Assis Brazil

The methodology was designed to be the same in both sites. However, during fieldwork the different conditions made it difficult to follow the same exact steps in both towns. There were four weeks of intense fieldwork in each place. The work included interviews with local authorities and 45 questionnaires with small farmers. In both cases indigenous peoples and extractive reserves were purposely excluded from in the research since for these populations the collective ownership of resources adds a dimension to land use decisions that is not considered in this research.

Fieldwork in Iñapari

The primary field work in Iñapari started on June 13th and finished on July 14th, 2004. The district is divided in 5 main sectors: Iñapari, La Colonia, Nueva Esperanza, Villa Primavera, and San Isidro de Chilina. The latter two were part of the government colonization projects. There is also one native community, Belgica, which is not being considered in this research. Iñapari and La Colonia are urban centers, while most of the farm lands are in Primavera, Nueva Esperanza and Chilina along the 50km road to Iberia. Given the spatial location of Chilina, it is more linked to Iberia than to Iñapari. Health care, agriculture, and INRENA offices in Iberia attend Chilinas needs. From 1995 to 1997 the Special Project for Land Titulation (Proyecto Especial de Titulación de Tierras PETT) worked in the district. For this reason at least 85% of farmlands now have titles.

During the first week in Iñapari the main activities were the interviews; these included: the Alcalde Provincial del Tahuamanu, INRENA (National Institute for Natural resources) manager, SENASA (National Service for Agrarian Health) manager, APEMI (Iñapari small loggers association), managers of the three forest concessions of the district, presidents of the farmers and cattle ranchers association, president of the mother's club, and the secondary school director. One key person was not possible to interview, the manager at the Agriculture office. Statistical data and existing maps, however, were made available for my use. Available information was not good enough to establish the number of farmers in the district, nor the spatial location of farmlands.

The second week was spent completing the interviews and deciding on the sampling method to apply the questionnaires. I decided to use the local health post census data, gathered in December 2002, which provided accurate data on population and covered most of the district except Chilina. The number of households in each sector was established (estimated for Chilina) and a proportional number of randomly chosen households from each sector was assigned to complete 50 households, 25% of the households that had a farm reported for Iñapari in 1994 (INEI 1999).

The third and fourth weeks were spent applying questionnaires (Appendix A); 45 questionnaires were carried out but only 36 were valid for this research[1], representing 18.3% of the district households that had a farm (INEI 1999). I started in Iñapari and La Colonia, the urban areas where most families were concentrated (78%). Appointments were made with family heads, since most work either at their farms or at the Municipalidad, the main source of employment, during the day. The fourth week was spent visiting Chilina (the farthest sector), Primavera, and Nueva Esperanza. See figure 3-1.

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[1] Questionnaires for households with more than two land holdings, with land holdings that had no productive activities and those who could not provide accurate information were considered invalid

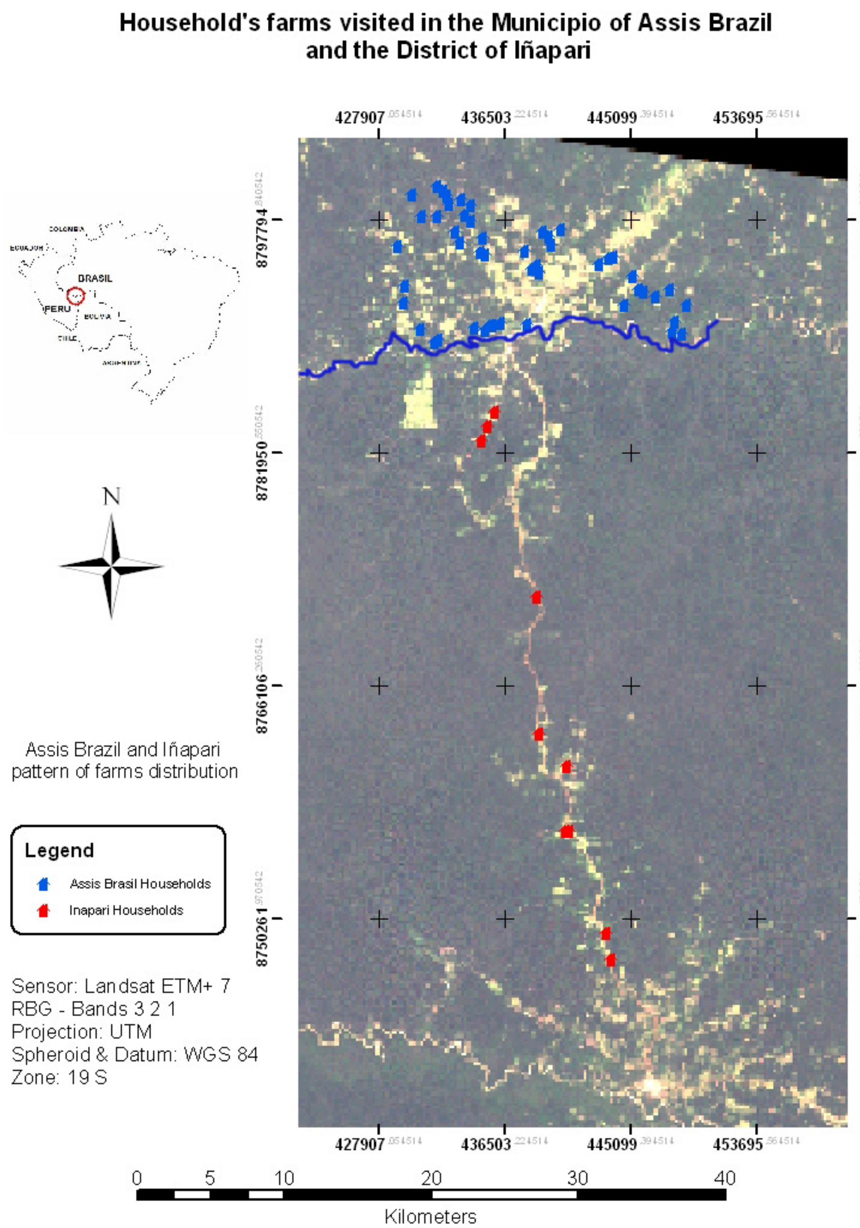

Figure 3-1. Household farms visited in the Municipio of Assis Brazil and in the District of Iñapari. While all questionnaires were made on the farm in the case of Assis Brazil, only some of them were made on the farm in the case of Iñapari. The Acre River that makes the international border is highlighted in blue.

Fieldwork in Assis Brazil

In Assis Brazil the main work was done from July 15th to August 14th. Four sectors were identified in the area: Paraguaçú, Santa Quitéria, São Francisco, and Assis Brazil.

The boundary between the Municípios of Assis Brazil and Brasielia is at km 8 on the Assis Brazil-Brasieleia road. These means that there are only 8km of paved road within Assis Brazil and, therefore, most farms in this Município are accessed with secondary roads. Most farmers do not have land titles; only in Santa Quitéria where INCRA had established Colonization Projects do farmers have land titles.

The first week, I presented my research proposal in a meeting of the Municipal staff. I had the opportunity to present myself and the research topic, and to get feedback and recommendations. Two interviews were carried out, one with the person in charge of the IBAMA office and one with the person in charge of SEATER (Executive Secretary for Technical Assistance, Rural Extension and Production Warranty).

A collaborative relation was established with SEATER, an organization which works directly with farmers associations. Since the government only supports associations, most farmers are part of one. Seven associations were identified in the area: Bacia, Livramento and Estrela Brilhante in Paraguaçú, São Felix and Fortaleza in Santa Quitéria; Novo Progresso and Iracema in São Francisco. Farmers that live along the secondary roads known as Beija Flor, Recife, Do Sete and in the main road near to Assis Brazil were included. The number of households in each association was established (estimated for Beija Flor, Recife, Do Sete) and a proportional number of randomly chosen households from each sector was assigned to complete 50 households, which represents 23.7% of the households that had a farm reported for the Municipio of Assis Brazil in 1995/1996 (IBGE 1998).

During the second, third, and fourth week a total of 45 questionnaires (Appendix B) were carried out and 41 were valid[2], representing 19.4% of the households that had a farm (IBGE 1998);, see Figure 3-1 for spatial distribution. A program was established to visit each farm with a technician and transportation provided through SEATER. We used a motorcycle for our transportation through secondary roads 8-15 km long; all of them depart around km 4 and 7 from the recently paved Pacific highway (BR-317). Most of them were passable only with a motorcycle.

First we visited São Felix, a Colonization Project of INCRA, then we visited Bacia, Iracema and Recife; the last one was very difficult to transit, even in August when it is the dry season. I also took a short trip up the Acre River to visit Novo Progresso. Finally, we visited Estrela Brilhante and Livramento. Fortaleza was not visited due to transportation issues. Then we applied questionnaires to farmers in Beija Flor and in the closer areas like the secondary road known as Sete and in the recently paved BR-317.

The Differences in Methodology and Their Implications

Interviews were an important component in the case of Iñapari, where two weeks were spent in this activity and more than fifteen interviews were carried out with local authorities and leaders. In fact, in theory, this will allow for a better contextualization of the responses obtained in the questionnaires. It will also allow for a comparison on the authorities' and leaders' perceptions with those of the farmers. In the case of Assis Brazil, only two interviews were carried out; however, I expect this not to be a major problem, since those interviewed were key persons: IBAMA and SEATER personnel.

[2] Questionnaires for households with more than two land holdings, with land holdings that had no productive activities and those who could not provide accurate information were considered invalid

In the case of questionnaires, although the number was the same in both places (45), there were some differences. For Iñapari 36 questionnaires were valid and were used in this research, representing 18.3% of the district households that had a farm (INEI 1999) in that area. In Assis Brazil 41 questionnaires were valid, representing 19.4% of the Município households that had a farm (IBGE 1998). This poses questions in terms of comparisons and statistical analysis. However, although the total number of valid questionnaires is different, they represent a very similar percentage of the total number of farmers in each site.

Operationalization of Variables

Five groups of variables have been developed for the present research. The first group is labeled land use outcomes; the variables in this group are indicators for household land use activities. The second group was labeled land cover outcomes; these variables are indicators for deforestation since arrival to the farm. The third group is labeled background information; these variables are the control variables. The fourth group, labeled land use drivers, is composed of two sections: markets and credit, and road infrastructure variables. Finally, the fifth group is labeled household life cycles; these variables account for household level variance. The variable 'place' that represents whether a household is located in Iñapari or in Assis Brazil is also included.

It is important to place the hypotheses and framework for the present research within the context of Assis Brazil and Iñapari. Market variables are at the local and regional level, credit variables are at the national level, and road infrastructure variables are at the national, regional and local level. Household life cycle variables are at the household level, the same as land use, land cover, and control variables.

In order to address the central research questions, several data analysis steps will follow. First, descriptive statistics for both Iñapari and Assis Brazil will be presented in order to provide a general idea of the characteristics for the whole area. Second, means comparison of each variable for Iñapari and Assis Brazil will be presented in order to reveal the differences for each town. Third, in order to observe the relation between dependent variables and dependent (outcome) and independent variables, bivariate correlations will be presented. Fourth, to gain insights on how each group of variables interacts and affects the outcome variables, multivariate models between each outcome variable and each group of independent variables will be presented. Fifth, multivariate models for each outcome variable will be developed by using the independent variables found to be significant in the previous steps.

Tables 3-1to 3-4 present descriptive statistics for the dependent and independent variables used in this study. Data for variables with skewness over 1 were transformed by converting to the natural logarithm and adding 1 unit to avoid 0 values. This procedure reduced overall skewness and improved normality for statistical analyses. Mean values are presented for the raw data, the transformed data and for the antilog of the previously transformed data. Skewness is presented for both the raw and transformed data. The sample size of 77 households is the same for all variables.

Table 3-1 presents descriptive statistics for the dependent variables: land use outcomes and land cover outcomes, for Iñapari and Assis Brazil in the year 2003. Four land use outcomes and four land cover outcomes are considered. Land use outcomes were reported as hectares (ha) in annual crops, perennial crops and pasture. The number of heads of cattle is also included since some farmers have pasture and no cattle. The area in annuals includes rice, corn, beans, manioc, other vegetables (including tomatoes, lettuce, herbs, spinach, and others) and the various combinations. Also included in this category are hectares of corn mixed with pasture and with bananas. The area in hectares under perennials includes banana, citrus, pepper, palillo, pijuayo, açai, coffee, and their various combinations. The combinations usually include fruit trees, palms, and timber trees.

Table 3-1. Descriptive statistics for land use and land cover outcome variables. Iñapari and Assis Brazil, 2003.

Variable	Unit	Mean	Mean*	Std. Deviation	Skewness	N
		(1)	(2)	(3)	(4)	(5)
Land use outcomes						
Annual crops	ha	2.86		2.05	0.79	77
Perennial crops	ha	0.75		0.92	2.53	77
Pasture	ha	16.85		23.25	3.30	77
Heads of cattle		28.78		63.19	5.85	77
Land cover outcomes						
Old growth forest	ha	55.19		53.68	2.79	77
Secondary forest	ha	8.84		11.84	2.82	77
Deforested area (a)	ha	20.15		23.96	2.51	77
% deforested of forest (b)	%	25.93		25.10	1.11	77
Transformed values ln (1+var)						
Land use outcomes						
Annual crops		1.20	1.22	0.57	-0.40	77
Perennial crops		0.75	0.78	0.30	-1.10	77
Pasture		2.21	3.37	1.25	-0.26	77
Heads of Cattle		2.16	3.20	1.71	0.00	77
Land cover outcomes						
Old growth forest		3.67	14.39	0.97	-1.42	77
Secondary forest		1.75	2.12	1.06	0.01	77
Deforested area		2.39	4.02	1.30	-0.44	77
% deforested of forest		2.68	5.36	1.33	-0.77	77

*antilog of mean logs, (a) Hectares deforested since arrival to the farm (initial old growth forest - old growth forest), (b) % forest cleared since arrival (ha deforested x 100 / ha initial old growth forest).

Land cover outcomes were reported in ha of old growth forest, secondary forest, deforested area, and percentage of cleared forest. The deforested area was calculated by subtracting the current area of forests from the initial (that which was existing when the family arrived to the farm) area in hectares of forest. The percentage of cleared forest was calculated by dividing the total area deforested by the initial area of forest.

The high standard deviation for the number of heads of cattle responds to the inclusion of one medium size rancher household from Assis Brazil in the dataset. While most households had less than 100 heads of cattle this household had 500. The data were included in the analysis since they are representative of a very small group of ranchers in Assis Brazil. For old growth forest, secondary forest, deforested area and % deforested land, antilog transformed mean data was found to differ substantially from non-transformed mean data.

Table 3-2 presents descriptive statistics for household background information. This category presents seven variables. The ones measured in hectares (ha) are land size, initial old growth forest and initial secondary forests. Household sources of off-farm income like regular monthly income (e.g. wage, retirement), daily wage or other irregular income sources (e.g. taxi driver) are reported through yes/no answers. The region of birth of the household head indicates whether they were born in the Madre de Dios-Acre-Pando region or elsewhere. The number of years the head of household has received formal education are also provided. For the yes/no answers the mean value gives the percentage of yes answers.

The mean area in old growth and secondary forest was 75 and 6 ha respectively. Almost half of the families possessed a regular monthly income and almost one third had a daily wage. More than half of the heads of households were born in the MAP region and household heads had an average of 5 years of education.

Table 3-2. Descriptive statistics for household background information variables. Iñapari and Assis Brazil, 2003

Variable	Unit	Mean (1)	Mean* (2)	Std. Deviation (3)	Skewness (4)	N (5)
Background information						
Farm size	ha	83.51		59.47	2.3	77
Initial old growth forest	ha	75.34		60.16	2.21	77
Initial secondary forest	ha	5.95		11.90	3.64	77
Regular monthly income	0=no, 1=yes	0.40		0.49	0.41	77
Daily wage	0=no, 1=yes	0.27		0.45	1.04	77
Born in the MAP area	0=no, 1=yes	0.66		0.48	-0.70	77
Education		5.43		4.44	0.65	77
Transformed values ln (1+var)						
Farm size		4.27	26.31	0.56	0.64	77
Initial old growth forest		4.07	21.48	0.82	-1.55	77
Initial secondary forest		1.06	1.07	1.25	0.76	77

*antilog of mean logs

Table 3-3 provides descriptive statistics for place, markets, credit, and road infrastructure. Place refers to whether the household is located in Assis Brazil or in Iñapari. The six market variables are: distance to the nearest market, whether the household sells annual crops, perennial crops, small animals or cattle, and an index of farm product commoditization. This index assigns a value to each one of the different combinations of products sold. It ranges from 1 to 13; the lowest values are assigned to households that sell annuals and small animals and the highest to households that sell cattle and perennials.

Credit refers to the number of times the household had used credit since arriving to their farm. Road infrastructure groups six variables: whether the household is located in a main road, a secondary road, a tertiary road, or a walking path; the distance in kilometers from the main road, and a transportation time index. This index was created to combine road infrastructure variables, It was calculated by dividing the known distances (obtained from the interviews and tracked roads) to the markets of either Assis Brazil or Iñapari by approximate average travel velocities for primary, secondary, and tertiary roads, and walking paths (45, 20, 15, and 4 kilometers per hour, respectively) and obtaining a total travel time by adding each section. For the yes/no answers the mean value gives the percentage of yes answers.

Table 3-3. Descriptive statistics for place, markets, credit and road infrastructure variables. Iñapari and Assis Brazil, 2003

Variable	Unit	Mean (1)	Mean* (2)	Std. Deviation (3)	Skewness (4)	N (5)
Place *(Iñapari/Assis Brazil)*	0=I, 1=A	1.53		0.502	-0.133	77
Market and credit						
Distance from nearest market	km	12.41		6.28	0.33	77
Sells annual crops	0=no, 1=yes	0.70		0.46	-0.90	77
Sells perennial crops	0=no, 1=yes	0.13		0.34	2.25	77
Sells small animals	0=no, 1=yes	0.42		0.50	0.35	77
Sells Cattle	0=no, 1=yes	0.56		0.50	-0.24	77
Farm product commoditization	index	6.61		4.79	-0.12	77
Times credit was received		1.06		1.49	2.68	77
Road Infrastructure						
Lives in main road	0=no, 1=yes	0.12		0.32	2.43	77
Lives in secondary road	0=no, 1=yes	0.34		0.48	0.70	77
Lives in tertiary road	0=no, 1=yes	0.29		0.46	0.97	77
Lives in walking path	0=no, 1=yes	0.26		0.44	1.12	77
Distance from main road	km	5.59		4.62	0.33	77
Transportation time	hours	0.60		0.38	1.10	77
Transformed values ln (1+var)						
Times credit was received		0.55	0.64	0.56	0.77	77
Transportation time		0.45	0.57	0.22	0.46	77

* antilog of mean logs

The mean distance to nearest market was short (12.41 km) compared to other areas. More than two thirds of households sell annual crops and only a small portion of households sell perennial crops. As for animals, almost half of households sell small animals while more than half of households sell cattle.

On average all households had received credit once in the past. Spatially a small percentage of households lives along a primary road while more that one third lives along a secondary road and almost one third lives along a tertiary path and along a walking respectively. The mean distance to the main road was 5.59 km while the mean transportation time, as obtained from the index, was 36 minutes.

Table 3-4 provides descriptive statistics for the household life cycle; this category groups eight variables. The first is the time the household has lived on the farm (years on the farm), the age of household head, the number of family members currently living on the farm, the number of family members that participate in land use activities, the number of children in the family and the number of adults in the family. Additional indices are presented for labor hired and labor exchanged. Values range from one to four, one meaning no labor was exchanged or hired during the last 12 months; two, labor exchanged for reasons other than forest clearing; three, labor exchanged for forest clearing; and four, labor exchanged for 2 and 3. For the labor hired index, five represents labor hired all year round.

Table 3-4. Descriptive statistics for household life cycle variables. Iñapari and Assis Brazil, 2003.

Variable	Unit	Mean	Mean*	Std. Deviation	Skewness	N
		(1)	(2)	(3)	(4)	(5)
Years on farm		13.90		10.63	1.26	77
Age of household head		44.78		14.29	0.67	77
Family members on lot		4.55		1.88	0.58	77
Family members working farm		2.48		1.54	1.13	77
Number of children		1.70		1.57	0.87	77
Number of adults		4.18		2.89	1.34	77
Labor hired	index	2.58		1.44	0.36	77
Labor exchanged	index	2.06		1.23	0.57	77
Transformed values ln (1+var)						
Years on farm		2.43	4.16	0.80	-0.49	77
Family members working farm		1.15	1.16	0.47	-0.59	77
Number of adults		1.52	1.68	0.48	0.73	77

*antilog of mean logs

The families had spent an average of 14 years on their plot by the summer, 2003, when this study was conducted. The mean head of the household was 44 years old. Though there were an average of 5 family members, only 2 were actively working on the farm. The number of children was half the number of adults when the definition of adult was older than 14 years of age. Families, on average, hired labor and exchanged labor for purposes other than land clearing, although there seems to be a trend in which labor is hired for land clearing purposes.

Comparing Variable Means for Assis Brazil and Iñapari

Table 3-5 provides the results of independent t-tests for the means of land use and land cover outcomes, background information, markets, credit, infrastructure, and household life cycle variables between Iñapari and Assis Brazil. Both raw and transformed data means are compared, but means are considered significantly different according to the transformed means.

All means for land use outcomes were significantly different. Assis Brazil had a significantly larger area of annual and perennial crops and pasture, and nearly four times the heads of cattle than did Iñapari, in the year 2003. Land cover outcomes means were not found to be different except the percentage of forest cleared since arrival to the farm, which is significantly less in Assis Brazil than in Iñapari, mainly due to the larger average farms in Assis Brazil. Although not significant, there was an apparent trend of larger areas of old growth forest in Assis Brazil than Iñapari.

Table 3-5. T-test of means for land use outcomes, land cover outcomes, background information, markets and credit, road infrastructure and household life cycle variables according to location in Iñapari or Assis Brazil, 2003.

Variables	unit	Means Iñapari (1)	Assis Brazil (2)	T (3)
Land use outcomes				
Annual crops	ha	2.38	3.27	-1.95+
Perennial crops	ha	0.65	0.85	-0.95
Pasture	ha	11.79	21.29	-1.82+
Heads of cattle	count	13.31	42.37	-2.17 (a)*
Land cover outcomes				
Old growth forest	ha	45.69	63.54	-1.55 (a)
Secondary forest	ha	8.57	9.09	-0.19
Deforested area (b)	ha	20.46	19.88	0.11
% deforested of forest (c)	%	28.07	24.05	0.70
Background information				
Farm size	ha	68.4	96.78	-2.25(a)*
Initial old growth forest	ha	66.15	83.42	-1.33 (a)
Initial secondary forest	ha	2.18	9.26	-2.86 (a)**
Regular monthly income	0=no, 1=yes	0.31	0.49	-1.64 (a)
Daily wage	0=no, 1=yes	0.42	0.15	2.69 (a)**
Born in the MAP area	0=no, 1=yes	0.50	0.80	-2.90 (a)**
Education	years	7.75	3.39	4.91**
Transformed values				
Land use outcomes				
Annual crops		1.06	1.33	-2.12*
Perennial crops		0.67	0.82	-2.12*
Pasture		1.89	2.50	-2.2*
Heads of cattle		1.44	2.80	-3.79**
Land cover outcomes				
Old growth forest		3.68	3.65	0.11 (a)
Secondary forest		1.68	1.81	-0.57
Deforested area (b)		2.58	2.23	1.19
% deforested of forest (c)		2.96	2.43	1.82 (a)+
Background information				
Farm size		4.16	4.36	-1.60(a)
Initial old growth forest		4.11	4.03	0.48 (a)
Initial secondary forest		0.55	1.52	-3.77 (a)**
Regular monthly income	0=no, 1=yes	0.31	0.49	-1.64 (a)
Daily wage	0=no, 1=yes	0.42	0.15	2.69 (a)**
Born in the MAP area	0=no, 1=yes	0.50	0.80	-2.90 (a)**
Education	years	7.75	3.39	4.91**

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) F test found variance significantly different ($p<0.05$) for T test equal variance is not assumed, (b) Hectares deforested since arrival to the farm (initial old growht forest - old growth forest), (c) % forest cleared since arrival (ha deforested x 100 / ha initial old growth forest).

Table 3-5. Continued

Variables	unit	Means Iñapari (1)	Assis Brazil (2)	T (3)
Market and Credit				
Distance from nearest market	km	14.59	10.50	2.89 (a)**
Sells annual crops	0=no, 1=yes	0.64	0.76	-1.11 (a)
Sells perennial crops	0=no, 1=yes	0.14	0.12	0.22
Sells small animals	0=no, 1=yes	0.28	0.54	-2.37 (a)*
Sells Cattle	0=no, 1=yes	0.33	0.76	-4.064**
Farm product commoditization	index	5.08	7.95	-2.732**
Times credit was received (e)		1.42	0.76	1.90 (a)+
Road Infrastructure				
Lives in main road	0=no, 1=yes	0.22	0.02	2.66 (a)*
Lives in secondary road	0=no, 1=yes	0.22	0.44	-2.06 (a)*
Lives in tertiary road	0=no, 1=yes	0.00	0.54	-6.81 (a)**
Lives in walking path	0=no, 1=yes	0.56	0.00	6.61 (a)**
Distance from main road	km	3.24	7.65	-4.74**
Transportation time	hours	0.76	0.46	3.56 (a)**
Household life cycle				
Years on farm	years	14.08	13.73	0.14
Age of household head	years	44.72	44.83	-0.03
Family members on lot	count	4.53	4.56	-0.08
Family members working farm		2.17	2.76	-1.70+
Number of children	count	1.56	1.83	-0.76
Number of adults	count	3.86	4.46	-0.91
Labor hired	index	2.00	3.10	-3.60**
Labor exchanged	index	2.14	2.00	0.49
Transformed values ln (1+var)				
Times credit was received (e)		0.66	0.45	1.688+
Transportation time		0.53	0.37	3.24 (a)**
Years on farm		2.38	2.47	-0.48
Family members working farm		1.03	1.25	-2.16*
Number of adults	count	1.46	1.57	-0.96

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) F test found variance significantly different ($p<0.05$) for T test equal variance is not assumed, (e) Since arrival to the property.

Variables that represent the farmer’s background had means that were not significantly different except for initial area in secondary forest and percentage of family chiefs that were born in the MAP area. Both variables presented higher values for Assis Brazil. The percentage of households receiving a daily wage, and years of education, presented significantly higher values for Iñapari.

Market variables showed that surveyed households in Iñapari were located significantly further from the nearest market than those in Assis Brazil. A significantly larger number of households in Assis Brazil sold small animals and cattle than households in Iñapari. This was reflected in the farm product commoditization index which was significantly greater for Assis Brazil than for Iñapari

As for credit, interestingly, households in Iñapari had received significantly more credit more than households in Assis Brazil since their arrival to the property. Credits were provided by the Agrarian Bank in Peru from the late 1950s until 1991. In Assis Brazil credit access is more recent; most households did not have credit available until the late 1990s.

The road infrastructure variables show that farmers in Iñapari are significantly more likely to live along a main road than those in Assis Brazil, but are significantly less likely to live along a secondary road. The majority of households in Assis Brazil (54%) lived along tertiary roads while no households in Iñapari were found on tertiary roads, and instead the majority of households in Iñapari (56%) were found along walking paths, where none were found for Assis Brazil (see Figure 3-1). Walking paths and tertiary roads are in different categories because walking paths were found in Iñapari only, they are not passable by motor vehicles and they start in the border of the main road. Households in Assis Brazil were found more than twice as far (7.65 km), on average, than those in Iñapari (3.24 km). Transportation time to the nearest market (either in Assis Brazil, Iñapari or Iberia) is greater (31.8 minutes) for Iñapari households than for those in Assis Brazil (22.2 minutes). This is explained because the index assumes motor vehicle transportation for roads, and walking speed for walking paths, which makes transportation time greater for Iñapari households

Of the eight household life cycle variables only two were found to be significant. The number of family members working on the farms and the days of labor hired were significantly higher in Assis Brazil than in Iñapari.

Relating the results of the mean analysis to the first hypothesis for this research we may say that land use outcomes are larger in area (annual crops, perennial crops, pasture) and in number (heads of cattle) in Assis Brazil than in Iñapari as was expected. This may be explained by significantly different market and road infrastructure variables. However the second part of the hypothesis is not as expected: differences in land cover outcomes, in particular in area deforested at the household level, are not significant. This can be explained by significantly different background variables such as initial area of secondary forest, that is four times higher in Assis Brazil. The higher percentage of old growth forest cleared in Iñapari is in part explained by the smaller farm sizes in Iñapari.

As for the second hypothesis we may say that household life cycle variables are not significantly different from Iñapari to Assis Brazil except for the family members working the farm and labor hired; therefore differences in land use outcomes may be due to the effect of the variables external to the household .

However it is necessary to explore the way in which the dependent and independent variables interact to be able to draw more meaningful statements with respect to both hypotheses. The following analysis steps will treat all the questionnaires as a single sample and not as separate ones since the sample number is very low. Instead, the variable “place” will be included; this will allow us to use the whole sample and to observe the differences between the two sites.

Correlations Between Independent and Dependent Variables

Bivariate correlations are the third step in this analysis. Significant positive or negative correlations provide insight into relationships between individual variables and/or outcomes. Tables 3-6 to 3-14 present bivariate correlation coefficients (Pearson correlation) between each land use and land cover outcome, as well as against the entire suite of measured variables.

Table 3-6 presents the correlations among the land use outcomes and land cover outcomes. These outcomes were natural log transformed prior to analysis. All significant correlations were found to be positive. Households having larger areas in perennials also had larger areas in annuals. For obvious reasons, farms with more heads of cattle also had a greater area in pasture.

Table 3-6. Correlations between land use outcomes and land cover outcomes variables. Iñapari and Assis Brazil, 2003.

Variable	Annuals (1)	Perennials (2)	Pasture (3)	Cattle (4)
Land use outcomes				
Ln ha annual crops	1			
Ln ha perennial crops	0.983**	1		
Ln ha pasture	0.145	0.061	1	
Ln number heads of cattle	0.128	0.052	0.750**	1
Land cover outcomes				
Ln ha old growth forest	0.200+	0.222+	0.030	-0.049
Ln ha secondary forests	0.296**	0.317**	0.004	-0.095
Ln ha deforested (a)	0.264*	0.184	0.490**	0.304**
Ln % deforested of forest (c)	0.196	0.127	0.343**	0.216+

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) ha deforested since arrival to the farm (initial old growth forest - old growth forest), (b) % forest cleared since arrival (ha deforested x 100 / ha initial old growth forest), N=77.

The correlations with the land cover outcomes provided less obvious results. The area in old growth, secondary growth, and deforested were all positively correlated with the area in annuals. These same land cover outcomes, with the exception of area deforested, were also significantly correlated with area in perennials. Increasing area of pasture was found with increasing deforested area and % forest cleared since arrival. Greater numbers of cattle also were related to increasing levels of deforestation and % forest cleared.

Table 3-7 shows correlations between land use outcomes and background information variables. All significant correlations were found to be positive. Larger initial farm sizes (ha), and head of household born within the MAP region, were both related to larger areas of annuals and perennials. Increasing area of pasture was related with increasing areas of: initial farm size and initial area of old growth forest, as well as the household having a regular monthly income. Initial farm size, initial area in old growth, initial area in secondary growth, having a regular monthly income and having a daily wage were all higher as the head of cattle owned by the household increased.

Table 3-7. Correlations between land use outcomes and background information. Iñapari and Assis Brazil, 2003

Variable	Annuals (1)	Perennials (2)	Pasture (3)	Cattle (4)
Background information				
Ln ha of farm size	0.228*	0.194+	0.503**	0.335**
Ln initial ha old growth forest	0.165	0.127	0.338**	0.192+
Ln initial ha secondary forest	0.027	0.057	0.097	0.196+
Regular monthly income (0=no, 1=yes)	-0.141	-0.157	0.229*	0.229*
Daily wage (0=no, 1=yes)	-0.130	-0.122	-0.150	-0.192+
Born in the MAP (area 0=no, 1=yes)	0.243*	0.254*	-0.064	-0.018
Years of education	0.066	0.033	-0.027	-0.160

+ p < 0.1, * p < 0.05, ** p < 0.01, N=77

Table 3-8 shows correlations between land use outcomes and place, market and credit, and road infrastructure variables. Living in Assis Brazil was correlated with increases in all the land use outcomes. In the market category selling perennials was not correlated to any land use outcome. Selling annuals and small animals was positively correlated with area under annuals and under perennials. As expected, selling cattle and the commoditization index were positively correlated with pasture and heads of cattle.

Table 3-8. Correlations between land use outcomes market and credit and road infrastructure. Iñapari and Assis Brazil, 2003

Variable	Annuals (1)	Perennials (2)	Pasture (3)	Cattle (4)
Place *Iñapari/Assis Brazil (0=I, 1=A)*	0.238*	0.238*	0.246*	0.402**
Market and credit				
Distance in km from nearest market	0.129	0.185	-0.209+	-0.315**
Sells annual crops (0=no, 1=yes)	0.387**	0.423**	-0.026	-0.117
Sells perennial crops (0=no, 1=yes)	0.109	0.067	0.009	0.067
Sells small animals (0=no, 1=yes)	0.361**	0.352**	0.234*	0.190+
Sells cattle (0=no, 1=yes)	0.232*	0.178	0.592**	0.732**
Farm product commoditization (index)	0.024	-0.035	0.569**	0.715**
Times credit was received	0.103	0.083	0.083	-0.126
Road infrastructure				
Lives in main road (0=no, 1=yes)	-0.089	-0.137	-0.179	-0.276*
Lives in secondary road (0=no, 1=yes)	0.384**	0.368**	0.359**	0.404**
Lives in tertiary road (0=no, 1=yes)	0.017	0.055	-0.029	-0.022
Lives in walking path (0=no, 1=yes)	-0.367**	-0.353**	-0.227*	-0.211+
Distance in km from main road	0.161	0.217+	0.050	0.213+
Ln transportation time (index)	-0.016	0.049	-0.251*	-0.213+

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, N=77

The credit variable was not correlated with any land use outcome. Households living on secondary roads had larger areas of all land use outcomes and owned more head of cattle; however, those living on walking paths had smaller areas of annuals and pasture and owned less head of cattle. Cattle herd size decreased for households living on main roads, tertiary roads, or walking paths, but increased for those families living on secondary roads.

Table 3-9 presents the correlations between land use outcomes and household cycles. The area in annuals or perennials increased for households ranking higher on the “labor exchanged” index. Households that had more family members working on the farm had greater areas planted with perennial crops. The area of pasture and the numbrr of heads of cattle increased with the time on the farm, the number of children, the number of adults, but, declined for older farms, with more adults in the family, and for the ones that ranked higher in the labor exchange index.

Table 3-9. Correlations between land use outcomes and household cycles. Iñapari and Assis Brazil, 2003

Variable	Annuals (1)	Perennials (2)	Pasture (3)	Cattle (4)
Household life cycle				
Ln years on farm	0.135	0.062	0.564**	0.391**
Age of household head	-0.133	-0.172	0.218+	0.263*
Family members on lot	-0.091	-0.048	-0.262*	-0.184
Ln family members working the farm	0.208	0.264*	-0.041	-0.036
Number of children	-0.054	-0.004	-0.309**	-0.297**
Ln number of adults	-0.015	-0.050	0.352**	0.325**
Labor hired index	0.146	0.106	0.296**	0.365**
Labor exchanged index	0.360**	0.349**	-0.168	-0.182

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, N=77

Table 3-10 shows the correlations between land use outcomes and land cover outcomes. The only significant, and fairly obvious, relationship in this table is between increasing hectares of forest deforested since arrival accompanying higher percentages of initial forest area being deforested.

Table 3-10. Correlations between land use outcomes and land cover outcomes. Iñapari and Assis Brazil, 2003

Variable	Old growth forest (1)	Secondary forest (2)	Ha deforested (3)	% deforested (5)
Land cover outcomes				
Ln ha old growth forest	1			
Ln ha secondary forests	-0.049	1		
Ln ha deforested (a)	0.186	-0.080	1	
Ln % deforested of forest (b)	-0.025	-0.080	0.929**	1

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) ha deforested since arrival to the farm (initial old growth forest - old growth forest), (b) % forest cleared since arrival (ha deforested x 100 / ha initial old growth forest), N=77

In table 3-11 the correlations between land cover outcomes and background information are shown. Larger farms and farms with more initial area under old growth forest were more likely to have larger areas of old growth forest and at the same time more deforested area. The area and percentage of forest area cleared since the household's arrival to the parcel was smaller on farms with larger initial areas of secondary forest.

Table 3-11. Correlations between land cover outcomes and background information. Iñapari and Assis Brazil, 2003

Variable	Old growth forest (1)	Secondary forest (2)	Ha deforested (3)	% of forest cleared (5)
Background information				
Ln ha farm size	0.746**	0.107	0.459**	0.147
Ln initial ha old growth forest	0.799**	-0.132	0.636**	0.437**
Ln initial ha secondary forest	-0.105	0.299**	-0.526**	-0.564**
Regular monthly income (0=no, 1=yes)	0.046	0.046	-0.010	-0.034
Daily wage (0=no, 1=yes)	-0.074	-0.191+	-0.089	-0.049
Born in the MAP area (0=no, 1=yes)	0.025	0.043	-0.035	-0.049
Years of education	0.060	0.012	0.152	0.131

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, N=77

Table 3-12 shows correlations between land cover outcomes, markets and credit, and road infrastructure. Farms located further from, and having longer transportation times, to the nearest markets, or selling annual crops, had a larger area in old growth forest. Those households that were selling annual crops and that did not live on walking paths had increasingly larger areas in secondary forest. More hectares had been deforested since arrival by households that sold cattle but fewer had been deforested by those who live on tertiary roads. The percentage of initial forest deforested was higher for households that sold cattle, had received more credit since arrival, or that ranked highly on the "farm product commoditization" index. A smaller percentage was deforested, however, by families living on tertiary roads.

Table 3-13 shows the correlations between land cover outcomes and household cycles. A greater area in secondary forest was found for older farms, that had more family members working on them, or that ranked highly on the "labor exchanged" index. Hectares deforested since arrival also was higher for older farms, with older household heads, that had a larger numbers of adults, or that ranked higher on the "labor exchanged" index. A greater percentage of the initial forest had been deforested on older farms that had more adults in their households.

Table 3-12. Correlations between land cover outcomes, markets and credit and road infrastructure. Iñapari and Assis Brazil, 2003

Variable	Old growth forest (1)	Secondary forest (2)	Ha deforested (3)	% deforested (a) (5)
Place *Iñapari/Assis Brazil (0=I, 1=A)*	-0.013	0.065	-0.136	-0.201
Market and Credit				
Distance in km from nearest market	0.221+	-0.026	0.077	0.108
Sells annual crops (0=no, 1=yes)	0.390**	0.262*	0.108	-0.002
Sells perennial crops (0=no, 1=yes)	0.034	-0.13	0.05	0.076
Sells small animals (0=no, 1=yes)	0.076	0.070	0.133	0.144
Sells Cattle (0=no, 1=yes)	-0.157	-0.082	0.238*	0.257*
Farm product commoditization (index)	-0.158	-0.100	0.214+	0.214+
Times credit was received	0.135	0.146	0.329**	0.244*
Road infrastructure				
Lives in main road (0=no, 1=yes)	0.035	0.119	0.188	0.189
Lives in secondary road (0=no, 1=yes)	-0.011	0.141	0.181	0.133
Lives in tertiary road (0=no, 1=yes)	0.026	-0.003	-0.192+	-0.233*
Lives in walking path (0=no, 1=yes)	-0.041	-0.236*	-0.136	-0.042
Distance in km from main road	0.176	-0.073	-0.109	-0.145
Ln transportation time (index)	0.260*	-0.074	-0.027	0.005

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) % forest cleared since arrival (ha deforested x 100 / ha initial old growth forest), N=77

Table 3-13. Correlations between land cover outcomes and household cycles. Iñapari and Assis Brazil, 2003

Variable	Old growth forest (1)	Secondary forest (2)	Ha deforested (3)	% deforested (a) (5)
Household life cycle				
Ln years on farm	0.013	0.280*	0.562**	0.460**
Age of household head	-0.148	0.048	0.205+	0.165
Family members on lot	-0.076	-0.008	-0.05	0.041
Ln family members working the farm	-0.099	0.269*	0.011	0.036
Number of children	0.004	-0.107	-0.143	-0.079
Ln number of adults	-0.129	0.086	0.256*	0.215+
Labor hired (index)	0.116	0.101	-0.026	-0.107
Labor exchanged (index)	0.180	0.190+	0.203+	0.165

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) % forest cleared since arrival (ha deforested x 100 / ha initial old growth forest), N=77

Results from this section mainly provide a general idea of the existing relationships between dependent and independent variables. Land use outcomes were more likely to be significantly correlated to the market, credit and road infrastructure while valuables land cover outcomes were more likely to be significantly correlated with background information variables. For a better understanding of these relationships, the next section presents multivariate models for land use and land cover outcomes.

Multivariate Models

This section constitutes the fourth step in the data analysis. Here Ordinary Least Square (OLS) regression models were run to gain insights into the way variables interact, since correlations provide limited information in this aspect. A total of five models were run for each land use and land cover outcome. Model 1 presents the results (beta coefficient, significance, r square and F) after regressing a given outcome (e.g. area in annual crops) against the background information (BI) variables. Model 2 presents market and credit (MC) variables, Model 3 presents road infrastructure (RI) variables, and model 4 presents household life cycle (HLC) variables.

The fifth model (termed the “comprehensive” model) integrates the variables that were found to be significant in Models 1 to 4, as well as variables that were significantly correlated to the outcome (from Tables 3-6 to 3-13).

Land Use Models

For area in annual crops (Table 3-14) the BI model shows that those who had a regular monthly income had less area in annual crops. Conversely, those born in the MAP area, having more years of education, and living in Assis Brazil rather than in Iñapari had a larger area of annual crops.

Table 3-14. Models of farm area in annual crops outcome regressed on background information, market & credit road infrastructure, and household life cycle in Assis Brazil and Iñapari, 2003.

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	-0.288				
Ln ha of farm size	0.154				
Ln initial ha old growth forest	0.02				
Ln initial ha secondary forest	-0.01				
Regular monthly income (0=no, 1=yes)	-0.327*				
Daily wage (0=no, 1=yes)	-0.170				
Born in the MAP (area 0=no, 1=yes)	0.246+				
Years of education	0.04*				0.042**
Place	0.363*				
Market & credit					
Constant		0.626*			
Distance in km from nearest market		0.01			
Sells annual crops (0=no, 1=yes)		0.328*			0.335**
Sells perennial crops (0=no, 1=yes)		0.02			
Sells small animals (0=no, 1=yes)		0.189			
Sells cattle (0=no, 1=yes)		0.969**			1.109**
Farm product commoditization (index)		-0.09**			-0.088**
Times credit was received		0.05			
Place		0.08			
Road infrastructure					
Constant			0.897+		
Lives in main road (0=no, 1=yes)			-0.183		
Lives in secondary road (0=no, 1=yes)			0.312+		
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			-0.595*		-0.463**
Distance in km from main road			-0.02		
Ln transportation time (index)			0.867*		0.648*
Place			0.06		
Household life cycle					
Constant				0.463	
Ln years on farm				0.103	
Age of household head				-0.01+	
Family members on lot				-0.05	
Ln family members working the farm				0.286+	
Number of children				-0.01	
Ln number of adults				0.125	
Labor hired index				0.08	
Labor exchanged index				0.184**	0.101*
Place				0.134	
R2	0.241	0.380	0.260	0.322	0.538
F	2.705*	5.220**	4.091**	3.573**	11.483**

+ p < 0.1, * p < 0.05, ** p < 0.01, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

The MC model shows that those who sold annuals or cattle and who ranked lower in the “farm product commoditization” index had more land in annual crops. In Model 3 (RI variables) farms on secondary roads or with higher transportation times (as calculated in the “transportation time” index) had a larger area, and farms located on walking path had a smaller area, of annual crops.

The HLC model shows that households with a younger “head of household”, with more family members working in the farm, and/or those who exchanged more labor kept more area in annual crops. By observing the modells R^2 values we may say that market and credit variables (R^2 = 0.380) are the ones that explain the most variation, followed by household life cycle variables (R^2 = 0.322), road infrastructure variables (R^2 = 0.260), and finally the background information variables (R^2 = 0.241).

The area in perennial crops (Table 3-15) for the BI model (incorporating “background information” variables, as previously explained) shows similarity to the case of area in annual crops. The MC model (incorporating market and credit variables) shows that those who were farther from the nearest market, who sold annual crops, or cattle, and those who ranked lower in the farm product commoditization index had more area in perennial crops.

The RI model (incorporating road infrastructure variables) shows that households located on walking paths and households who had lower transportation times to the nearest market maintained a smaller area in perennial crops.

Table 3-15. Models of farm area in perennial crops outcome regressed on background information, market & credit road infrastructure, and household life cycle in Assis Brazil and Iñapari, 2003

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	0.055				
Ln ha of farm size	0.066				
Ln initial ha old growth forest	0.013				
Ln initial ha secondary forest	0.001				
Regular monthly income (0=no, 1=yes)	-0.176*				
Daily wage (0=no, 1=yes)	-0.082				
Born in the MAP (area 0=no, 1=yes)	0.137+				
Years of education	0.018**				0.019**
Place	0.175**				
Market & credit					
Constant		0.413+			
Distance in km from nearest market		0.009+			
Sells annual crops (0=no, 1=yes)		0.184**			0.182**
Sells perennial crops (0=no, 1=yes)		-0.023			
Sells small animals (0=no, 1=yes)		0.085			
Sells cattle (0=no, 1=yes)		0.518**			0.597**
Farm product commoditization (index)		-0.051**			-0.052**
Times credit was received		0.012			
Place		0.067			
Road infrastructure					
Constant			0.621*		
Lives in main road (0=no, 1=yes)			-0.162		
Lives in secondary road (0=no, 1=yes)			0.138		
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			-0.362*		-0.261**
Distance in km from main road			-0.089		
Ln transportation time (index)			0.532*		0.448**
Place			0.005		
Household life cycle					
Constant				0.404*	
Ln years on farm				0.028	
Age of household head				-0.007+	
Family members on lot				-0.027	
Ln family members working the farm				0.183*	
Number of children				-0.003	
Ln number of adults				0.069	
Labor hired index				0.034	
Labor exchanged index				0.091**	0.044*
Place				0.069	
R2	0.222	0.414	0.284	0.312	0.549
F	2.432*	6.007**	4.619**	3.370**	11.983**

+ p < 0.1, * p < 0.05, ** p < 0.01, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

The variables influencing the HLC model (incorporating household life cycle variables) are similar to those that influenced the area in annual crops. In the case of perennials, as in the case of annuals, market and credit variables (R^2 = 0.414) were the ones that had the most explanatory power, followed by household life cycle variables (R^2 = 0.312), road infrastructure variables (R^2 = 0.284) and background information variables (R^2 = 0.222).

The variables explaining area in pasture (Table 3-16) from the BI model showed that larger sized farms had a larger area in pasture. The MC model shows that farms closer to the nearest market, that sold small animals, who ranked higher in the farm product commoditization index and those who received credit a greater number of times had a greater area of pasture.

The RI model shows that farms on secondary roads had more area in pasture. Finally, the HLC model shows that households who had greater residence times on their farms and those whose families were of younger age had more area in pasture. Conversely, those households with more adults and those who exchanged less labor had more area in pasture. According to the R^2 coefficients household life cycle variables (R^2 = 0.508) are the ones that perform better, followed by market and credit variables (R^2 = 0.446), background variables (R^2 = 0.327), and road infrastructure variables (R^2 = 0.179).

For heads of cattle owned (Table 3-17) the BI model shows that farms in Assis Brazil had more cattle than those in Iñapari. The MC related variables of the second model shows that farms located closer to the nearest market, and farms who ranked higher in the farm product commoditization index, owned more cattle. The RI model shows that farms on secondary roads and farms in Assis Brazil had more cattle.

Table 3-16. Models of farm area in pasture outcome regressed on background information, market & credit, road infrastructure, and household life cycle in Assis Brazil and Iñapari, 2003.

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	-3.063**				
Ln ha of farm size	1.382**				0.632**
Ln initial ha old growth forest	-0.294				
Ln initial ha secondary forest	-0.038				
Regular monthly income (0=no, 1=yes)	0.333				
Daily wage (0=no, 1=yes)	-0.004				
Born in the MAP (area 0=no, 1=yes)	-0.433				
Years of education	0.010				
Place	0.469				
Market & credit					
Constant		1.571*			
Distance in km from nearest market		-0.045*			
Sells annual crops (0=no, 1=yes)		0.020			
Sells perennial crops (0=no, 1=yes)		-0.179			
Sells small animals (0=no, 1=yes)		0.464+			
Sells cattle (0=no, 1=yes)		0.634			
Farm product commoditization (index)		0.093+			0.115**
Times credit was received		0.454*			
Place		-0.134			
Road infrastructure					
Constant			2.771+		
Lives in main road (0=no, 1=yes)			-0.484		
Lives in secondary road (0=no, 1=yes)			0.683+		
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			-0.020		
Distance in km from main road			-0.008		
Ln transportation time (index)			-0.844		
Place			0.259		
Household life cycle					
Constant				0.377	
Ln years on farm				0.838**	0.538**
Age of household head				-0.025*	
Family members on lot				-0.100	
Ln family members working the farm				0.054	
Number of children				-0.094	
Ln number of adults				0.702+	
Labor hired index				0.093	0.136*
Labor exchanged index				-0.181+	
Place				0.356	
R2	0.327	0.446	0.179	0.508	0.632
F	4.139**	6.843**	2.551*	7.681**	30.948**

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

Table 3-17. Models of head of cattle outcome regressed on background information, market & credit, road infrastructure, and household life cycle in Assis Brazil and Iñapari, 2003

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	-2.944+				
Ln ha of farm size	0.794				
Ln initial ha old growth forest	0.001				
Ln initial ha secondary forest	0.075				
Regular monthly income (0=no, 1=yes)	0.444				
Daily wage (0=no, 1=yes)	-0.021				
Born in the MAP (area 0=no, 1=yes)	-0.593				
Years of education	-0.002				
Place	1.219*				
Market & credit					
Constant		1.088			
Distance in km from nearest market		-0.071**			-0.048*
Sells annual crops (0=no, 1=yes)		-0.054			
Sells perennial crops (0=no, 1=yes)		0.332			
Sells small animals (0=no, 1=yes)		0.219			
Sells cattle (0=no, 1=yes)		0.924			
Farm product commoditization (index)		0.157*			0.200**
Times credit was received		0.014			
Place		0.194			
Road infrastructure					
Constant			-1.010		
Lives in main road (0=no, 1=yes)			0.554		
Lives in secondary road (0=no, 1=yes)			1.582**		0.693**
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			1.589		
Distance in km from main road			0.057		
Ln transportation time (index)			-1.237		
Place			1.562*		
Household life cycle					
Constant				-1.084	
Ln years on farm				0.642*	0.305*
Age of household head				0.000	
Family members on lot				0.033	
Ln family members working the farm				-0.083	
Number of children				-0.266+	-0.236**
Ln number of adults				0.234	
Labor hired index				0.173	
Labor exchanged index				-0.228+	
Place				1.151*	0.482+
R2	0.277	0.635	0.351	0.425	0.712
F	3.251**	14.776**	5.358**	5.492**	28.800**

+ p < 0.1, * p < 0.05, ** p < 0.01, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

Model 4, incorporating HLC variables, shows that households who had greater tenure on the farm, lower numbers of children, who exchanged less labor, and farms in Assis Brazil had more cattle. Observing the R^2 values we may say that market and credit variables are the ones that performed best ($R^2 = 0.635$), followed by the household life cycle variables ($R^2 = 0.425$), the road infrastructure variables ($R^2 = 0.351$), and explaining the least of the variation, the background information variables ($R^2 = 0.277$).

Land Cover Models

The BI model variables that explained best why larger areas in old growth forest (Table 3-18) existed were larger area of secondary and old growth forests in farms on arrival. These farms had more area in old growth forest in the year 2003. The MC model shows that those who sold annual crops had more area in old growth forest. The third model (with RI variables) shows that farms with greater transportation times to the nearest market or farms who exchanged more labor (as shown in the HLC model) had more area in old growth forest. The model R^2 values show that, background variables ($R^2 = 0.695$) explain most of the variation, followed by market & credit variables ($R^2 = 0.197$), road infrastructure variables ($R^2 = 0.116$) and, household life cycle variables ($R^2 = 0.101$).

For the area of the parcel in secondary forest (Table 3-19) the BI model shows that larger farms, those with smaller initial areas in old growth forest, and households without daily wages had a greater area of secondary forests. The second model (with MC variables) shows that households who sold annual crops had more area in secondary forest. The one significant RI variable in the third model shows that those who lived on walking paths had less area in secondary forest.

Table 3-18. Models of area of old growth forest outcome regressed on background information, market and credit, road infrastructure, and household life cycle in Assis Brazil and Iñapari, 2003.

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	-1.136+				
Ln ha of farm size	0.241				
Ln initial ha old growth forest	0.918**				0.977**
Ln initial ha secondary forest	0.168*				0.167**
Regular monthly income (0=no, 1=yes)	-0.083				
Daily wage (0=no, 1=yes)	0.152				
Born in the MAP (area 0=no, 1=yes)	0.104				
Years of education	0.000				
Place	-0.136				
Market & credit					
Constant		2.644**			
Distance in km from nearest market		0.027			
Sells annual crops (0=no, 1=yes)		0.069**			0.240+
Sells perennial crops (0=no, 1=yes)		0.122			
Sells small animals (0=no, 1=yes)		-0.055			
Sells cattle (0=no, 1=yes)		-0.360			
Farm product commoditization (index)		0.011			
Times credit was received		0.135			
Place		0.170			
Road infrastructure					
Constant			2.891**		
Lives in main road (0=no, 1=yes)			0.339		
Lives in secondary road (0=no, 1=yes)			0.090		
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			-0.363		
Distance in km from main road			0.013		
Ln transportation time (index)			1.572*		0.707*
Place			0.017		
Household life cycle					
Constant				3.692**	
Ln years on farm				0.110	
Age of household head				-0.011	
Family members on lot				-0.023	
Ln family members working the farm				-0.179	
Number of children				0.030	
Ln number of adults				-0.058	
Labor hired index				0.104	
Labor exchanged index				0.187+	
Place				-0.083	
R2	0.695	0.197	0.116	0.101	0.724
F	19.333**	2.086*	1.525	0.836	47.110**

+ p < 0.1, * p < 0.05, ** p < 0.01, (a) All models use OLS estimation, and coefficients are unstandardized slopes.

Table 3-19. Models of area of secondary forest outcome regressed on background information, market and credit, road infrastructure, and household life cycle in Assis Brazil and Inapari, 2003.

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	0.453				
Ln ha of farm size	1.230**				1.012**
Ln initial ha old growth forest	-0.867**				-0.962**
Ln initial ha secondary forest	0.080				
Regular monthly income (0=no, 1=yes)	-0.072				
Daily wage (0=no, 1=yes)	-0.506+				
Born in the MAP (area 0=no, 1=yes)	0.058				
Years of education	0.019				
Place	-0.315				
Market & credit					
Constant		1.381*			
Distance in km from nearest market		-0.015			
Sells annual crops (0=no, 1=yes)		0.511+			0.669**
Sells perennial crops (0=no, 1=yes)		-0.518			
Sells small animals (0=no, 1=yes)		0.178			
Sells cattle (0=no, 1=yes)		-0.187			
Farm product commoditization (index)		0.002			
Times credit was received		0.265			
Place		0.104			
Road infrastructure					
Constant			1.850+		
Lives in main road (0=no, 1=yes)			-0.075		
Lives in secondary road (0=no, 1=yes)			0.111		
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			-0.956+		
Distance in km from main road			-0.058		
Ln transportation time (index)			1.033		
Place			-0.012		
Household life cycle					
Constant				0.249	
Ln years on farm				0.388*	0.367*
Age of household head				-0.007	
Family members on lot				0.017	
Ln family members working the farm				0.820**	
Number of children				-0.127	
Ln number of adults				-0.224	
Labor hired index				0.155	
Labor exchanged index				0.135	
Place				-0.171	
R2	0.218	0.119	0.100	0.233	0.309
F	2.365*	1.152	1.294	2.260*	8.042**

+ p < 0.1, * p < 0.05, ** p < 0.01, (a) All models use OLS estimation, and coefficients are unstandardized slopes.

The HLC model shows that those who had more years on the farm and more family members working in the farm had a greater area in secondary forest. According to the R^2 value, household life cycle variables ($R^2 = 0.233$) performed better, followed by background information variables ($R^2 = 0.218$), market and credit variables ($R^2 = 0.119$) and road infrastructure ($R^2 = 0.100$) variables.

The background information variables (from model 1) show more hectares of land deforested since arrival to the farm (Table 3-20) for those farms who had larger initial areas in old growth forest, while farms who had smaller initial areas of secondary forests had deforested a larger area. The MC model shows that those who received credit more times since arrival, and households who lived in Iñapari, had deforested a larger area. There were no significant RI variables. In the HLC model it is shown that older farms (years since establishment) had cleared more hectares of forest. The R^2 values for the models: background information, market & credit, and household life cycle (excluding road infrastructure which had no significant variables), were 0.523, 0.260, and 0.375, respectively.

For percentage of old growth forest cleared since arrival (Table 3-21) the BI model shows that those who had smaller farms, larger areas of initial area in old growth forest, and farms which had smaller initial areas of secondary forests, had higher percentages of cleared forest. Model 2 (MC variables) shows that those who sold cattle, who ranked lower in the farm product commoditization index, who received more credit, and farms in Iñapari had cleared a higher percentage of the initial old growth forest since arriving.

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Table 3-20. Models of area (ha) deforested outcome regressed on background information, market and credit, road infrastructure, and household life cycle in Assis Brazil and Iñapari, 2003.

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	-1.048				
Ln ha of farm size	0.388				
Ln initial ha old growth forest	0.528+				0.577**
Ln initial ha secondary forest	-0.432**				-0.390**
Regular monthly income (0=no, 1=yes)	-0.110				
Daily wage (0=no, 1=yes)	-0.321				
Born in the MAP (area 0=no, 1=yes)	0.047				
Years of education	0.022				
Place	0.054				
Market & credit					
Constant		2.185**			
Distance in km from nearest market		0.004			
Sells annual crops (0=no, 1=yes)		0.242			
Sells perennial crops (0=no, 1=yes)		-0.132			
Sells small animals (0=no, 1=yes)		0.354			
Sells cattle (0=no, 1=yes)		0.694			
Farm product commoditization (index)		0.030			
Times credit was received		0.796**			
Place		-0.700*			
Road infrastructure					
Constant			3.123*		
Lives in main road (0=no, 1=yes)			0.413		
Lives in secondary road (0=no, 1=yes)			0.520		
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			-0.765		
Distance in km from main road			-0.018		
Ln transportation time (index)			0.662		
Place			-0.621		
Household life cycle					
Constant				0.868	
Ln years on farm				0.971**	0.693**
Age of household head				-0.016	
Family members on lot				-0.018	
Ln family members working the farm				0.029	
Number of children				-0.018	
Ln number of adults				0.198	
Labor hired index				0.026	
Labor exchanged index				0.148	
Place				-0.465	
R2	0.523	0.260	0.125	0.376	0.667
F	9.329**	2.990**	1.672	4.492**	48.789**

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

Table 3-21. Models of percentage of initial forest deforested since arrival outcome regressed on background information, market and credit, road infrastructure, and household life cycle in Assis Brazil and Iñapari, 2003.

Variables	Model 1 BI	Model 2 MC	Model 3 RI	Model 4 HLC	Model 5 Comp.
Background information					
Constant	2.767*				
Ln ha of farm size	-0.813+				-1.144**
Ln initial ha old growth forest	0.915*				0.905**
Ln initial ha secondary forest	-0.405**				-0.413**
Regular monthly income (0=no, 1=yes)	-0.027				
Daily wage (0=no, 1=yes)	-0.340				
Born in the MAP (area 0=no, 1=yes)	0.076				
Years of education	0.013				
Place	0.047				
Market & credit					
Constant		3.137**			
Distance in km from nearest market		0.002			
Sells annual crops (0=no, 1=yes)		-0.051			
Sells perennial crops (0=no, 1=yes)		-0.064			
Sells small animals (0=no, 1=yes)		0.432			
Sells cattle (0=no, 1=yes)		1.247+			0.687**
Farm product commoditization (index)		-0.021*			
Times credit was received		0.579*			
Place		-0.977**			
Road infrastructure					
Constant			3.386**		
Lives in main road (0=no, 1=yes)			0.521		
Lives in secondary road (0=no, 1=yes)			0.527		
Lives in tertiary road (0=no, 1=yes)					
Lives in walking path (0=no, 1=yes)			-0.441		
Distance in km from main road			-0.015		
Ln transportation time (index)			0.521		
Place			-0.639		
Household life cycle					
Constant				1.630*	
Ln years on farm				0.852**	0.640**
Age of household head				-0.016	
Family members on lot				0.044	
Ln family members working the farm				0.049	
Number of children				-0.030	
Ln number of adults				0.168	
Labor hired index				-0.020	
Labor exchanged index				0.090	
Place				-0.596+	
R2	0.417	0.261	0.112	0.289	0.634
F	6.074**	2.995**	1.470	3.023**	24.619**

+ p < 0.1, * p < 0.05, ** p < 0.01, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

The second model (incorporating MC variables) shows that households who sold cattle, that ranked lower in the farm product commoditization index, who received credit a greater number of times, and those who lived in Iñapari had a higher percentage of old growth forest cleared since arrival. The RI model shows that the road infrastructure variables are not significant. The HLC model shows that households who had lived more years on their farms and who lived in Iñapari had a cleared a higher percentage of old growth forest since their arrival

Land Use and Land Cover Final Models

Tables 3-22 and 3-23 present the final models obtained for each land use and land cover outcome. The tables show all the independent variables that were found to be significant for land use and land cover outcomes for comparison purposes. It is evident that the are planted in annual or perennial crops is determined by market and road infrastructure variables. Household and background variables are not important for determining crops. Area under pasture and the number of heads of cattle on the other hand, were higher on farms that had been occupied for a longer time.

For land cover outcomes, background variables are more helpful in explaining deforestation and current areas under old growth and secondary forests. However, time of residence in the farm way also an important variable to explain area deforested since arrival, and percentage deforested. Market and credit variables do not seem to explain land cover outcomes. However there seem to be larger ares of old growth forest in farms with higher transportation times. Selling cattle is linked to higher percentages of deforestation

Table 3-22. Final models for land use outcomes showing all the independent variables that were significant in final multivariate land use and land cover models. Assis Brazil and Iñapari, 2003.

Variables	Land Use			
	annuals	perennials	pasture	cattle
Background information				
Ln ha of farm size			0.632**	
Ln initial ha old growth forest				
Ln initial ha secondary forest				
Years of education	0.042**	0.019**		
Market & credit				
Distance in km from nearest market				-0.048*
Sells annual crops (0=no, 1=yes)	0.335**	0.182**		
Sells cattle (0=no, 1=yes)	1.109**	0.597**		
Farm product commoditization (index)	-0.088**	-0.052**	0.115**	0.200**
Road infrastructure				
Lives in secondary road (0=no, 1=yes)				0.693**
Lives in walking path (0=no, 1=yes)	-0.463**	-0.261**		
Ln transportation time (index)	0.648*	0.448**		
Household life cycle				
Ln years on farm			0.538**	0.305*
Number of children				-0.236**
Labor hired index			0.136*	
Labor exchanged index	0.101*	0.044*		
Place				0.482+
R2	0.538	0.549	0.632	0.712
F	11.483**	11.983**	30.948**	28.800**
Constant	0.324+	0.306**	-2.896**	0.130

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

Table 3-23. Final models for land cover outcomes showing all the independent variables that were significant in final multivariate land use and land cover models. Assis Brazil and Iñapari, 2003.

Variables	Land Cover old growth forest	secondary forest	area deforest.	percentage deforest.
Background information				
Ln ha of farm size		1.012**		-1.144**
Ln initial ha old growth forest	0.977**	-0.962**	0.577**	0.905**
Ln initial ha secondary forest	0.167**		-0.390**	-0.413**
Years of education				
Market & credit				
Distance in km from nearest market				
Sells annual crops (0=no, 1=yes)	0.240+	0.669**		
Sells cattle (0=no, 1=yes)				0.687**
Farm product commoditization (index)				
Road infrastructure				
Lives in secondary road (0=no, 1=yes)				
Lives in walking path (0=no, 1=yes)				
Ln transportation time (index)	0.707*			
Household life cycle				
Ln years on farm		0.367*	0.693**	0.640**
Number of children				
Labor hired index				
Labor exchanged index				
Place				
R2	0.724	0.309	0.667	0.634
F	47.110**	8.042**	48.789**	24.619**
Constant	-0.968*	-0.011	-1.220*	2.382**

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, (a) All models use OLS estimation, and coefficients are unstandardized slopes, N=77

With respect to hypotheses H1: Access to markets, credit, and road infrastructure, drove more deforestation in Assis Brazil than in Iñapari.

In comparing Iñapari and Assis Brazil, we did find differences in land use outcomes, but not in land cover outcomes. These differences, however, are not a result of location per se but rather of the differences found in key variables that influence land use decisions. Important variables were found to be significantly different from one place to the other, especially road infrastructure variables, market variables and background information variables. This is evident when comparing correlations between the variable place and land use outcomes (Table 3-8 and 12), with the final multivariate models for land use and land cover outcomes (Tables 2-22 and 23). When all variables are considered, the differences between places are well explained by road infrastructure, market and background information variables, although place as a variable by itself does not show significant relations with land use nor land cover outcomes

Regarding market access, from the six market variables considered in this research, four were significantly different: households in Assis Brazil were on average closer to markets, more households in Assis Brazil sold small animals and cattle, and households in Assis Brazil were ranked higher in the farm product commoditization index. Multivariate models showed that market variables were important in determining land use outcomes, especially the area planted in annual and perennial crops. Market variables also were important in determining the heads of cattle owned, and the area in pasture, although these outcomes were also correlated. According to the market variables observed, the effects in land cover outcomes may vary. For example, if a household is selling annual crops it is likely to have a larger area in old growth and secondary forest, while selling cattle is related to having higher levels of deforestation.

Access to credit differed between the two study sites, with households in Iñapari having received significantly more credit than households in Assis Brazil. Since the late 1950s and through the early 1990s, households in Iñapari had access to credit. Households in Assis Brazil have had access to credit only more recently, since the late 1990s. However, other sources of off-farm income, such as retirement funds, were available for households in Assis Brazil. In the multivariate model that included market and credit variables, the number of times a household had received credit had a significant influence only on the ha in pasture and the percentage of forest cleared. However, in the final multivariate model it did not have a significant influence on any land use or land cover outcomes. This may be may be due to temporal scale issues, such as the different times credit resources become available in each town.

All six road infrastructure variables at the local level were significantly different. While in Assis Brazil there was a larger network of roads, and most households were located adjacent to one, in Iñapari more than half of the households were located on only walking paths. Like market variables, road variables were important in determining the area in annual and perennial crops. However, they were not relevant for determining the area in pasture or heads of cattle owned. Road infrastructure variables are significant in modeling the area in old growth forest, with longer transportation to market times being related with larger areas of old growth forest, but they are not relevant in any other land cover model. These variables were less influential than had been expected. This may be due to the small spatial scale over which the research was conducted. Spatially more extensive studies are likely necessary to capture the effect of increasing distance to the road, since in this study all households were located within 15km from the main road.

As for deforestation, the variables used as indicators for land cover were not significantly different between Assis Brazil and Iñapari at the household level. This poses interesting questions because the variables used as indicators for land use outcomes were significantly different. Land cover outcomes were more determined by background variables related to the size of the property, the initial area in old growth and secondary forest than by the variables considered as land use drivers in the present study: market, credit, road infrastructure.

The variables that were chosen as land use drivers were not good to model land cover outcomes as, while they may help in understanding who would be expected to have more area in annual crops, perennial crops, and pasture, they do not help to understand if an area in old growth forest or an area in secondary forest would be allocated to a certain land use activity.

With respect to H2: Land use drivers do not have a linear influence on households; instead, much depends on the phase they occupy in their life cycle.

This part of the analysis is more related to the integrated framework that was proposed in Chapter 2. Household life cycles in Iñapari and Assis Brazil did match the adaptive cycles proposed from panarchy theory. Households that had older heads of households, had a longer residence time on the farm, had less children and more adults, and, therefore, seemed to follow the household transformation frame. The matter is to characterize the adaptive cycle phases according to household demographic characteristics.

Considering the role of household demography as a mediator for the effect of land use drivers, from the correlation analysis it is apparent that older households had more heads of cattle and more pasture. Demographic variables were less important in modeling the area in annual and perennial crops. It is suggested that the general subsistence character of the farming activities would encourage the continuity in annual crops. On the other hand, perennial crops are discouraged by the number of cases of burned plantations and the frequent attacks of fungi; besides, the households that established perennial plantations were often supported by a national program, as high initial investments were usually required.

The most important demographic variable seems to be the time of residence in the farm. In the multivariable models this variable was determinant of the area in pasture and the number of heads of cattle. Furthermore, this was one of the few variables that was important for both land use and land cover outcomes. Households that had lived on their farms for longer periods appeared to have more area in secondary forests, more are deforested since arrival, and a higher percentage of forest cleared since arrival.

These results suggest that households slowly move from (exploitation) r to k (conservation) and major changes are produced once children reach adulthood (over 14 years old) allowing for the release and reorganization of household resources, after which a cattle ranching cycle is strengthened or started. However, other land use activities are also carried out.

Land use drivers considered in the present study were conceptualized as local level factors; however they were not always only local. Market was, in general, at the local level, but cattle had a more regional character since buyers often came from state capital

cities. Credit was a factor at the national level since in both places they were part of national policies whose objective was to give support to rural farmers. Road infrastructure had a mixed character; main road improvement and paving are part of national policies with broad support at the regional level. Secondary roads have only infrequently been created and maintained by regional or local governments.
Cross-scale interactions at the broader and slower levels seem to be more obvious; road infrastructure upgrading (national level) does improve market access (local and regional level), by diminishing transportation time. In the case of cattle it has an interesting effect since it provides buyers access to the farms. In terms of faster levels, household demography does influence the way in which the households in Assis Brazil and Iñapari allocate their resources. The pattern, as was mentioned before, is similar to the one presented by McCracken (2002), although older families in Assis Brazil and Iñapari do not tend to rely more on perennials but rather on pasture and cattle. When heads of households were asked what their future plans were, and what they would do if they could get credit for the next year, one-third responded, in both sites, that they would invest in cattle-related activities. Policy may also play a role in future decisions; the legal reserve law was brought up by many of the farmers that expressed having future plans of planting perennial crops and increasing the number of small animals.

It is clear that land use drivers do not have a linear influence on a household land use decisions; instead much depends on the phase they occupy in their life cycle. It is uncertain how future changes will alter the influence of the household life cycle on land use decision making. Assis Brazil and Iñapari may soon be in the center of an important international trading route, and although most farmers have expressed positive expectations, the Pacific Highway is already bringing new settlers to the urban areas of both towns.

Further research is required in order to be able to better delineate the household adaptive cycle. A second time survey and a bigger sample would allow for better results. Other indicators for household demography should also be tested

CHAPTER 4
CONCLUSIONS

This study compared current land use and land cover in Assis Brazil and Iñapari. However it actually compared the outcome of a historical process that has led to the current landscape. The area of study is also currently undergoing important changes. The first steps toward the building of the Interoceanic highway are underway.

Important differences were found between Assis Brazil and Iñapari that influence the land use and land cover outcomes in each place. For the present study they did so via the operation of widely used variables in explaining land use and land cover change. The most important were found to be road infrastructure and market variables. Variables that are not so widely used were also found to be important. like background information variables. The findings show that place does make a difference, but exactly how that is so remains an empirical question, that may have roots in local, national or global processes that comparative studies may help to identify.

In regard to the role of roads in defining land use and land cover outcomes, the study indicates that road infrastructure for Assis Brazil and Iñapari is relevant in affecting decisions about areas to be used for annual or perennial crops. However, the activity showing the most rapid expansion in the area is cattle ranching. Under current conditions road infrastructure by itself is not a relevant factor when taking decisions on cattle ranching expansion in the area, since market factors are stronger for this specific activity. If under current conditions cattle ranching is expanding, with the Interoceanic highway the process may accelerate.

Agriculture may also expand with the Interoceanic highway. The presence of one case of mechanized agriculture for rice production in Iñapari, and the use of a singular greenhouse system for vegetables production in Assis Brazil, suggest that technological improvements for agriculture may also expand.

Current land use practices, however, present an uncertain future for the area. While household life cycle stages do not seem to influence decisions on agriculture, older households tend to have more pasture and cattle. The hypothesized trend towards perennial crops for older households is not present in the study area. Limiting factors are two-fold. First, the widespread use of fire as part of farming practices, without adequate rules, has led to accidental burning of many of the perennial crops established in the area in the past. The second limiting factor is the lack of adequate technical assistance for perennial crop establishment and management, especially in regard to pests.

More land under annual crops, perennial crops and pasture does not necessarily translate into more deforestation at the household level. Deforestation in this case is better explained by the initial extent of old growth and secondary forests, since we do not know if an area in old growth forest or an area in secondary forest will be allocated to a certain land use activity.

While road infrastructure, market and background information variables explain differences in land use and land cover, these variables themselves are explained in great part by policies defined at different levels. This is more evident for the case of road infrastructure; in Assis Brazil roads were developed from a combination of, national, state and local policies, while in Iñapari road infrastructure was almost entirely a national level policy matter, and therefore the site did not have secondary roads. In providing systematic information about existing differences and similarities among the authorities and farmers in Assis Brazil and Iñapari, this research contributes to a cross-border development process that recognizes the distinct aspects of each side of the border.

The integrated framework proposed in this research remains to be further developed and critiqued. Its assessment in the present research is limited to cross-sectional data, and it really requires a multitemporal approach, ideally complemented by panel data and satellite image analysis. Despite the high quality and large amount of data required to test integrated theoretical approaches for modeling land use and land cover change, such efforts can contribute to research in the land use and land cover change field by differentiating local processes from broader ones.

APPENDIX A
QUESTIONNAIRE APPLIED IN IÑAPARI, PERU

Investigación de tesis de maestría
"Cambio en el uso y en la cobertura de la tierra"
Angelica Almeyda
Universidad de Florida
Centro de Estudios Latinoamericanos
Programa Desarrollo y Conservación en los Trópicos

Cuestionario confidencial para pobladores de Iñapari (Madre de Dios, Perú)
Julio del 2003

Número de cuestionario ________________________
Fecha de entrevista ________________________
Fecha de revisión ________________________
Coordenadas geográficas ____

A. Parámetros demográficos de la familia

A.i Jefe de familia:

1). ¿Cuantos años tiene? ___________________________ (edad)

2). ¿Desde cuando reside en Iñapari? ___________________________ (años)

3). ¿Cual es su lugar de nacimiento?

____ (distrito, departamento)

4). ¿Cual es su lugar de procedencia?

____ (distrito, departamento)

5). ¿A que se dedica actualmente?

____

6). ¿A que se ha dedicado antes?

____

7). ¿Cual es su grado de educación?

____(años, nivel)

A.ii Familia:

8). ¿Cuantas personas hay en su familia/casa? ______________________________

9). Edad, genero, actividad principal

N	Edad	Genero	Actividad principal	Actividad en el uso de la tierra
1				
2				
3				
4				
5				
6				
7				

B. Actividades económicas

10). ¿Cuales son sus fuentes de ingreso? (agricultura, ganado, recolección, caza, comercio, sueldos…)

____

11). ¿Posee o usted o usa propiedad en área urbana? Donde? Ha?

____

12). ¿Posee usted o propiedad en alguna área rural? Donde? Ha?

____

13). ¿Cuando fue la ultima vez que intercambio labor con otras familias? Como? Frecuencia?

____

14). ¿Cuando fue la ultima vez que contrato mano de obra? para realizar que labores? Frecuencia?

____

C. Cambio en el uso y en la cobertura de la tierra

C.i Régimen de tenencia de la tierra

15). ¿Cual es la condición de tenencia de la tierra q usted ocupa actualmente?

(1) Propietario (2) Arrendador (3) Encargado (4) Ocupante (5) Otro______

16). ¿Desde cuando está en estas tierras? _____________________ (año)

17). ¿Cual fue la situación de la propiedad cuando llegó?

(1) Propietario (2) Arrendador (3) Encargado (4) Ocupante (5) Otro______

18). ¿Cual es el área de la tierra? ____________________________(ha)

19). ¿Hubieron dueños anteriores o es usted el primero en vivir aquí?

____

D. Actividades relacionadas al uso de la tierra

20). ¿Cual es el área actual bajo producción de:

(1) Anuales____(ha)

(2) Perennes____(ha)

(3) Pasto______________________________¿cuantas cabezas ?_______(ha)

(4) Otro____(ha)

21). ¿Cual fue el área inicial bajo producción de:

(1) Anuales____(ha)

(2) Perennes____(ha)

(3) Pasto______________________________¿cuantas cabezas? _______(ha)

(4) Otro____(ha)

22). ¿Cual es el área actual de bosques

(1) Primarios____(ha)

(2) Secundarios____(ha)

23). ¿Cual fue el área inicial de bosques

(1) Primarios____(ha)

(2) Secundarios____(ha)

24). ¿Que emplea usted en sus actividades agropecuarias? Cuando?

(1) Fertilizantes ____

(2) Herbicidas____

(3) Vacunas____

(4) Maquinaria____

(5) Otros____

25). ¿Como clasificaría a sus suelos en relación a otros suelos de Iñapari?

(1) Fértiles (2) Regulares (3) Malos

26). ¿Realiza usted alguna practica de reforestación? ¿Cual? ¿Por que? ¿Desde cuando?

____

____

_

E. Crédito, carreteras y mercado

27). Actualmente tiene usted acceso a líneas de crédito?

____

28). Cuando llego a estas tierras tuvo usted acceso a líneas de crédito?

____

29). Si hizo uso antes de líneas de crédito, ¿como? ¿cuando? ¿en que lo empleo?

____

30). ¿Cual es la distancia actual a la carretera principal?

___________________________(km)

31). ¿Cual era la distancia inicial a la carretera principal?

___________________________(km)

32). ¿Cual es la distancia actual a las carreteras secundarias?________________(km)

33). ¿Cual era la distancia inicial a las carreteras secundarias?

___________________________ (km)

34). ¿Como calificaría las condiciones actuales de acceso al predio?

(1) Buenas (2) Regulares (3) Malas

35). ¿Como calificaría las condiciones iniciales de acceso al predio?

(1) Buenas (2) Regulares (3) Malas

36). ¿A quien vende actualmente sus productos?

(1) Anuales ____

(2) Perennes ____

(3) Ganado ____

(4) Forestales maderables ____

(5) Forestales no maderables _______________________________________

(6) Otros ____

37). ¿Cual era el mercado inicial para sus productos?

(1) Anuales ____

(2) Perennes ____

(3) Ganado ____

(4) Forestales maderables ______________________________

(5) Forestales no maderables ___________________________

(6) Otros ____

F. Planes a futuro

38). ¿Cuales son sus planes para el futuro? por que?

____

____

39). ¿Si en este momento accediera a una línea de crédito, en que la emplearía?

____

____

40). ¿Si estuviera mas cerca de la carretera, cambiaria sus actividades?

____

____

41). ¿Cual será el efecto de la carretera interoceanica en sus actividades?

____

____

42). ¿Que medidas se deberían tomar para mejorar la vida del poblador de Iñapari?

____

____

APPENDIX B
QUESTIONNAIRE APPLIED IN ASSIS BRAZIL, BRAZIL

Pesquisa de tese de mestrado
"Mudança no uso e na cobertura da terra"
Angelica Almeyda
Universidade da Florida
Centro de Estudos Latino-americanos
Programa de Desenvolvimento e Conservação nos Trópicos

Questionário confidencial para moradores do Município de Assis Brasil (Acre, Brasil)
Julio e Agosto de 2003

Número de questionário ______________________
Data da entrevista ______________________
Data da revisão ______________________
Coordenadas geográficas

____

B. Parâmetros demográficos da família

B.i Chefe da família:

1). Quantos anos tem? ______________________ (idade)

2). Desde quando reside em Assis Brasil? ________________________ (anos)

3). Onde você nasceu?

____ (município, estado)

4). Em que lugar você morou anteriormente?

____ (município, estado)

5). A que se dedica atualmente?

____

6). A que se dedicava antes?

____

7). Qual o seu grau de estudo?

____(anos, nível)

B.iiFamília:

8). Quantas pessoas tem na sua família/casa? ______________________________

9). Idade, gênero, atividade principal

N	Idade	Gênero	Atividade principal	Atividade no uso da terra
1				
2				
3				
4				
5				
6				
7				

C. Atividades econômicas

10). Quais são suas fontes de renda? (agricultura, gado, coleta, caça, comércio, salários…)

____

11). Possui ou usa propriedade em área urbana? Onde? Ha?

____

12). Possui propriedade em alguma área rural? Onde? Ha?

____

13). Quando foi a última vez que fez adjunto com outras famílias? Como? Freqüência?

____

14). Quando foi a última vez que contratou mão-de-obra? para que? Freqüência?

____

D. Mudança no uso e na cobertura da terra

D.i Tipe da terra

15). Qual é o tipo de condição de posse da terra que você ocupa atualmente?

(1) Proprietário (2) Arrendado (3) Encarregado (4) Ocupante (5) Outro____

16). Desde quando trabalha nestas terras? _____________________ (ano)

17). Qual era a situação de posse da propriedade quando chegou?

(1) Proprietário (2) Arrendado (3) Encarregado (4) Ocupante (5) Outro____

18). Qual é a área da terra? ____________________________(ha)

19). Haviam donos antes de você?

____

E. Atividades de uso da terra

20). Qual é a área atual de produção:

(1) Anuais____(ha)

(2) Perenes____(ha)

(3) Pasto_______________________________quantas cabeças?_______(ha)

(4) Outro____(ha)

21). Qual foi a área inicial de produção:

(1) Anuais____(ha)

(2) Perenes____(ha)

(3) Pasto_______________________________quantas cabeças? _______(ha)

(4) Outro____(ha)

22). Qual é a área atual de bosques

(1) Mata bruta, virgem ____(ha)

(2) Capueira____(ha)

23). Qual foi a área inicial de bosques

(1) Mata bruta, virgem____(ha)

(2) Capueira____(ha)

24). Que usa em suas atividades agropecuárias? Quando?

(1) Fertilizantes____

(2) Herbicidas____

(3) Vacinas____

(4) Maquinaria____

(5) Outros____

25). Como classificaria os seus solos?

(1) Férteis (2) Regulares (3) Maus

26). Você realiza alguma prática de reflorestamento? Qual? Por que? Desde quando?

____

____

F. Crédito, estradas e mercado

38). Atualmente você tem acesso a linhas de crédito?

____

39). Quando chegou a estas terras teve acesso a linhas de crédito?

____

40). Você usou linhas de crédito antes, como? quando? Em que o empregou?

____

41). Qual é a distância atual até a estrada principal?

_________________________(km)

42). Qual era a distância inicial até a estrada principal?

_________________________(km)

43). Qual é a distância atual até o ramal mais próximo?

_________________________(km)

44). Qual era a distância inicial até o ramal mais próximo?

_________________________(km)

45). Como qualificaria as condições atuais de acesso à moradia?

(1) Boas (todo o ano) (2) Regulares (no verão) (3) Ruins (difícil acesso)

46). Como qualificaria as condições iniciais de acesso à moradia?

(1) Boas (todo o ano) (2) Regulares (no verão) (3) Ruins (difícil acesso)

47). Para quem vende seus produtos atualmente?

(1) Anuais ____

(2) Perenes ____

(3) Gado ____

(4) Florestais madeirabeis_____________________________________

(5) Florestais não madeirabeis _________________________________

(6) Outros ____

48). Para quem vendeu seus produtos no inicio?

(1) Anuais ______________________________

(2) Perenes ______________________________

(3) Gado ______________________________

(4) Florestais maderabeis ______________________________

(5) Florestais não madeirabeis ______________________________

(6) Outros ______________________________

G. Planos para o futuro

41). Quais são seus planos para o futuro? por que?

____

____

42). Si neste momento tivesse uma linha de crédito, em que usaria?

____

____

43). Si estivesse mais perto da estrada, mudaria suas atividades?

____

____

41). Que efeito esta causando a estrada interoceânica em suas atividades? Que efeito poderá causar a continuidade da estrada e a ponte que nos ligará ao Pacífico?

____

____

42). Que medidas seriam necessárias para melhorar a vida do morador de Assis Brasil?

____

____

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BIOGRAPHICAL SKETCH

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