Land Use Strategies and Their Causal Forces in Rondônia, Brazil, With Special Reference to the Rondônia Natural Resources Management Project (PLANAFLORO)

By

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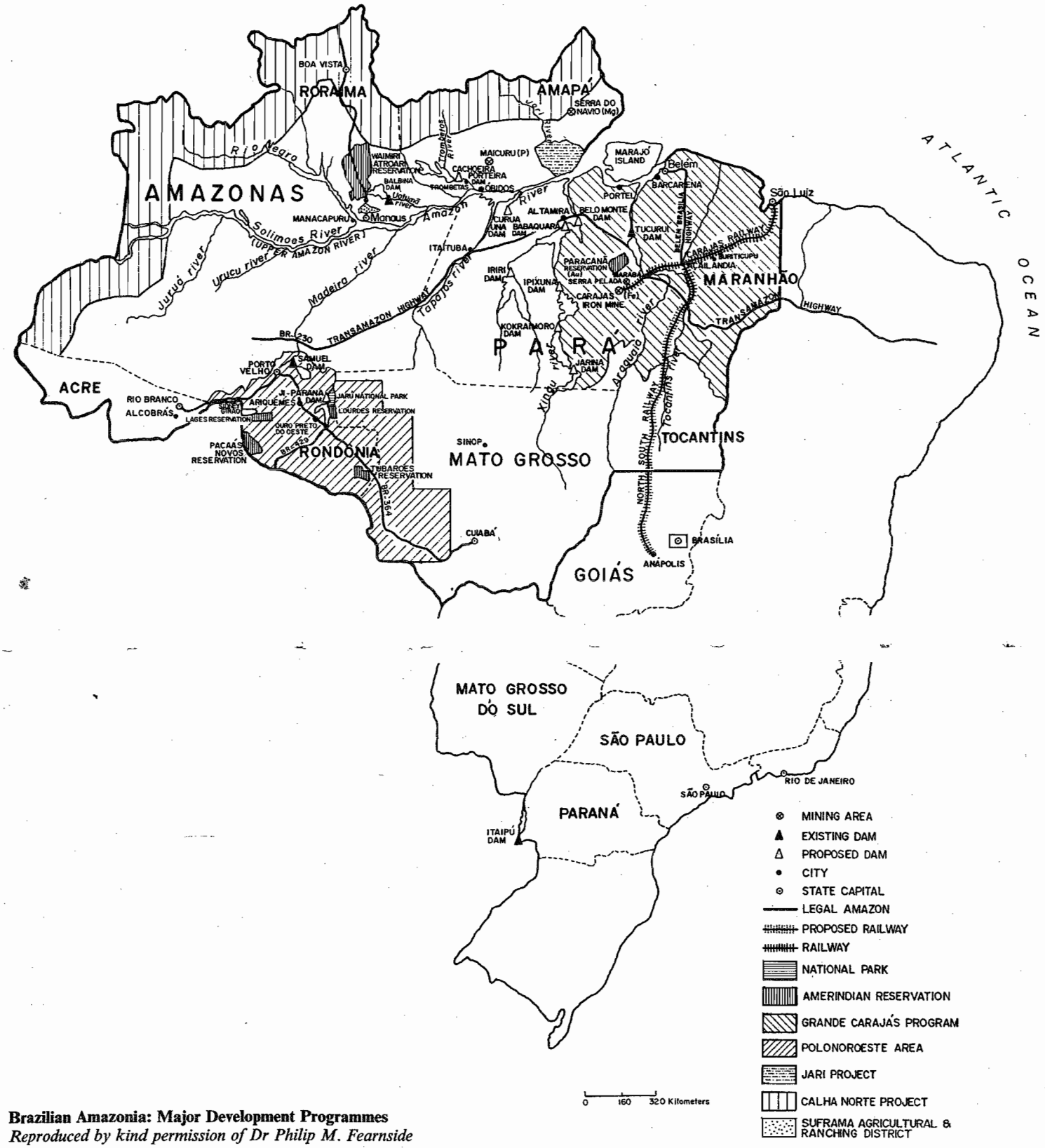

Brazilian Amazonia: Major Development Programmes
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(Goodman and Hall 1990, xx)

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Abstract

This paper explores the factors contributing to the expansion of small-scale farming, ranching, logging, mining, and subsistence extraction as land use choices in Rondônia, Brazil. As a framework, these factors are grouped into the broad descriptive categories of environmental, social, political, and economic. Through a greater understanding of forces determining the predominance of small-scale farming, ranching, logging, mining, and subsistence extraction as types of land use in Rondônia, the conditions necessary for minimizing environmental degradation are illuminated.

Understanding the factors shaping land use choice in Rondônia is particularly useful in the design and analysis of conservation programs such as PLANAFLORO, which strives to better ecological and social conditions in the state. PLANAFLORO, also known as the Rondônia Natural Resource Management Project, was begun by the Brazilian government in partnership with the World Bank in 1992 and implements a program of agro-ecological zoning that aims to slow deforestation and conserve resources through prescriptive land use planning. This agro-ecological zoning program categorizes land into one of six zones, based on the type of activities best suited to its current environmental characteristics.

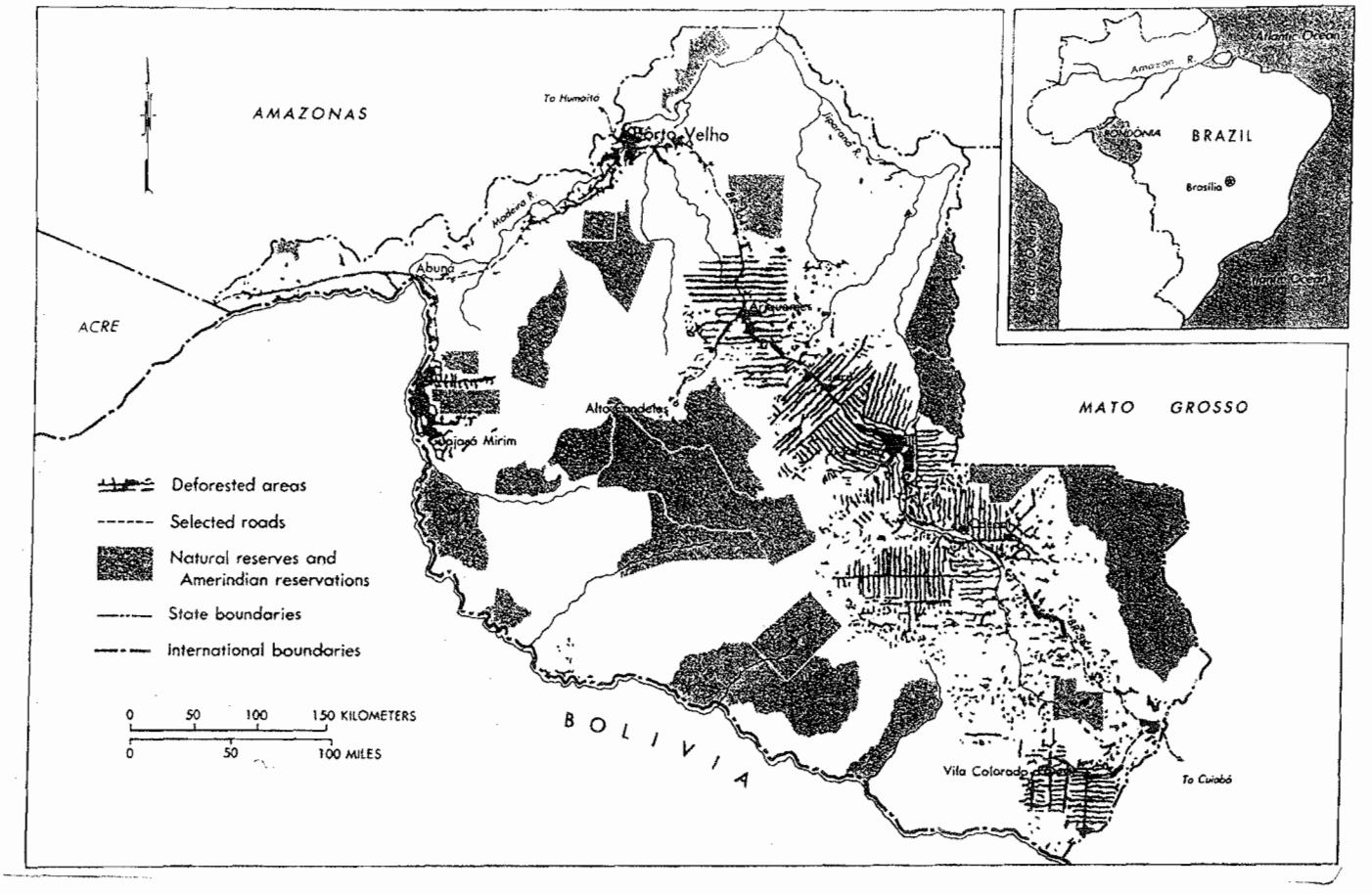
In order for the agro-ecological zoning program of PLANAFLORO to achieve its goals, certain measures need to be taken to address specific problems rooted in environmental, social, political, and economic conditions which significantly influence land use choice in Rondônia. Thus, a complete assessment of these causal forces is necessary.

Chapter One: Introduction

The Brazilian Amazon spans just over five million square kilometers, constituting 58 percent of Brazil's total land area and stretching over seven states and territories. Despite its expansive area, the region is home to only 10 percent of Brazil's population. The tropical rain forests of the Amazon remain as some of the most biologically diverse on the planet, containing 30,000 known plant species, as compared to the estimated 10,000 species found in temperate Latin America (Mahar 1989, 1). The expansion of human activities in the region from the mid 1960s to the late 1980s grew rapidly, and to facilitate this transformation large sections of the forest were cleared. By 1988, 12 percent of the Brazilian Amazon had been deforested, escalating from just 0.6 percent in 1975 (Mahar 1989, 9). A particularly devastating case within this story has been that of the western state of Rondônia. Rondônia, a state constituting roughly 243, 000 square kilometers of tropical forest (Browder 1994, 47), has witnessed significant deforestation and land degradation due to massive migration and poor development policy in the past three decades.

Today, the forest landscape of Rondônia is severely fragmented, with upwards of 25 percent of original forest cover destroyed (Pedlowski et al 1997, 149), primarily occurring in areas surrounding the major highway BR-364. The state's population numbers at approximately 1.3 million, with the majority of colonists working as small-scale farmers (Pedlowski et al 1997, 152). In addition to small-scale farming, other land use activities predominant in Rondônia include ranching, logging, mining, and subsistence extraction.

Deforestation in Rondônia, 1983



(Mahar 1989, 32)

On average, small-scale farmers in Rondônia possess land holdings of 50 to 200 hectares in size, and practice a system of slash and burn agriculture (Martine 1990, 33). This involves clearing small, irregularly shaped patches of forest for a mix of annual and perennial crops every two or three years. In addition, secondary growth is often also cleared at this rate for the purpose of pasture (Pedlowski et al. 1997, 152). Major annual crops grown by small-scale farmers in Rondônia include maize, upland rice, and kidney beans. These annual crops are extremely important to small farm survival, but due to their considerable labor requirements, place constraints on the farm household. Major

perennial crops to small farms in Rondônia include cacao, coffee, and rubber. These crops are also labor intensive, and furthermore demand significant capital. Thus, perennial cropping systems often place financial constraints on small farms in Rondônia due to their need for agricultural credit and/or additional (non-household) labor (Millikan 1992, 5). Because of these and other financial and labor limitations, small farmers in Rondônia rely on cattle raising as a less precarious agricultural endeavor, despite its potential for soil degradation and need for large tracts of land.

In addition to its role on small farms, cattle ranching in Rondônia also occurs on a commercial scale, and is one of the state's major types of land use. Unlike in other parts of the Brazilian Amazon, cattle ranching in Rondônia is often the result of small-farm failure and land aggregation. When small farmers are forced to sell their land due to debt, farms that were used for cattle pasture will often be purchased by larger ranchers. These large ranchers will clear the land completely in order to be able to feed their herds throughout the year. An analysis of 1996 LANDSAT images of Rondônia determined that an average of 80 to 90 percent of all large land holdings (250 hectares or more) are cleared for pasture (Pedlowski et al. 1997, 153). Due to its extensive nature and large land holdings, cattle-ranching is responsible for more deforestation in Rondônia than any other type of land use (Pedlowski et al. 1997, 153).

Logging in Rondônia began in the early 1970s, with the arrival of the first wave of colonists to the state. Also at that time, mahogany was discovered in the territory, and the newly constructed BR-364 facilitated the transport of timber to Brazil's wood-processing plants in the south (Browder and Godfrey 1997, 169). Despite severely depleted forests, logging continues in Rondônia today. Sawmills and furniture building

are major industries in Rondônia, accounting for 34.5 percent of state industries in 1994 (Pedlowski et al. 1997, 155). Due to environmental restrictions, most logging in Rondônia is illegal, and thus largely unregulated.

Mining came to Rondônia in the 1950s, with the discovery of tin casserite deposits. Today, however, the vast majority of mining in Rondônia is undertaken in search of gold. Gold mining occurs on both individual and group scales, and is the most common form of livelihood for failed colonist farmers. The most popular site for gold mining in Rondônia is the Madeira River, which extends along the northernmost section of the state. A combination of simple manual tools, boats and divers, as well as drills, are used to extract gold from the riverbed. Most significantly, miners use large amounts of mercury during the amalgamation process to prevent the washing away of gold particles (Pedlowski et al. 1997, 154). It is estimated that through the 1980s, approximately 100 tons of mercury were released into the atmospheric and aquatic environments along the Madeira River (Boishio and Cernichiari 1998, 79). This use of mercury has resulted in significant ecological degradation and human health endangerment.

A more recent type of land use in Rondônia is subsistence extraction, which occurs in the twenty-two extractive reserves established since 1990. These extractive reserves total 988, 000 hectares of state territory and are administered by a combination of federal, state, and local authority (Brown and Rosendo 2000, 38). Non-wood forest products available for extraction include rubber, brazil nuts, and heart of palm. Despite the potential for livelihood supplement, colonists in Rondônia rarely practice subsistence extraction. For traditional forest dwelling peoples, however, subsistence extraction remains a very significant portion of household income.

This paper will explore the factors contributing to the expansion of small-scale farming, ranching, logging, mining, and subsistence extraction as land use choices in Rondônia, Brazil. As a framework, these factors will be grouped into the broad descriptive categories of environmental, social, political, and economic.

Environmental factors shaping land use choice in Rondônia include a variety of physical characteristics such as soils, climate, and natural resources; as well as more dynamic conditions like crop pathogens and forest cover. Environmental factors such as these determine crop choice, resource extraction, and the need for landscape protection.

Social conditions such as labor availability and cultural traditions are also key to land use choice in Rondônia. The availability of labor determines the feasibility of small farmers to plant labor-intensive perennial crops, and can be threatened by such factors as disease or household size. The cultural tradition of rubber tapping among many forest dwelling people greatly influenced the establishment of extractive reserves in Rondônia, and drives the persistence of this type of land use.

Politically, development policy and global concerns shape the state's landscape. Development policy has played a significant role in drawing colonists to Rondônia, and has also encouraged the persistence of perennial cash crops, the establishment of extractive reserves, and the prevalence of forest clearing for pasture. Global environmental concerns fostered the establishment of extractive reserves, as well as the promotion of more sustainable tree crops.

Finally, both local and world markets serve as significant economic influences on land use choice in Rondônia. Local markets determine the availability of crop inputs such as fertilizers and pesticides, as well as influence the prevalence of cattle ranching

due to local beef and dairy demand. World markets influence the types of crops grown, as well as provide competition for Brazilian products, which leads to domestic subsidies, as in the case of rubber.

By examining the influences on land use choice from environmental, social, political, and economic perspectives, a more complete and balanced assessment will be achieved. Furthermore, through a greater understanding of forces determining the predominance of small-scale farming, ranching, logging, mining, and subsistence extraction as types of land use in Rondônia, the conditions necessary for minimizing environmental degradation are illuminated.

Understanding the factors shaping land use choice in Rondônia is particularly useful in the design and analysis of conservation programs such as PLANAFLORO, which strives to better ecological and social conditions in the state. PLANAFLORO, also known as the Rondônia Natural Resource Management Project, was begun by the Brazilian government in partnership with the World Bank in 1992 and implements a program of agro-ecological zoning that aims to slow deforestation and conserve resources through prescriptive land use planning. This agro-ecological zoning program categorizes land into one of six zones, based on the type of activities best suited to its current environmental characteristics (Mahar and Ducrot 1998, 4).

Areas which were severely deforested, primarily in the region surrounding the main highway BR-364, were categorized into Zone 1 for large-scale agriculture, livestock, and agroforestry. Zone 2, also located in areas of forest fragmentation, was allocated to small-scale farmers with mixed cropping systems (Mahar and Ducrot 1998, 6). To improve the living conditions of colonists living in Zones 1 and 2, program funds

activities for deforested areas, while it is important that health and financial support is increased for the human population living in these zones in order to lessen the chance of farm failure. Amerindian reserves and their buffer zones have suffered repeated illegal logging, and thus it is important to provided extra protection for these areas. The prevalence of gold extraction along the Madeira River has left its environs severely degraded, and thus due to health concerns, fishing and other livelihood strategies would not be advisable.

Understanding these relationships between humans and the environment is crucial to the creation and implementation of an effective agro-ecological zoning program for PLANAFLORO. In a 1992 study of the social causes of deforestation and land degradation in Rondônia, geographer Brent Millikan noted that, "Well intentioned attempts at agro-ecological zoning must seriously evaluate the forces underlying current processes of indiscriminate land use and occupation on the frontier" (Millikan 1992, 9). Thus, it is necessary to examine the complex linkages between environmental, social, political, and economic conditions and land use choice in Rondônia.

Chapter Two: History of Settlement and Development in Rondônia

Previous to the mid-twentieth century, Rondônia, along with much of the Brazilian Amazon, remained largely isolated from the rest of the country, peopled primarily by indigenous Amerindian groups, as well as a small number of forest dwelling settlers of mixed Amerindian, european, and African ancestry known as *caboclos.* Colonists began trickling into Rondônia in the mid nineteenth century, in the first of what would be three major waves of migration, all in response to the area's natural wealth (Browder and Godfrey 1997, 55). These three waves of migration were centered on rubber, tin, and agricultural development booms.

Beginning in the mid-nineteenth century, rubber prices skyrocketed in response to growing demand on the part of the newly industrialized United States and Western Europe, motivating thousands of Brazilians to venture into the Amazon and seek their fortune as rubber tappers. By 1912, it is estimated that 103, 000 workers had migrated to Rondônia as part of the rubber boom (Browder 1994, 48). This boom continued up until the emergence of competition from the forests of Southeast Asia in the early twentieth century (Brown and Rosendo 2000, 36). With world markets flooded, rubber prices plummeted from three dollars a pound in 1910 to 63 cents a pound in 1914 (Mahar 1989, 11). For Brazil, the rubber boom was over, and by 1950, there remained only 37,000 people in Rondônia (Martine 1990, 25).

In 1943, Rondônia was designated a federal territory, and this new status was followed by land speculation and the emergence of new urban centers (Browder 1994, 48). Pushing this second wave of migration was the discovery of tin casserite in northern Rondônia in 1952, creating jobs in not only resource extraction but later in mechanized

tin production as well. At the height of this tin boom in the late 1950s, mining accounted for 45, 000 workers in Rondônia (Martine 1990, 25).

Finally, the third and most significant wave of migration into Rondônia occurred in the mid 1970s, with the construction of a major highway running through the state (BR-364) and the launching of several large agricultural colonization projects (Brown and Rosendo 2000, 37). This final wave of migration and the actions leading up to it will be examined in greater detail.

In 1964 the Brazilian Military seized power of the Brazilian government, beginning what would be two decades of an authoritarian military regime. Two years later, in December of 1966, President General Castello Branco announced the launching of Operation Amazonia; a government agenda comprised of a series of legislation aimed at the development and occupation of the Amazon region. These various legislative acts and decrees allowed for extensive road and highway building, fiscal incentives to attract investment, as well as the creation of two federal agencies to facilitate the development process: the Superintendency for the Development of Amazonia (SUDAM), and the Bank of Amazonia (BASA). The motives underlying these plans were for the most part geopolitical, striving to establish sovereignty in the region at a time when Peru and Venezuela were developing their own Amazonian regions (Mahar 1989, 11). In addition to these geopolitical motives, the newly empowered Brazilian government viewed the Amazon as a bastion of natural wealth, and this development as a pathway to economic prosperity for all of Brazil.

One of the most prominent components of the Brazilian government's plan for development of the Amazon were the ambitious road and highways to be built, which

would not only carry products out of the forest, but just as significantly lead migrants into the region. These plans began in 1964 with the construction of the Belém-Brasília Highway, a nineteen hundred kilometer highway connecting the new capital of Brasília with the city of Belém at the mouth of the Amazon River. It has been estimated that from 1960 to 1970, the population of the areas within reach of this road increased from just one hundred thousand to two million (Mahar 1989, 12). Nearly a decade later, Rondônia would experience a similar population explosion with the construction of the Cuíaba-Pôrto Velho Highway.

The Cuíaba-Pôrto Velho Highway (BR-364), begun in 1968, opened up the previously remote state of Rondônia to thousands of prospectors in search of the state's natural wealth in rubber, tin, and gold. In addition, significant numbers of small scale farming families arrived from the south, many had become unemployed as a result of mechanized agriculture, land redistribution, and killing frosts (Mahar 1989, 29). The 1970 road building project sponsored by the newly created National Integration Program (PIN) and its companion agency the Land Redistribution Program (PROTERRA) mandated the construction of over fifteen hundred kilometers of roads connecting Amazonia with the northeast as well as the south and southeast. These construction plans allowed for the reservation of 20 kilometer strips on either side of the roads for federally sponsored settlement projects, and coincided with the unveiling of a PIN financed irrigation project in the northeast (Mahar 1989, 25).

The fiscal incentives key to the General's plan for luring investors into the Amazon included a twelve year tax exemption (which was later extended to seventeen), 75 percent of project costs being financed by the federal government, as well as special

credit lines available from BASA, the federal bank specifically created to finance Amazonian development (Hecht and Cockburn 1990, 120). SUDAM, the federal agency responsible for assigning priority to pending projects allocated over 44 percent of its tax credit funds to livestock projects alone. These livestock projects were typically large ranches, averaging 24, 000 hectares. Despite their large size, these ranches did not serve as significant employers, needing only one worker per two hundred and fifty to three hundred hectares, in exception to the initial clearing period. The prevalence of livestock development resulted in a significant landscape transformation from forest to pasture, destroying the livelihoods of traditional extractors. Many former Brazil nut gatherers migrated to nearby towns and cities, relying on temporary employment from the cattle ranches (Mahar 1989, 16).

In Rondônia, livestock development occurred through different means. The initial development strategy undertaken by the Brazilian government in Rondônia was focused on providing land to the small farmers in the Northeast and South that were left jobless due to the mechanization of agriculture. A major influence on the selection of Rondônia for agricultural settlement was a preliminary land survey that indicated that over a third of the state's land was suited to crop cultivation (Browder 1994, 49). Later surveys reveal the percentage to be lower than 10 percent, an estimate that reflected the lack of success of many farmers. Livestock development in Rondônia often occurred as a result of land aggregation following farm failure.

Despite recruitment on the part of the federal government, significant numbers of colonists did not begin arriving into much of the Amazon including Rondônia until the 1980s. An offshoot of PIN, the National Institute for Colonization and Agrarian Reform

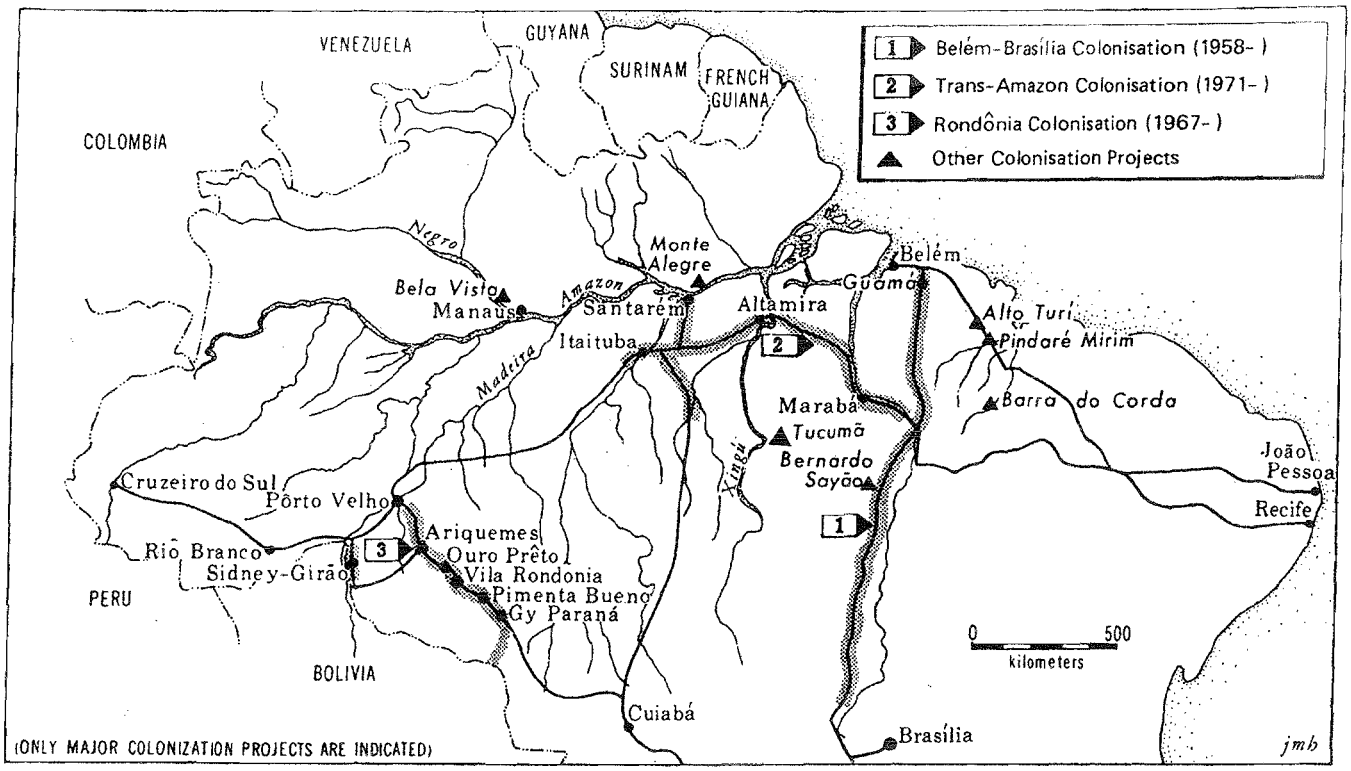
(INCRA), was created in 1970 to specifically award property titles and mediate any land disputes. INCRA actively sought to colonize the Brazilian Trans-Amazon, with the goal of settling seventy thousand families between 1972 and 1974. The area known as the Trans-Amazon followed the newly constructed Trans-Amazonian Highway, which stretched from the eastern state of Maranhão into western Amazonia, terminating at Labrea, just north of Pôrto Velho. Strategies for attracting settlers included transportation to the region, titles to 240 acre plots, credit for crop plantings, as well as household and food subsidies to help buffer any initial setbacks. In addition to these appropriations, promises of the construction of schools, hospitals and housing were included in the propaganda. Yet despite all of these assurances, only eight thousand families had been settled as of 1979 (Hecht and Cockburn 1990, 124).

Central to the blame for the lack of colonists to the Trans-Amazon was poor planning on the part of PIN. The topography of the area was hilly; with only about 3 percent of all soils considered naturally fertile, resulting in both soil erosion and the need to burn the forest for nutrients. This type of landscape modification fostered a habitat for the *Anopheles* mosquito, the area's principle carrier of malaria. Through the early 1970s, malaria infection among colonists to the Trans-Amazon was approximately 20 percent (Mahar 1989, 27). Thus settlers to the Trans-Amazon area were challenged by not only poor soil quality but also a debilitating disease that shared its period of transmission with that of the planting and harvesting seasons.

In addition to these challenges, colonists were encouraged by government planners to cultivate upland rice varieties, which are typically determined to be unsustainable in tropical forests except when they are produced under the very best of

conditions. Also, any modern inputs such as fertilizers or pesticides which may have proven helpful in sustaining a rice crop were rendered nearly unattainable by their inflated prices due to the large cost of transport to the Amazon (Mahar 1989, 27).

Major Colonization Projects and Roads in the Brazilian Amazon



In Rondônia the colonization endeavor embarked upon by INCRA a few years later was instantly successful, between 1970 and 1975, the Brazilian National Institute for Colonization and Reform (INCRA), established seven colonization projects totaling over 2.7 million hectares in the state of Rondônia. Rather than actively recruiting colonists, INCRA provided the lots and the infrastructure, and from there relied on spontaneous migration (Mahar 1989, 29). These differences made for a success unlike the Trand-Amazonian project. Also central to the success of this project was the construction of the

Cuíaba-Pôrto Velho Highway in 1968, which opened up the previously remote region to thousands of peasant farmer migrants as well as prospectors in search of the state's natural wealth in rubber, tin, and gold (Mahar 1989, 29).

A key stimulant to migration to Rondônia was the decline of employment opportunities in the south in large part due to the shift to a mechanized system of soybean production. Other factors included land redistribution and coffee crop-killing frosts in the south (Hecht and Cockburn 1990, 107). By 1977, 58,000 families had migrated to Rondônia, the vast majority coming from agricultural backgrounds and with little capital (Pedlowski et al. 1997, 151). Yet as this demand for land continued to climb, INCRA could no longer ensure supply. Thus many colonists ended up sharecropping on the fields of established colonists, or squatting on the fringes of settlement projects, Indian reservations, and forest reserves. The rapid growth in population and infrastructure experienced by Rondônia during the 1970s and 1980s had resulted in significant deforestation, eventually clearing nearly 25 percent of the state's forest (Pedlowski et al, 149).

In response to Rondônia's land crisis, the Brazilian government established the Northwest Brazil Integrated Development Program (POLONOROESTE) in 1981. The goal of POLONOROESTE was to reduce forest clearing on lands that had potential for long-term agricultural production, and promote sustainable agriculture through tree crops. The program also strove to incorporate land use planning, concentrated access, and agricultural research into the government's long-term vision for Rondônia. Despite these goals, over half of the program's initial budget of US$1.1 billion was allocated to improving and paving the BR-364. Of the balance, $520 million went to agricultural

development and settlement projects, and $36 million to environmental conservation and protection of Amerindian reserves (Browder 1994, 50). Consequently, these efforts did not slow deforestation, largely due to continued migration, exemplified by the 160,000 migrants entering the state annually from 1984 to 1986. The population of Rondônia has grown annually at a rate of 14 percent, and had a reported population of 1.2 million in 1987 (Mahar 1989, 35).

Another contributing factor to the deforestation of Rondônia has been the colonist's widespread violation of the 50 percent rule. The 50 percent rule, mandated by the federal Institute of Forestry Development (IBDF), states that no more than 50 percent of a farmer's land may be cleared. The IBDF has had little success in enforcing this rule, and farmers in Rondônia have been recorded to have cleared as much as 90 percent of their holdings (Mahar 1989, 36).

By the late 1980s the Brazilian Amazon was in a state of crisis. A rocky transition to democracy was underway in the midst of impossible levels of inflation. International pressure against deforestation was mounting as a response to both the biodiversity crisis as well as the "greenhouse effect", for which the clearing of the Amazon was being largely blamed. In late 1988 the assassination of rubber tapper leader Chico Mendes gained international attention, further pressuring the Brazilian government to act in order to save not only its public appearance, but also perhaps more importantly funding from various international lending institutions, including the World Bank (Keck 1995, 417; Diegues 1998, 61). Thus, in 1989 the Brazilian government responded to worldwide criticism by establishing the Our Nature program. The nationalistic tone of the program's name reflected its goal of combating the internationalization of the region,

and consisted principally of broad-based ideals of environmental conservation and the creation of national parks (Diegues 1998, 61). Yet, as anthropologist Stephen Schwartzman notes, the Western model for conservation (primarily parks and other protected areas) does not work in the Brazilian Amazon due to the economic nature of its state. There exists no large middle class population willing to support such a leisure activity nor a history of landscape protection in the country as a whole (Schwartzman 1989, 151). Fortunately, at this time the social movements of traditional forest dwellers had gained so much support that a new type of resource management institutions was proposed and eventually accepted: extractive reserves (Diegues 1998, 68).

The Ministry of Agrarian Reform and Development (MIRAD) has defined extractive reserves to be "forest areas inhabited by extractive populations granted long-term usufruct rights to forest resources which they collectively manage" (Schwartzman 1989, 151). By 1994, nine federal extractive reserves had been established, covering two million hectares with over twenty-eight thousand inhabitants. Federal extractive reserves are administered by the National Environmental Agency (IBAMA) (Brown and Rosendo 2000, 37). The primary extracting activities that are carried out in the reserves are rubber tapping, brazil nut and cashew gathering, and fishing (Diegues 1998, 68). From the colonial period onwards, extractive-based economies of the Amazon have been criticized as primitive and socially backwards, and discouraged by the central Brazilian government in favor of timber extraction (Allegretti 1995, 159). Just as the livelihood of extraction was perceived as backwards, the people of the Amazon who identified themselves as traditional extractors suffered the disfavor of the Brazilian government. In 1990 this attitude took a dramatic turn with the federal establishment of extractive reserves, which

occurred primarily as a result of a five-year struggle on the part of the National Council of Rubber Tappers (CSN).

The rubber tappers of the Brazilian Amazon are concentrated in the state of Acre, having arrived there nearly a century ago at the height of the rubber boom. During the mid 1970s, the rubber tappers began to organize as land redistribution and subsequent development began to threaten their livelihood. From the beginning, the rubber tappers relied on larger organizations with regional, national, and international alliances for support. Early on the rubber tappers found support with the Catholic Church, Workers Party, and the National Confederation of Agricultural Workers; and later, from the National Wildlife Federation, the Natural Resources Defense Council, and the Environmental Defense Fund (Keck 1995, 415). In 1985 the rubber tappers formed their own national organization, the CSN, with the goal of establishing government supported extractive reserves. It was not until the rubber tappers were able to link their movement to that of environmental protection advocates that their goal became plausible (Brown and Rosendo 2000, 36). Previously, the rubber tapper's plight was perceived solely as a pursuit of social justice, once the international community was able to connect the struggle of the CSN with the larger crisis of the destruction of the Amazon, the Brazilian government was forced to seriously consider extractive reserves.

The emergence and success of extractive reserves signifies an important shift for development, both from a social and environmental perspective. Socially, the establishment of extractive reserves marks an important moment for traditional forest dwellers; their persistence to preserve their livelihood, combined with their own local knowledge, has gained not only the attention of the international community but also its

respect. Environmentally, extractive reserves represent a willingness on the part of the Brazilian government to allow a more sustainable and less industrial development for the Amazon.

Along with the establishment of extractive reserves, an additional form of government – mandated conservation was implemented in Rondônia beginning in 1992: PLANAFLORO. PLANAFLORO, or the Rondônia Natural Resources Management Project, is a conservation project created by the Brazilian government in partnership with the World Bank with the purpose of reducing deforestation through the implementation of an agro-ecological zoning plan. In part, PLANAFLORO was designed to address some the shortcomings of its predecessor, POLONOROESTE. PLANAFLORO's goals are stated specifically to be policy change among state agencies, protection of Amerindian reserve boundaries, develop integrative farming and forestry methods, invest in socioeconomic improvements, and better the infrastructure of state institutions (Pedlowski et al. 1997, 56). In addition, PLANAFLORO includes measures to create extractive reserves and other protected areas within the state. Despite its goals, PLANAFLORO has achieved little success, plagued by inter-institutional strife and loose enforcement, and is currently under review by the World Bank (Keck 1998). PLANAFLORO and its implications for land use will be discussed in further detail in Chapter Three.

Chapter Three: Predominant Land Use Strategies and Their Causal Forces

Introduction to Present Conditions

Land Use

Land use in Rondônia can be characterized by three predominant types: small-scale farming, commercial resource extraction, and extractive reserves. As a result of the development agenda of the Brazilian government, small-scale farming has become the most common type of land use in Rondônia. Furthermore, in terms of academic literature on land use in Rondônia, small-scale farming is probably the most popular focus (Browder 1994, Fujisaka et al. 1996, Fujisaka and White 1998, Jones et al. 1995, Martine 1990, Millikan 1992, Pedlowski et al. 1997, Wood and Schmink 1979). Commercial resource extraction, such as cattle ranching, logging, and gold mining, is also a significant type of land use in the state. A 1986 World Bank land use survey indicated that approximately 46 percent of deforested land in Rondônia was used as cattle pasture (approximately 30 percent of total surface area), 30 percent for annual crops, and 8.5 percent for perennial crops (Millikan 1992, 4). Extractive reserves are a relatively new type of land use in Rondônia and total over one million hectares (Brown and Rosendo 2000, 38).

Small scale farming in Rondônia consists of a combination of annual and perennial cropping systems, pasture, gold prospecting, and off-farm labor. It is only through this diversified "mixed economy" strategy that small farmers are managing to survive. While investment in perennial cropping systems such as coffee and fruit trees may be more beneficial in the long term, farmers in Rondônia often find that due to

various constraints, less labor-intensive forms of agriculture, such as annual cropping and cattle raising, is their best option. In addition, gold prospecting and off-farm labor are becoming increasingly essential for the survival of a small farm household.

Commercial resource extraction in Rondônia is represented by cattle ranches, gold and tin mining, and logging. As discussed in the background section, commercial cattle ranching played a key role in the economic development of the Brazilian Amazon, beginning in the 1960s. Today, cattle ranching continues to be a major activity in the landscape modification of Rondônia, with cattle ranchers wielding significant political influence within the state and thus largely ignoring any forest clearing regulations (Pedlowski et al. 1997, 153). Gold and tin mining in Rondônia is practiced largely by colonists who failed to acquire or sustain a farm, and have thus been driven to this option. Mining in Rondônia is for the most part un-regulated, and furthermore results in significant river pollution and ecological damage. Finally, like cattle ranches, logging has served as a significant destructive force in the Brazilian Amazon, causing considerable threat to numerous forest species. In Rondônia, logging is also becoming a significant threat to indigenous reserves, which are home to the state's last stands of marketable species (Fearnside 1990, 241).

Extractive Reserves were officially established in 1990, and there are currently twenty-one state administered reserves and one federally administered reserve in Rondônia (Brown and Rosendo 2000, 37). In total, the extractive reserves in Rondônia occupy just over one million hectares and are inhabited by over 400 families (Brown and Rosendo 2000, 42). The reserves are mostly located in the outer edges of the state, on lands least impacted by deforestation, and are likely distant from colonist settlements.

The relative remoteness of many extractive reserves creates at least two problems: it reduces the likelihood of colonist use and limits rubber tappers access to markets. In addition, the multi-level administration of these reserves which include government agencies, NGOS, and the local population, is yielding significant as well as interesting power struggles, all of which will be discussed later in this chapter.

Causal Forces

The three main forms of land use predominant to Rondônia all stem from environmental, social, political, and economic conditions. Environmental influences include soils, climate, vegetation, crop pathogens, and resources, all of which can affect crop choice, farm success, and resource extraction. Specific aspects of Rondônia's social networks, such as population background and health, determine labor availability and patterns of land use. Political influences on land use in Rondônia emerge from the grassroots, local, state, federal, and global level. The establishment of extractive reserves, colonization, and corporate investment are all tied to politics. Finally, economic and market factors play a considerable role in shaping land use in Rondônia. These factors determine the survival of extractive reserves, the effects of government subsidies, choices in commercial resource extraction, levels of migration, and types of crops grown.

Thus, by examining current trends in land use, as well as the forces that shape them, there emerges a more clear understanding of future implications for the survival of this state, its environments, and its people.

Small Scale Farming

Like much of the Brazilian Amazon, small-scale farming is central to land use in Rondônia. Since the construction of the Cuiaba-Porto Velho highway in 1960, colonists have poured into the state, each determined to make a living farming their own land. Despite this resolve, many environmental, social, political, and economic factors have challenged their success, significantly influencing the nature of this type of land use.

The current situation of small scale colonist farmers in Rondônia can be characterized by low productivity and frequent farm failure, with primary dependency on annual food cropping and small scale cattle raising (Browder 1994, 46). Typical small-scale farmers in Rondônia clear small patches of their holdings in irregular shapes and spatial patterns, for the purpose of mixed annual and perennial crops as well as pasture. Annual crops in Rondônia can be represented by maize, beans, and upland rice. Perennial crops that dominate the state include the tree crops of coffee, cocoa, and bananas. It has been recorded that small producers prefer to utilize older fields for pasture while continuing to clear new fields for crops (Pedlowski et al. 1997, 152).

This land management strategy contributes to an ever shrinking fallow period, evident in a 1995 study which recorded that 46 percent of all small scale farmers in Rondônia practice forest clearing on an average of every two years, and of that number, 53 percent also practice clearing on secondary growth areas. These practices have resulted in significant habitat destruction, particularly for large mammals, as well as overall forest fragmentation (Pedlowski et al. 1997, 152). Annual crops grown by small scale farmers in Rondônia have consistently under-produced levels achieved during controlled trials, ranging from 37 to 60 percent produced compared to that of the

experiments (Browder 1994, 51. Consequently, neither the goals of the Brazilian government, environmental protection interests, nor small-scale farmer are being achieved; the region continues to be plagued by impoverishment while the forest continues to be cleared.

Environmental Influences

Like most of the Brazilian Amazon, the majority of land area in Rondônia is environmentally ill suited to small scale farming, which in turn poses various challenges to small-scale farmers in the state. These challenges are prominent in the soil quality, forest species diversity, and crop pathogens of Rondônia. In terms of soil quality, Rondônia can be characterized as having dystrophic soils, highly acidic and high in aluminum levels (Browder 1994, 53). Soil studies show that more than 90 percent of Rondônia's surface area contains soils unsuitable for crop cultivation (Browder 1994, 53). The prevalence of these poor soils oftentimes contributes to the failure of both annual and perennial crop yields (Pedlowski et al. 1997, 152).

While the poor soil quality of Rondônia hinders its small producers in the field of agriculture, the tree species diversity of its forests further limits economic opportunity. While much secondary growth is cleared by slash and burn, initial forest clearing has the potential of yielding timber from which the farmer can gain a profit. Unfortunately, the forests of Rondônia are home to very few marketable hardwood species. In a 1985 study conducted by the Jamari National Forest, only five of the fifty-five commercial species were evident in an occurrence greater than one tree per hectare (Browder 1994, 54).

Thus even the destructive practice of forest clearing offers little hope of monetary gain from timber sales for the small producers of Rondônia.

An additional and very serious environmental challenge to small-scale farming in Rondônia today is the existence of crop pathogens, which particularly limit the success of perennial crops (Fearnside 1990, 243). These pathogens include insects such as *Perileucoptera coffeella, Hypothenemus hampei*, and *Oligonychus ilicis*, all of which afflict coffee; as well as the fungus witch's broom (*Crinipellis perniciousai)* which plagues cacao. These crop pathogens attack and severely weaken several different crops of Rondônia, yet due to economic constraints, less than half of all small farmers in Rondônia have ever used insecticides and fungicides (Browder 1994, 55). The presence of these pathogens often forces the small producer to revise his farming strategy, further jeopardizing his success.

Thus, at the environmental level, small-scale farmers in Rondônia are faced with a variety of challenges. Their trials do not, however, exist solely within the realm of the physical environment but rather extend into more culturally rooted institutions.

Social Influences

Socially, small-scale farmers in Rondônia face numerous challenges, most notably malaria, which in turn highlights other social problems such as labor force and traditional economic activities. The debilitating and too often deadly disease of malaria is responsible for an average of seventeen months of disease per family per year in Rondônia. In 1985, 42 percent of all reported cases of malaria in Brazil occurred in Rondônia (Browder 1994, 54). Malaria, of course, depends on various environmental

factors existing in the small farming settlements of Rondônia. These factors include high vector density, structures poorly suited to residual spraying, as well as insufficient health care facilities (Martine 1990, 39). Malaria in Rondônia proves to be a continued challenge in the face of small scale farming, with little hope of relief in the near future, as one government study determines, "...malaria control in Rondônia has been particularly difficult. Shortages of personnel, vehicles, insecticides and drugs have plagued the program...Logistics are extremely difficult in remote rural areas, where roads are often impassable in the rainy season..." (Martine 1990, 40).

The prevalence of this disease results in significant disruption of family farm labor, and consequently overall crop yield. Typically, small-scale farmers in Rondônia prepare for the onset of disease by increasing the size of their cattle herd, if at all possible (Browder 1994). This strategy, however, is not always sufficient and it is malaria that is often times the determining factor in a small farmer's decision to abandon his holdings. Larger commercial farmers and speculators, however, can hire out labor and need not reside in the community, thus allowing their endeavors a considerable advantage. This situation leads to a concentration of landholdings, therefore abandoning any sense of equity intended in the process of colonization (Martine 1990, 39).

The labor force of small scale farms in Rondônia draws almost solely from the household, but this is no longer adequate, as an increasing number of family members perform off farm labor, currently contributing to somewhere between 30 and 50 percent of rural income. This off farm work is typically either gold prospecting or sharecropping. While off farm labor is proving increasingly necessary to supplement poor agricultural productivity, it does result in a significant labor shortage, thus hindering the family

farm's chances for success. These labor shortages often force small-scale farmers to shift to less labor demanding farming strategies, typically pasture for cattle raising. In addition, many colonists are finding employment in the growing urban centers of the state, which offers considerably higher and more reliable wages than farm labor, and has the potential to severely threaten the viability of small farms in Rondônia (Browder 1994, 55).

Therefore, various elements of the colonist's society and culture also contribute to their struggles for survival. These elements, however, are in some cases within the control of the small farmer, allowing for the potential of a change in strategy that could aid him in his plight. Yet there are several challenges, which appear to exist outside of the realm of the colonist's control, many of which occur in the field of politics and economics.

Political Influences

Political factors influencing the persistence of small-scale farming as a predominant type of land use in Rondônia are most notably present in the form of development agendas, created and set forth by both the Brazilian government, non-governmental organizations, and the global community. Key development agendas that have shaped small-scale farming in Rondônia include Operation Amazonia and POLONOROESTE (discussed in Chapter Two), and the more recent PLANAFLORO.

In 1992, the Brazilian government instituted the Rondônia Natural Resources Management Project (PLANAFLORO). Funded primarily by the World Bank, PLANAFLORO was created in an effort to foster sustainable development of existing

natural resources in Rondônia (Pedlowski et al. 1997, 155). The goals of PLANAFLORO were specifically to conserve biodiversity, protect the boundaries of Indian reserves and protected areas, and improve the infrastructure of state institutions. In addition, PLANAFLORO includes and implements a system of agro-ecological zoning. The agro-ecological zoning system entails six zones, distinguished by the type of land use allowed. The following table introduces each zone by land use type and area.

Table 1. Area and Prescribed Land Use of Agro-ecological Zones Under PLANAFLORO

Zone	Land Use	Area (square km.)
1	Agricultural intensification, agroforestry, and cattle ranching	61, 950
2	Small-scale farming	30, 150
3	Riverine activities, fishing, riverbed cultivation	5, 890
4	Extractive reserves	35, 000
5	Selective logging	24, 350
6	Conservation and permanent preservation	64, 000

(Pedlowski et al 1997, 156)

This program, despite its delayed implementation, promises to both better the environmental stability of Rondônia while simultaneously restricting the income-garnering activities of small-scale farmers. Through protection of Amerindian and extractive reserves, colonist farmers will have reduced access to land and timber. Thus, while the intentions of such government programs as PLANAFLORO is to aid in Rondônia's development, the effects may prove detrimental to the region's small producers. In recognition of this possible outcome, PLANAFLORO contains measures

to improve socioeconomic conditions of small farmers through investment in better health and education facilities, as well as the development of more sustainable agroforestry strategies.

Economic Influences

Economic conditions, particularly land valuing and market fluctuations, play a considerable role in determining the nature of small-scale farming in Rondônia. Increasing demand for land in Rondônia has escalated prices, rising from about twelve US dollars per hectare in 1977 to an average of US $186 in 1984. This increase led to fairly common levels of illegal squatting from the mid 1980s on, and resulted in an estimated 31 percent of colonists not owning titles to their fields. In order to correct this (gain a title to their land), colonists could prove to INCRA that improvements had been made. The easiest and quickest way to achieve this was to clear forested land for pasture (Browder 1994, 56), thus not only modifying the landscape in an environmentally negative manner, but also determining a farmer's need for livestock. High land prices and limited availability has contributed to the sharp increase in landless peasants in Rondônia, reported by the World Bank in 1987 to be as high as 65 percent within the thirteen official colonization areas (Browder 1994, 55). A factor contributing to landlessness is the Amazonian phenomenon of land speculation. In Rondônia, land speculation was most prevalent from the 1970s to mid 1980s. In those years, colonists could clear land and gain a title from INCRA, and then sell to speculators for a 15 to 25 percent profit (Browder 1994, 56).

Market fluctuations also pose significant challenges to small-scale farmers in Rondônia, both in the realm of crop markets and the strength of the Brazilian currency, the Cruzeiro. Small-scale farmers in Rondônia complain of unfair "downgrading" of their products by the government's grain storage company, CIBRAZEM. CIBRAZEM has reportedly participated in corrupt practices in their dealings with small scale farmers, dishonestly deeming grains brought to the market as of a lower grade and thus cheating the small scale farmers out of their deserved wage (Browder 1994, 57). Hyperinflation, completely out of the control of small producers, has continued to plague all of Brazil, rising from 1,765 percent to 16,000 percent from 1989 to 1990. When these types of situations occur, small scale farmers are forced to focus on short term production, liquidating any assets and planting annual crops, thus continuing the cycle of debt (Browder 1994, 58).

Other economic factors shaping the nature of small-scale farming in Rondônia include perceived prospects for markets and sustainability, as well as labor and capital inputs required. This relationship is perhaps best reflected through the examination of perennial crop choices and livestock production. Despite their low success rates, perennial crops such as coffee, cacao, and black pepper continue to be popular features of government and NGO development plans due to their perceived value to foreign markets and prospects for sustainability (Fearnside 1990, 243). In contrast, despite its degrading character, livestock production is favored among small-scale farmers for its requirements of only minimal amounts of labor and capital (Millikan 1992, 6).

parks). Despite these restrictions, monitoring of these areas are rather lax, and logging continues illegally and unregulated (Pedlowski et al. 1997, 155).

Environmental Influences

Environmental factors influencing commercial resource extraction in Rondônia include tree species diversity, decreased forest cover, and the existence of gold and tin casserite. As discussed earlier, tree species diversity has been a key determinant in the logging industry of Rondônia. The presence of mahogany acted as a catalyst for the emergence of logging companies, loggers, and mill towns in Rondônia in the early 1980s Browder and Godfrey 1997, 169). Today, in most areas of colonist settlement, the occurrence of valuable hardwoods is low. Yet while it was Rondônia's environmental wealth that brought the logging industry to the state, the near extirpation of most marketable hardwood species seemed to do little to slow the industry's growth. In 1994, furniture making and sawmills accounted for an astounding 34.5% of state industries (Pedlowski et. al 1997, 155). This, in turn, has resulted in the destruction of vast tracts of forest in the process of searching for the few remaining suitable species. Particular targets of these destructive forces are Amerindian and extractive reserves, which are perceived to have the most valuable timber.

Decreased forest cover is a second environmental factor influencing commercial resource extraction in Rondônia. The destruction of forest removes the possibility of forest product extraction (at either a commercial or sustainable scale), but facilitates another type of commercial resource extraction: cattle ranching. Cattle ranching has become a dominating presence in areas of highest deforestation, as reflected in the agro-

ecological zoning plan of PLANAFLORO, which places ranching in zone 1, the area surrounding BR-364, and thus the most severely deforested section of Rondônia (Mahar and Ducrot 1998, 6).

Finally, like in logging, the existence of gold and tin casserite sparked the development of a mining industry in Rondônia. As mentioned previously, mining remains as a key option for failed colonist farmers needing work or for small-scale farmers just looking to supplement their income. Mining in Rondônia thrives as a small-scale industry due to the fact that it requires little capital investment. Minerals are extracted from riverbeds (primarily the Madeira) using mercury, which results in devastating ecological damage, contaminating not only the aquatic and plant communities, but the human population as well.

Social Influences

Social conditions determining the prevalence of commercial resource extraction in Rondônia include labor availability and alternative employment opportunities. While some forms of commercial resource extraction such as ranching require very little labor inputs, mining and industries related to logging serve as principal forms of livelihood in Rondônia, following small-scale farming. A social consequence of ranching in Rondônia is increased marginalization of the poor and the loss of resource access, as small-farmer pastures become consolidated under commercial ownership. This contributes to urban migration, further removing smallholdings from the rural landscape.

As mentioned earlier, many "failed" colonists turn to mining as means of employment, either independently or working for someone else. Gold mining along the

Madeira River peaked in late 1980s, but still proves to be a significant type of land use and livelihood alternative. Due to the use of mercury during the amalgamation process, concern for both ecological and public health has erupted. During gold production, fine gold particles are mixed with elemental mercury and heated to separate gold particles from other minerals present in the gravel, such as iron (Pedlowski et al. 1997, 154). This releases methyl mercury, a known neurotoxicant, into the ecosystem and is thereafter bioaccumualted in the aquatic food chain. A particular focus of concern are infants, who are exposed to methyl mercury through their mothers both during pregnancy and subsequent breastfeeding periods (Boischio and Cernichiari 1998, 79). Studies have indicated that prenatal development of the central nervous system can be seriously affected by exposure to this neurotoxicant (Clarkson 1987), and thus this poses a great risk to local gold mining populations in Rondônia. Despite this health threat, gold mining continues as a major type of land use in Rondônia to a lack of alternative means of employment. Moreover, PLANAFLORO perpetuates exposure to this neurotoxicant by deeming the lands surrounding the Madeira suitable for fishing and other riverine activities.

Political Influences

Political factors contributing to the dominance of commercial resource extraction as a type of land use in Rondônia are most strongly evident in state, federal, and World Bank development agendas. At the state level, the economic value of commercial resource extraction industries such as ranching and logging serve as pivotal nodes of

power, which allows these industries considerable political influence. This only furthers the prevalence of commercial resource extraction as a type of land use in Rondônia.

At the federal level, commercial resource extraction has a long history as serving as a key component of development agendas. Desires on the part of the Brazilian government for modernization and occupation of the Amazon in the early 1960s led to a series of tax incentives and road building projects aimed at furthering ranching and logging endeavors in the region. These early policies set the tone for later development in states like Rondônia, which were not opened up to widespread migration until nearly a decade later (Mahar 1989, 29). Thus it was through the Brazilian government's desire for development and occupation of Rondônia that mining, ranching, and logging became principle forms of land use in the state.

At present, World Bank development plans are the most significant influence on agendas for land use in Rondônia. Through PLANAFLORO, commercial resource extraction is insured a continued place in Rondônia, listed as a principle form of land use for Zone 1, which comprises the plan's second largest zone (Mahar and Ducrot 1998, 5). In addition, due to the restriction of areas with the greatest number of valuable hardwoods, much of the logging of the past decade has been done illegally (Pedlowski et al. 1997, 155).

Economic Influences

Economic forces influencing the persistence of commercial resource extraction in Rondônia are seemingly countless, and are among the most significant influences.

Particularly powerful economic influences are timber markets, tin prices and domestic beef demand.

World timber markets have been incredibly important to the growth and persistence of the logging industry in Rondônia, as well as Amazonia as a whole. Current market conditions have limited the growth of the timber industry. In particular, competition from the forests of Southeast Asia is significant, given that they possess a greater number of marketable species in higher densities. The tropical forests of Southeast Asia have the advantage of being primarily comprised of a single plant family (Dipterocarpaceae), which can be categorized into one of six grades, simplifying extraction and marketing. Furthermore, the timber of Southeast Asia is typically lighter in color, which is currently the preference of western markets (Fearnside 1990, 241). World timber markets thus critically shape the logging industry of Rondônia.

A second economic factor key to the persistence of commercial resource extraction is world tin prices. In the late 1950s tin prices were at an all time high, spurring thousands of Brazilians to head west to Rondônia to make their fortune as miners. In 1971 individual mining was prohibited, leaving in their place federally created corporate mineração groups. Despite low tin prices since the mid 1980s, mining has continued as a major type of land use on a commercial as well as individual scale (Browder and Godfrey 1997, 167).

Thirdly, the prevalence of ranching in Rondônia is insured by two central economic factors: fiscal incentives and increasing domestic beef and dairy demand. In terms of fiscal incentives, converting land to pasture was the cheapest and fastest method of securing land claims, and allowed rapid investment into the region (Fearnside 1990,

234). As discussed earlier, the emergence of land speculation also contributed to the conversion of land to pasture. At present, this type of land use persists among colonist farmers to the state, who are attracted to ranching by the low amounts of labor and capital it requires (Millikan 1992, 6). Cattle can literally walk themselves to market, reducing transportation costs and need for suitable roads. Also, small-farmers value the added benefit of dairy products for household consumption that cattle raising brings (Millikan 1992, 7).

A second economic factor in the persistence of the cattle ranching industry in Rondônia is increasing local beef and dairy demand. As urbanization and development of the area increased, local demand for beef and dairy products increased as well, leading to an upsurge in investment in ranching (Faminow 1997, 1). It has been calculated that from 1960 to 1991, demand for beef in Rondônia increased by 25 times (Faminow 1997, 6). The production and consumption of dairy products in Rondônia has also risen in demand, and is reflected in the recent emergence of several cheese processing plants in the state (Fujisaka et al. 1996, 127). Thus, local and regional markets are becoming increasingly important in the growth of livestock related industries in Rondônia.

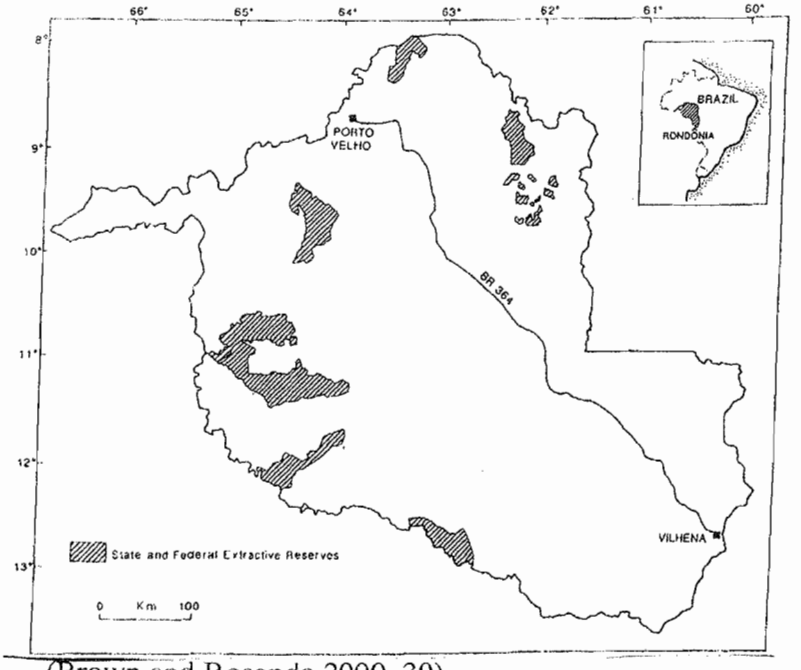
Extractive Reserves

The Ministry of Agrarian Reform and Development (MIRAD) has defined extractive reserves to be "forest areas inhabited by extractive populations granted long-term usufruct rights to forest resources which they collectively manage" (Schwartzman 1989, 151). Rondônia currently has a total of twenty-two extractive reserves, comprising approximately fifteen percent of total land area (Mahar and Ducrot 1998, 5). Officially

begun in 1990, extractive reserves emerged from a decade long struggle on the part of rubber tappers throughout Amazonia.

Despite achieving the establishment of extractive reserves, rubber tappers continue to be one of the poorest and most marginalized sectors of Rondônian society. Researchers Katrina Brown and Sérgio Rosendo have determined that this disempowerment is a result of, "...economic relations, physical isolation, poor or no access to social services, and neglect from policy makers (Brown and Rosendo 2000, 207). With the establishment of extractive reserves in Rondônia and their incorporation into PLANAFLORO, rubber tappers are guaranteed the opportunity to garner at least part of their income from their traditional livelihood activities. A recent partnership with the Swedish NGO World Worldwide Fund for Nature (WWF) aims to better this situation by providing supplemental livelihood opportunities to rubber tappers conducting their activities through PLANAFLORO (Brown and Rosendo 2000, 209).

Extractive Reserves in Rondônia



(Brown and Rosendo 2000, 39)

Environmental Influences

Environmental factors influencing the establishment and success of extractive reserves in Rondônia include decreased resource availability and the presence of extractable resources. As resources became decreased in availability, attention to developing sustainable methods of resource use increased, yielding extractive reserves as a solution. Most extractive reserves in Rondônia are located within the outer edges of the state, in areas least affected by deforestation and colonist migration. Another related influence on the persistence of extractive reserves is seasonality and forest production, both of which affect the success of extractive reserves in providing an adequate livelihood supplement to its users (Brown and Rosendo 2000, 219).

The continued presence of extractable resources contributes to the viability of extractive reserves as a dominant form of land use in Rondônia. Rubber, brazil nuts, cashews, and copaíba oil all exist naturally in the forests of the Brazilian Amazon, and all serve important purposes in livelihood supplement. Rubber is sold, brazil nuts and cashews can be both sold and eaten, and copaíba oil is an important traditional medicine (Brown and Rosendo 2000, 217). In addition, fishing and hunting within reserves are often critical in protein acquisition for forest users.

Social Influences

Social factors influencing extractive reserves as a type of land use in Rondônia include a lack of extractive tradition among colonist farmers, and the insufficiency of extractivism as a primary source of livelihood among traditional forest dwellers[1]. While

[1] "Traditional forest dwellers" refers to the indigenous, *ribeirinhos,* and *seringueiros* populations of Rondônia. *Ribeirinhos* are people of mixed indigenous, European, and African ancestry who live along

there has been a long, rich history of extractive-based livelihoods imbedded in the cultures of the traditional forest dwelling peoples of the Amazon, the colonists of Rondônia do not possess this tradition. Surveys indicate that only 5.5 percent of all rural colonist households in the Gy-Paraná settlement area practice rubber tapping, and approximately 29 percent utilize any other (particularly Brazil nut and palm heart) non-wood forest product to supplement their livelihoods (Browder 1994, 54). By not deriving a significant portion of their income from extractive products, small-scale farmers are not only limiting their economic success but also failing to recognize the sustainable income potential that exists in the forest. Furthermore, the absence of small-scale farmers from extractive reserves limits this institution's potential in terms of its future growth and persistence.

Regarding the role of extractive reserves in the livelihood of traditional forest dwellers, current conditions do not allow extractivism to be an adequate livelihood supplement. In a study conducted by Katrina Brown and Sérgio Rosendo, it was determined that in twenty –three out of thirty-four months, households of traditional forest dwelling people did not collect enough rubber to purchase basic supplies. It was suggested in this study that such households need to integrate extractivism with other forms of livelihoods, and veer away from becoming too dependant on one or two key products (Brown and Rosendo 2000, 219).

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floodplain areas and make their living from fishing, mining, farming, and rubber tapping. *Seringueiros* are rubber tappers, most of whom are also of mixed ancestry, and descend from those who migrated to the region during the 19th century rubber boom (Brown and Rosendo 2000, 206).

Political Influences

Political factors shaping the nature of extractive reserves in Rondônia include the continued grassroots movement of the rubber tappers throughout Amazonia and the intricately balanced power linkages regarding the reserve's administration. Today, the National Council of Rubber Tappers continues to play an important role in the operations of extractive reserves. At a local level, CSN members assess and address local needs, work toward the commercialization of extractive products, and work with local governments to ensure that education and health services are provided to reserve residents (Brown and Rosendo 2000, 38). CSN delegates defend extractive reserve interests at the national level, insuring that extractors have access to government credit programs and that rubber prices are protected.

An important partnership that has emerged from PLANAFLORO and the establishment of extractive reserves is that of the Worldwide Fund for Nature (WWF) and local rubber tappers of Rondônia. Recognizing the need for rubber tappers to expand their livelihood opportunities, the WWF has created several activities through which rubber tappers can earn household income through environmentally sustainable means. These activities include selective logging of extractive reserves, and creating more beneficial marketing strategies for extractive products. Timber is the most valuable product of extractive reserves, and WWF is working with local rubber tappers to design a management plan that would minimize impact of timber extraction on the surrounding vegetation and include measures for reforestation of the harvested species. In terms of marketing strategies, the WWF and local rubber tappers are striving to establish better prices for extractive products. This includes replacing marketing intermediaries with

local trading posts where rubber tappers can sell their goods. A third WWF strategy to better the situation of the rubber tappers is a study assessing the viability of extracting açaí fruit and palm hearts for commercial profit (Brown and Rosendo 2000, 221). Implementation of these programs is administered through local CSN chapters, illustrating the potential for this important political alliance to significantly improve conditions for rubber tappers and further the persistence of extractive reserves as a major type of land use in Rondônia.

Economic Influences

Economic factors such as access to and status of world product markets serve as key determinants in the success of extractive reserves in Rondônia. Access to reliable markets is a chief concern among many rubber tappers, and one that limits the success of extractive reserves (Brown and Rosendo 2000, 218). While access to and from extractive reserves continues to be a major limitation to most colonist farmers, rubber tappers are striving to better their access to markets through the establishment of local trading posts.

Another economic concern is whether extractive products are marketable. If the reserves are not able to produce goods valued in larger markets, their effectiveness as a sustainable economic endeavor is limited. Then, even if products have a place in the market, the price of this product may not be adequate. An example of this would be rubber, one of the chief products of extractive reserves. Due to its extremely low price in world markets, rubber is heavily subsidized in Brazil, and comprises one third of the total amount of rubber consumed by the country annually. While the price at which Brazil buys its domestic rubber is high compared to world markets, rubber tappers nonetheless

feel it is too low. Part of the reason for this is a situation similar to the timber markets; Brazil's rubber receives serious competition from the forests of Southeast Asia, where rubber is cheap and free of the *Microcyclus* fungus (Fearnside 1990, 242).

Thus, through the examination of factors shaping the predominant forms of land use in Rondônia, the inter-related influences of environmental, social, political, and economic conditions becomes evident. In order to illustrate how land use strategies are becoming increasingly diversified as a response to these various causal forces, the colonization settlement of Theobroma will be examined.

Chapter Four: A Case Study of the Theobroma Colonization Project

Background

Theobroma is located in the east-central part of Rondônia, approximately 350 kilometers southeast of the capital Porto Velho. Officially established as a government sponsored colonization project in 1979, Theobroma was spontaneously colonized years earlier, likely as result of its location along the state's major highway, BR-364. The settlement is comprised of approximately 3000 families on 300, 000 hectares of land. The population is primarily migrants, with only one percent of heads of households being born in Rondônia. On average, most colonists arrived in the state thirteen years ago, and settled in Theobroma ten years ago (Fujisaka et al 1996, 119). Overall, there seems to have been two major waves of migration to Theobroma, the first in the 1970s following the completion of BR-364, and the second in the 1980s, accompanied by a shift in development agenda on the part of the Brazilian government.

Environmentally, Theobroma is situated within a semi-deciduous forest zone, with a warm, humid tropical climate, and marked wet and dry seasons. Largely deforested, Theobroma appears to be located in Zone 1 of PLANAFLORO, which allows for large-scale agriculture, livestock, and agroforestry (Mahar and Ducrot 1998, 5). In an analysis of LANDSAT images of the settlement conducted in 1995, it was estimated that Theobroma would be entirely deforested within 32 years (Pedlowski et. al 1997, 153). Due to this forest depletion as well as other factors, small-scale farmers in Theobroma are moving to more diversified land use strategy, which provides short-term, if not sustainable, security.

Land Use Strategies

In terms of land use, Theobroma farmers find that they are moving increasingly towards a more mixed economy, relying on a combination of annual and perennial cropping systems, livestock, resource extraction, and off-farm labor as a means of livelihood (Fujisaka and White 1998). This shift in livelihood strategies reflects a response on the part of small farmers to various environmental, social, political, and economic constraints.

In late 1994, Fujisaka and White (1998) interviewed 74 local farmers and surmised that due to the region's decreasing forest and average farm size, as well as greater access to national markets in the center-South, a more mixed economy emerged. The following chart shows major sources of income cited by respondents in percentages.

Table 2. Sources of Income Among Small Farmers in Rondonia

Rice	Maize	Beans	Coffee	Cacao	Cattle	Milk	Wood	Brazil Nut	Labor
57%	16%	9%	26%	25%	30%	30%	9%	6%	53%

Sources of income absent in Theobroma but which were found in similar colonies by Fujisaka and White include cassava, banana, citrus, poultry/pigs, and rubber.

Conclusions

The "mixed economy" land use strategy adopted by small farmers in Theobroma reflects an effort to cope with the changing environmental, social, political, and economic conditions of the region. Environmentally, farmers in Theobroma have had to face decreasing forest cover and poor soil quality. These sort of conditions limit farmer's

ability to practice slash and burn agriculture. Socially, these farmers are coping with limited access to land and the adoption of an extractive tradition. Politically, Theobroma has been influenced by its federally sponsored establishment and the various development programs that have encouraged migration. Economically, Theobroma farmers have been motivated to plant perennial crops due to the existence of western markets. An example of this would be recent programs providing credit to farmers to grow the perennial crop acerola, for which government officials foresee a market. By practicing a "mixed economy," small farmers in Theobroma are not only bettering their chances of garnering sufficient income, but also lessening their impact on their farm (compared to only annual/pasture cropping), which is a strategy likely to be practiced in other parts of Rondônia.

Chapter Five: Conclusion

Land use choice in Rondônia is greatly influenced by a dynamic and inter-related combination of environmental, social, political, and economic conditions. Each of these perspectives contribute to the development and changing dynamics of small-scale farming, commercial resource extraction, and extractive reserves as predominant types of land use in Rondônia. Small-scale farming, perhaps the most prevalent and un-regulated type of land use in Rondônia, finds its influences in not only the actions and experiences of small farmers, but also market conditions and pre-existing environmental characteristics as well. Commercial resource extraction, a type of land use that has a history in that area longer than Rondônia has had statehood, also finds influences in environmental characteristics and markets, in addition to the extractive corporations themselves. Extractive reserves are a relatively new type of land use in Rondônia, and have been influenced by not only local and federal politics, but also by social movements and environmental conditions. Thus it is through this more balanced approach that the factors determining land use in Rondônia are better understood.

Environmentally, land use choice in Rondônia is shaped by physical characteristics of the landscape, including forest type, species composition, and cover, as well as other natural resources and occurrences. Tree species diversity is responsible for both the emergence of logging in the state as well as the limitation of income opportunities from timber for small-scale farmers. Poorer soils in the state further constrain the success of small farmers, and lessen the opportunity for the region to become a major producer of perennial crops. Decreasing forest cover throughout

Rondônia influences the prevalence of large-scale cattle ranching and annual cropping systems as types of land use, which both demand and perpetuate the clearing or rainforest. Additional environmental factors influencing the agricultural landscape of Rondônia are crop pathogens. Numerous insect and fungus species cause significant damage to perennial crops such as coffee and cacao, and often compel a small farmer's decision to increase his cattle herd. Finally, the presence of mineral deposits such as tin casserite and gold drive the persistence of mining as a major type of livelihood in Rondônia.

Social conditions such as labor availability, employment opportunities, and health concerns all influence how land is used in Rondônia. Labor conditions on both a micro and macro scale contribute to land use choice in Rondônia. At the local level, small farmers must consider the amount of labor available when deciding on a cropping strategy. Typically, cattle-raising and annual crops are preferred due to their lower capital and labor requirements in comparison to more sustainable perennial crops. The prevalence of malaria in Rondônia is a major drain on household farm labor in the state, averaging 17 months of illness per family per year. At the national level, reduced employment opportunities due to modernization in other areas of Brazil, combined with government propaganda and road building schemes has contributed heavily to migration into the state. The difficulty for many colonists to obtain land and frequent farm failure has driven many to small-scale gold mining, further influencing the persistence of this type of land use. Another social factor linked with this phenomena is concern over public health due to the high levels of mercury used in gold extraction, which will likely result

in significant illness among populations living along the Madeira River, Rondônia's principal site of gold mining.

Political factors, most significantly the development agendas of the Brazilian government, World Bank, and various local, national, and international non-governmental organizations play a critical role in determining land use. Over the past four decades, the Brazilian government has been a crucial actor in the shaping of the physical and cultural landscape of Rondônia, driving in-migration of small farmers, courting commercial resource extraction, and most recently, establishing extractive reserves. The World Bank has funded the majority of these development endeavors, shaping land use choice through the programs POLONOROESTE and PLANAFLORO. Local and national alliances such as the National Council of Rubber Tappers (CSN) have been critical in the establishment and administration of Rondônia's twenty-two extractive reserves. Linked to this political influence is the international non-governmental organization Worldwide Fund for Nature, which is joining forces with local rubber tappers to improve social conditions and ensure the persistence of extractive reserves in Rondônia.

Finally, economic factors such as markets and industries critically shape land use choice in Rondônia. Potential markets in the west continue to drive the persistence of perennial crop systems in the state, despite environmental, labor, and capital constraints. Flooded world rubber markets have resulted in the creation of a domestic subsidy for Brazilian rubber, allowing for the continuance of rubber tapping as a livelihood and extractive reserves as a predominate type of land use. Growing state industries such as dairy production and furniture making also shape land use choice in Rondônia, requiring

the persistence of cattle ranching and logging. Thus local, national, and international economic conditions play a critical role in determining land use in Rondônia.

Through greater understanding of the various conditions shaping land use choice in Rondônia, there emerges a clearer perception of how environmental degradation and social problems can be minimized. Moreover, conservation and development programs such as the Rondônia Natural Resources Management Project (PLANAFLORO) can benefit from such insights, taking into account how various environmental, social, political, and economic factors will effect the implementation and outcome of planning efforts. In particular, the agro-ecological zoning program outlined by PLANAFLORO provides several opportunities to consider the implications of various influences on land use choice in Rondônia. Examples of such implications include diversified livelihood strategies among small farmers, health risks among riverine populations, political empowerment of local rubber tappers, and local timber markets.

As illustrated in the case study of the Theobroma colonization project, small farmers in Rondônia are moving increasingly towards a more diversified, "mixed" economy, due to the dynamic nature of important environmental, social, political, and economic conditions. In addition to annual and perennial cropping systems, small farmers are relying on livestock raising, gold extraction, and off-farm labor to supplement their livelihoods, yet none of these types of land use are officially permitted within Zone 2, the area most populated with small farmers. Furthermore, due to their location, extractive reserves are beyond the reach of most small farmers in Rondônia, limiting access to this potential source of household income. By not acknowledging the needs and strategies of small farmers, the agro-ecological zoning program of PLANAFLORO is

not only limiting the success of Rondônia's small farmers, but also jeopardizing the entire program's success, and the World Bank funds that accompany it

A second example of how PLANAFLORO could benefit from increased understanding of how environmental, social, political, and economic conditions interact to determine land use is illustrated in Zone 3 of the agro-ecological zoning plan. Lands zoned under Zone 3 are deemed suitable for "riverine activities, including floodplain agriculture and fishing" (Mahar and Ducrot 1998, 6). These lands are located along the Madeira River, which has been the site of intensive gold mining since the early 1980s, resulting in the release of an estimated 100 tons of mercury into the river and its environs. By encouraging continued settlement of this area, PLANAFLORO is not only exposing thousands of people to a major health hazard, but also increasing the likelihood of continued mineral extraction, which under PLANAFLORO is illegal.

The political empowerment of the rubber tappers is another important example of how the causal forces of land use choice in Rondônia are critical to the success of PLANAFLORO. For extractive reserves to continue as a major type of land use in Rondônia, local rubber tappers need to maintain an active role in reserve administration. Furthermore, alliances between rubber tappers and other organizations (such as the WWF) should be fostered in order to strengthen the income potential of extractive reserves. By understanding the local, national, and international political conditions necessary to sustain extractive reserves, the likelihood of their success is increased.

The timber market is also an example of how PLANAFLORO can benefit from an analysis of the factors determining land use in Rondônia. Despite the scarcity of marketable hardwood species, logging continues throughout the state both legally and

illegally. A particular target of illegal logging are areas surrounding Amerindian reserves, which due to their remote nature and protected status contain the state's majority of remaining marketable tree species. By deeming lands surrounding protected areas to be suitable for sustainable forestry, PLANAFLORO is risking increased illegal logging in those areas. In order to remedy this, serious measures must be taken to ensure that forest monitoring and persecution of violators is carried out. Without these measures, PLANAFLORO's claim to landscape conservation will have little validity.

In conclusion, small-scale farming, commercial resource extraction, and extractive reserves are predominant types of land use in Rondônia as a result of various environmental, social, political, and economic conditions. These conditions are neither independent nor static, but rather quite interrelated and dynamic. By examining the linkages between various environmental, social, political, and economic factors determining land use in Rondônia, there emerges a greater understanding of how environmental and social degradation can be minimized. This sort of analysis could be particularly useful in the design of conservation and development programs such as PLANAFLORO. While the agro-ecological zoning program outlined by PLANAFLORO promises to lessen the environmental degradation that accompanies development in Rondônia, this can only be achieved with careful consideration of the factors influencing land use choice. Thus, determining and understanding the various underlying forces shaping land use in Rondônia is imperative to the success of future conservation efforts in the state.

Works Cited

Allegretti, Mary Helena. 1995. "The Amazon and Extracting Activities." *Brazilian Perspectives on Sustainable Development of the Amazon Region.* Eds. M. Clusener-Godt and I. Sachs. Paris: UNESCO and The Parthenon Publishing Group, 157-173.

Boischio, Ana A.P., and Elsa Cernichiari. 1998. "Longitudinal Hair Mercury Concentration in Riverside Mothers along the Upper Madeira River (Brazil)." *Environmental Research* 77, 79-83.

Browder, John O. 1994. "Surviving Rondônia: The Dynamics of Colonist Farming Strategies in Brazil's Northwest Frontier." *Studies in Comparative International Development* 29 (3), 25-69.

Browder, John O. and Brian J. Godfrey. 1997. *Rainforest Cities.* New York: Columbia University Press.

Brown, Katrina, and Sergio Rosendo. 2000 "Environmentalists, Rubber Tappers and Empowerment: The Politics and Economics of Extractive Reserves." *Development and Change* 31, 201-227.

Brown, Katrina, and Sérgio Rosendo. 2000. "The Institutional Architecture of Extractive Reserves in Rondônia, Brazil." *The Geographical Journal* 166 (1), 35-48.

Clarkson, T.W. 1987. "Metal Toxicity in the Central Nervous System." *Environmental Health Perspectives* 75, 59-64.

Diegues, Antonio Carlos. 1998. "Social Movements and the Remaking of the Commons in the Brazilian Amazon." *Privatizing Nature: Political Struggles for the Global*

Commons. Ed. Michael Goldman. New Brunswick: Rutgers University Press, 54-75.

Faminow, Merle D. 1997. "Spatial Economics of Local Demand for Cattle Products in Amazon Development." *Agriculture, Ecosystems, and the Environment* 62, 1-11.

Fearnside, Phillip M. 1990. "Predominant Land Uses in the Brazilian Amazon." *Alternatives to Deforestation.* Ed. Anthony B. Anderson. New York: Columbia University Press, 233-251.

Fujisaka, Sam, and William Bell, Nick Thomas, Liliana Hurtado, and Euan Crawford. 1996. "Slash and Burn Agriculture, Conversion to Pasture, and Deforestation in Two Brazilian Amazon Colonies." *Agriculture, Ecosystems, and the Environment.* 59: 115-130.

Fujisaka, S., and D. White. 1998. "Pasture or Permanent Crops After Slash-and-Burn Cultivation? Land-use Choice in Three Amazonian Colonies." *Agroforestry Systems* 42, 45-59.

Goodman, David, and Anthony Hall, eds. 1990. *The Future of Amazonia: Destruction or Sustainable Development?* New York: St. Martin's Press.

Hecht, Susanna, and Alexander Cockburn. 1990. *The Fate of the Forest.* New York: Harper Perennial.

Jones, Donald W., Virginia H. Dale, John J. Beauchamp, Marcos A. Pedlowski, and Robert V. O'Neill. 1995. "Farming in Rondônia." *Resource and Energy Economics* 17, 155-188.

Keck, Margaret. 1995. "Social Equity and Environmental Politics in Brazil: Lessons from the Rubber Tappers of Acre." *Comparative Politics* 27 (4), 409 – 424.

Keck, Margaret. 1998. "Planaloro in Rondônia: the Limits of Leverage." *The Struggle for Accountability: The World Bank, NGOs, and Grassroots Movements.* Eds. J.A. Fox and L.D. Brown. Cambridge: the MIT Press, 181- 218.

Mahar, Dennis J. 1989. *Government Policies and Deforestation in Brazil's Amazon Region.* Washington D.C.: The World Bank.

Mahar, Dennis J., and Cecile E.H. Ducrot. 1998. *Land-Use Zoning on Tropical Frontiers: Emerging Lessons from the Brazilian Amazon.* World Bank EDI Case Studies.

Moran, Emilio F. 1990. "Private and Public Colonization Schemes in Amazonia." *The Future of Amazonia: Destruction or Sustainable Development?* Eds. David Goodman and Anthony Hall. New York: St. Martin's Press, 70-89.

Martine, George. 1990. "Rondônia and the Fate of Small Producers." *The Future of Amazonia: Destruction or Sustainable Development?* Eds. David Goodman and Anthony Hall. New York: St. Martin's Press, 23-48.

Millikan, Brent. 1992. "Tropical Deforestation, Land Degradation, and Society." *Latin American Perspectives.* 19(1) 45-57.

Pedlowski, Marcos A., Virginia H. Dale, Eraldo A.T. Matricardi, and Eliomar Pereira da Silva Filho. 1997. "Patterns and Impacts of Deforestation in Rondonia, Brazil." *Landscape and Urban Planning* 38, 149-157.

Schwartzman, Stephan. 1989. "Extractive Reserves: The Rubber Tapper's Strategy for Sustainable Use of the Amazon Rainforest." *Fragile Lands of Latin America.* Ed. John O. Browder. Boulder: Westview Press, 150-162.

Wood, Charles H. and Marianne Schmink. 1979. "Blaming the Victim: Small Farmer Production in an Amazonian Colonization Project." *Third World Societies* 7, 77-93.