Agrarian Change, Cattle Ranching and Deforestation: Assessing their Linkages in Southern Pará

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ABSTRACT

In this paper, I illustrate the dynamics of frontier development in the Redenção area in southern Pará, one of the oldest agricultural frontiers in the Brazilian Amazon. This frontier has evolved from a landscape initially dominated by large-scale corporations investing in cattle ranching, to another in which medium-scale cattle ranchers and to less extent smallholders expanded their influence in the local economy. The initial stage was driven by fiscal incentives and subsidies from the government. The latter stage features more developed markets for beef and milk products, and is associated with an expansion of slaughterhouses and dairy processing plants, the modernisation of livestock production, fragmentation of large estates, and competition for land. The latter phase originated with the arrival of new investors in medium-scale cattle ranching, and with expanding pressure from smallholders and landless people looking for land. The process of land occupation and agrarian development has inevitably led to forest conversion mainly to pasture. Finally, environmental policies seeking to halt deforestation have been largely ineffective under these conditions of frontier development.

KEYWORDS

Brazilian Amazon, agricultural frontier, cattle ranching, deforestation.

Environment and History **15** (2009): 493–520.
doi: 10.3197/096734009X12532652872072

1. INTRODUCTION

The Redenção area in southern Pará is one of the oldest frontiers in the Brazilian Amazon, and its origins are largely linked to the opening of the Belém-Brasília highway in the 1960s. In its early stage, the frontier was dominated by large corporations attracted by public incentives. Over time, medium-scale ranches (*fazendas*) have become a feature and the associated ranchers gained influence in local politics. More recently, smallholders supported by agrarian reform have begun to compete for land by contesting the rights of landholders with large holdings of low productivity. Fifty years of occupation and land use renders this region an ideal case to analyse and evaluate the implications of shifting policies and development of markets for beef and dairy production, and their implications for land tenure, agrarian transformation and patterns of land use.

In order to accomplish this goal, I examine both the factors that drive the formation of the agricultural frontier, and the economic, social and political conditions that shape its further development. The emergent path of development strongly depends on the initial conditions, which in the study area were the availability of cheap land and public incentives. These fostered the development of large-scale, extensive systems for livestock production. However, development of markets linked to investments in beef and milk processing capacity, and increasing competition for land, have over time promoted the modernisation of production systems and fragmentation of estates. In this paper, I analyse the interaction of these factors in the Redenção area.

The theoretical foundations of this paper are diverse. I draw heavily on the emerging science of land-use change which aims to understand the human and environmental dynamics influencing change in the type, location and magnitude of land use and vegetation cover.[1] Furthermore, this work relies on considerations of political economy and regional political ecology – broadly interpreted – in order to explore the politico-economic implications of regional development of the frontier and changes to land use.[2]

I have adopted a step-wise approach to interpreting the varied dimensions of frontier development and their evolution over time. The advantage of this approach is that it provides a flexible framework for pulling together a patchwork of factors in spite of incomplete data coverage. Most primary social, economic and political information was gathered during semi-structured interviews with 50 rural producers and key informants in southern Pará during 2003 and 2004. A land-use change dataset was produced through remote sensing analysis of Landsat TM and ETM+ images for five years between 1986 and 2002. A supervised classification was performed based on training sites identified during fieldwork. A maximum likelihood procedure was performed in IDRISI software. Deforestation data for the period from 2003 to 2006 was updated with the digital information provided by the Brazilian Institute of Spatial Research (INPE)[3].

This paper is organised in six sections including this introduction. In the second section, I provide a theoretical review of the forces shaping frontier development, much of it drawn from literature produced in the Amazon. The third section depicts the history of land occupation in southern Pará which is surprisingly relatively unknown, and has only been analysed in fragmented pieces elsewhere. In the next section, I analyse the interactions between the expansion of cattle production, land tenure, and local power relationships. In the fifth section, I explore the main land-use change trajectories taking place in the study area, assessing the independent contribution of each type of actor to deforestation. Finally, I provide a synthesis and major conclusions.

2. A REVIEW OF THE FACTORS SHAPING FRONTIER DEVELOPMENT

The factors driving frontier development can be classified as exogenous and endogenous. The exogenous factors are primarily public policy decisions about road construction and land distribution, along with some incentive policies. The location, extent and shape of the road network are important features determining the spatial pattern of land occupation by influencing where people and firms migrate and settle.[4] Land policies exert a large influence on who owns land, shaping the structure of land tenures.[5] In turn, incentive policies determine who benefits from institutional rents provided by the state in the form of fiscal incentives, tax holidays, cheap credit, or roads that facilitate access to markets.[6]

After an initial period of occupation, there are several endogenous interactions that operate on the frontier, contributing to their spatial and socio-economic configuration. The main interactions are related to the influence that roads and urban centres exert on the spatial distribution of farms and ranches, the functioning of land markets that promote either land concentration or fragmentation linked to the arrival of investors interested in buying lands or setting up processing plants (slaughterhouses, meat packing plants, or dairy processing plants), and the local power relations that tend to reinforce local social structures. Opportunities to gain land on the frontier contribute to subsequent affluence. Furthermore, improved road access, better market conditions and new investments stimulate the modernisation of production systems, making them more profitable.

In its initial stage, frontier occupation is motivated by the appropriation of nature and its transformation into natural resources to be traded as commodities. The question about who appropriates such resources and the way in which the resulting economic rents are distributed is related to the origins of property – how resources were originally distributed among groups and individuals. Thus, initial occupation and resource appropriation can be seen as a process of primitive accumulation of capital.[7] In the early stage of frontier development, a logic

of natural resource mining predominates.[8] Land and forest are exploited in an extractive way by influential social groups that squat on public land or acquire it, often through fraudulent means. By using the land so acquired, individuals in these groups can make a profit which is then enlarged by capturing institutional rents provided by the nation-state.[9]

Nation-states which still have abundant public lands, such as Brazil, are often committed to development of the frontier for both political and economic reasons. The political goal is to guarantee physical control of their territories.[10] The economic goal is to articulate the frontiers into broader circuits of capital, labour and exchange of goods by converting what are often considered idle lands to productive uses[11]. However, this creates complex challenges related mainly to the distribution of benefits within society and the sustainable use of natural resources.[12]

The motivation underlying public policies aimed at developing the frontier tend to change with shifting priorities of governments. In the Amazon, for instance, there has been a transition from conceptions of regional planning towards neo-liberal notions of market-based development. Regional planning for the frontier focused on infrastructure, large-scale projects, encouragement of growth poles, and infusions of population. Under neo-liberal policies of development, in contrast, market dynamics increased their weight in driving development, with a concomitant decline in the role of public policy.[13]

It is a paradox of frontier development that although the nation-state promotes occupation of the frontier, state institutions have little presence there.[14] The state stimulates the arrival of pioneers seeking to enlarge their self-interest. These pioneers benefit from state inaction (for instance in controlling land squatting), but also from incentives granted through public policy. The state often arrives later in an attempt to expand the provision of services and to capture a portion of the rents from private earnings.[15] However, in recent times and in the face of the growing influence of markets, the state has increasingly attempted to regulate the use of natural resources mainly as a way to halt depletion of forests.[16] Yet the paradox persists due to the limited capacity of the state to influence the behaviour of landholders. This favours a 'law of the jungle' situation in which influential social groups enforce their interests.[17]

The fiscal and credit incentives provided by the state have proved to be relatively efficient mechanisms for promoting occupation of land in the frontiers. Occupation of land may be driven by speculation stimulated by expectations of profit from both agricultural development and state subsidies.[18] However, as the frontier develops, occupation of land becomes more strongly tied to agricultural use,[19] and although land speculation persists, it is increasingly linked to the marketable value of land. In the Brazilian Amazon, state subsidies explain much of the expansion of cattle ranching in the early stages of frontier development.[20] However, subsequent development has been driven by improved access

to markets and profitable cattle ranching associated with the modernisation of cattle production systems.[21]

The modernisation of cattle ranching is a process of relative intensification of range fattening of cattle or calf production.[22] It is motivated by at least three factors: availability of new technologies and management practices, public regulations forcing producers to adopt new practices, and market demand for high quality beef. Research has yielded pastures better adapted to climatic conditions, rotational pasture management, and genetic improvement of animal stocks.[23] Public regulations that have triggered improved management practices are aimed at enforcing the traceability of animals, and the eradication of foot and mouth disease by sanitary regulations. Finally, slaughterhouses have demanded higher quality beef. To remain competitive, ranchers have had to improve their management practices.[24] Not all producers, however, are in a position to adopt the new technologies, particularly those with little access to investment capital. [25]

Being less efficient, extensive systems of cattle production require more land per animal. Suggestions that improvements in livestock technology will take pressure off forests assume that if ranchers can raise the same amount of cattle on less land they will not need to convert as much forest to pasture.[26] Thus, technologies that reduce pasture degradation will allow farmers to persist in an area rather than clearing additional forest for new pastures. However, in some cases, the reality could be the opposite.[27] The effect of capital- and labour-intensive technologies depends on the time scale involved. In the short run, new technologies will tend to reduce deforestation, as land managers concentrate more on a smaller area, but over time higher profits will attract additional labour and capital to the region, leading to a net increase in deforestation. The latter seems to be the case in the Amazon since deforestation takes place at the same time as the modernisation of beef production practices.

3. DYNAMICS OF LAND OCCUPATION IN THE REDENÇÃO AREA

Redenção is located in the southeastern portion of the south of the State of Pará.[28] It embraces the municipalities of Redenção, Santa Maria das Barreiras, and Santana de Araguaia to the south, and the municipality of Cumarú do Norte to the west, plus a portion of the southeast of São Félix de Xingu. The western border of the adopted zone is defined by the edge of the satellite imagery used for land-use classification (Figure 1). It is bordered by the State of Mato Grosso to the south, and the Araguaia River forms the border with the State of Tocantins to the east. The total area under consideration is 4.7 million ha. It was originally covered mostly by forests. Currently, about 2.8 million ha is still covered with forest, and most of the cleared land is under pasture.

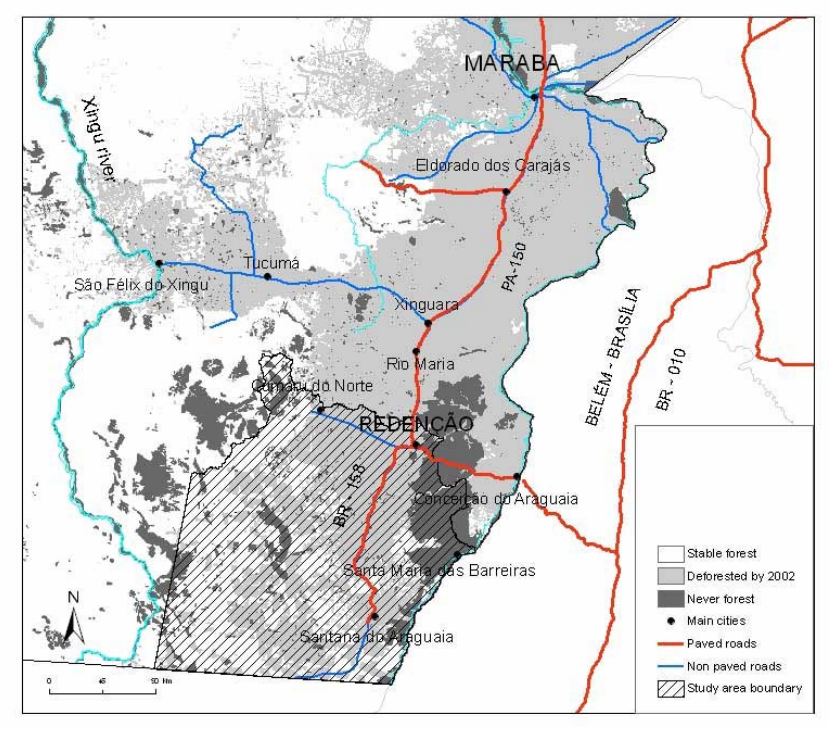

FIGURE 1. The research site in the southern State of Pará

The population of the Redenção region during the first decades of the last century was about 7,000 people. While the rural population grew in the 1970s to 89,000, it declined sharply during the 1980s by about half. The initial increase was a response to demand for manual workers to log and clear forest, as well as to an expansion of gold mines (*garimpos*). The subsequent decrease was driven by increasing use of machinery and the closure of *garimpos*. Much of the rural population moved to urban centres in the 1980s, mainly to Redenção which is the main city of the region. In parallel, commercial services demanded by the expansion of the livestock economy stimulated the growth of urban centres. The total urban population in 2000 was 108,000 people.

The occupation of land in the Redenção area occurred in four episodes. The first was the development of rubber (*caucho*) extraction in the late nineteenth century. The second, which began in the 1960s, was characterised by the expansion of corporate ranching by companies from southern Brazil, which in turn stimulated the arrival of medium- and large-scale traditional ranchers. The third episode is a depression cycle driven by the reduction of state incentives and the failure of corporate ranching during the mid-1980s and subsequently. The

last began in the mid-1990s with the definitive collapse of corporate ranching accompanied by the expansion of medium-scale ranching, driven in part by the arrival of new investors, but also by the growth of smallholder settlements implanted by agrarian reform.

When the first episode of occupation of the Redenção area began in the late nineteenth century, the region was still populated by the indigenous Karajás and Kayapó groups. The village of Conceição do Araguaia was established during this period and was the most important urban centre, being the marshalling point for most of the flow of manufactured goods coming from other regions of the country, and rubber extracted in the region being transported to the external city of Belém.[29] The rubber industry was based on *caucho* (*Castiloca elastica*) rather than rubber trees (*Hevea brasiliensis*), and required the trees to be cut down in order to extract their resin. This fostered nomadic activity in the forest and did not support a large population.

Little remained during the first decades of the twentieth century after the extractive *caucho* economy collapsed. Scattered villages around the main rivers were associated with incipient agriculture based on small-scale farming that produced a diversified basket of crops (i.e. rice, corn, beans and manioc), and some small cattle herds. In contrast, cattle ranches were established and flourished in the eastern bank of the Araguaia River in *cerrado* (savanna) areas. These supplied beef to Conceição de Araguaia, by then a small city and still the most important urban centre. The forest cover constrained the expansion of cattle ranching to the west of the Araguaia River. From 1920 to 1950, agriculture was primarily limited to subsistence goals.

In the late of 1950s and early 1960s, the opening of the Belém-Brasília highway coincided with the first attempts to find gold in the Redenção area. A group of gold-seekers from the southern states of Brazil obtained information about the availability of public lands and claimed a portion of them.[30] This stimulated development of a livestock industry because it was followed by the arrival of large corporations from the south of the country supported by a programme of fiscal incentives put in place by SUDAM (Superintendence for Amazonian Development) in the early 1960s. This stimulated privatisation of land which until then had been the property of the State of Pará. Land was granted to corporations and individual investors for the purpose of agricultural development. Most of the land was sold through sealed tenders of land units (*glebas*) for a maximum of 900 *alqueires*[31] (Figure 2).

By the mid-1970s, 74 projects were supported by SUDAM in the area south from Marabá, of which 52 were in the southeast portion of the state of Pará. Two main factors justified these corporate investments, neither of them related to revenue from cattle ranching: in the short run, the main source of profit were the institutional rents from state incentives (i.e., cheap credit and tax holidays); in the long run, they were motivated by the likelihood of profiting through land speculation.[32]

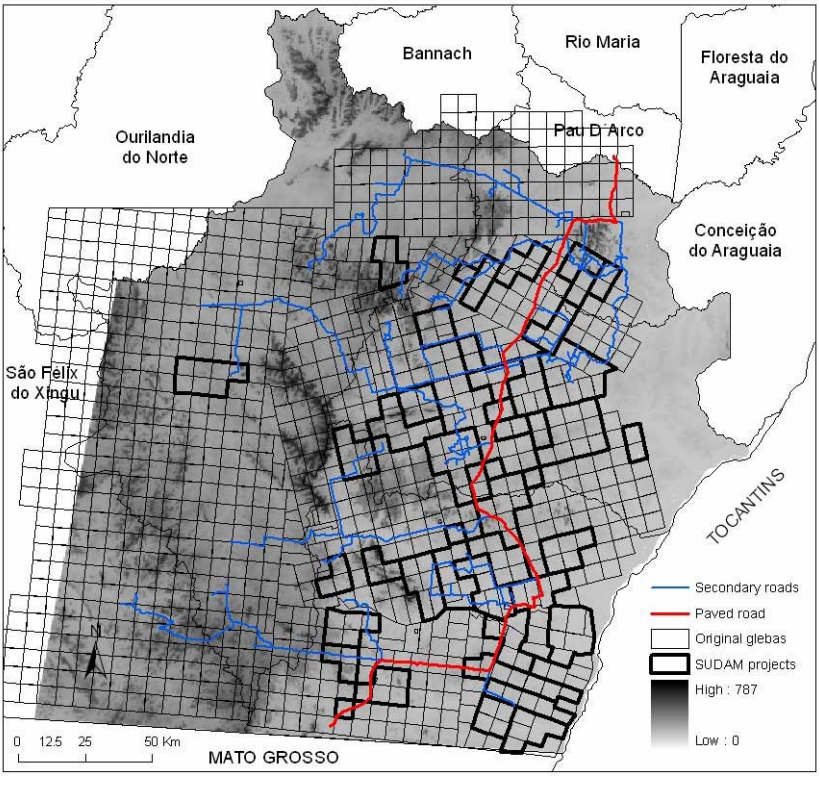

FIGURE 2. Redenção area: mosaic for land selling and SUDAM projects
Source: Elaboration by author based on data from SUDAM

Much of the timber cut during forest clearing was wasted. It was not until the 1970s that timber companies arrived in the region to exploit mahogany (*Swietenia macrophylla*). This occurred mostly in the area between Marabá and Redenção, with less intensity to the south where the species is less common. Timber extraction was strongly associated with pasture expansion since the former facilitated access for the latter and allowed cattle ranchers to sell mahogany encountered during forest clearing. When the supply of mahogany was exhausted in the mid-1980s, several loggers became cattle ranchers to secure ownership of the areas they had cleared.

In the mid-1970s, some medium-scale entrepreneurs arrived to the Redenção area from southern states, motivated by the lower price of land.[33] While these ranchers did not benefit from SUDAM incentives as corporate ranches had, they were able to access PROTERRA loans for land acquisition, and this line of credit was instrumental in the expansion of non-SUDAM ranches.[34] About 60%

of rural PROTERRA credit was applied to forest removal, pasture development, and acquisition of stock.[35]

The peak of public incentives and private investment was in the earlier 1970s, with a decline during the remainder of that decade. By 1978, about one billion dollars had been invested by SUDAM in corporate ranches, about US$ 2.7 million per ranch in direct investment.[36] Yet it has been argued that SUDAM funding did not achieve the anticipated pasture creation and expansion of cattle herds.[37] However, it did contribute to the introduction of high-quality livestock and an expansion of the road network.[38]

In the mid-1980s, most of the SUDAM ranches began to show signs of failure for several reasons. Firstly, the corporations were not involved directly in their administration, leaving much room for managers to take decisions that were not always in the corporate interest. Secondly, the productivity of pastures particularly of the *colonião* variety reached a crisis.[39] A new grass variety (*Brachiaria*) developed by the Brazilian Agricultural Research Agency (EMBRAPA) was introduced.[40] During the second half of the 1980s and in the 1990s, there were serious efforts by ranchers to convert their pastures to the productive *Brachiaria*. It was at this time that several (ex)SUDAM projects began to dissolve and the corporation sold their lands. In 1985, only 22 of the 52 SUDAM ranches were still supported with state incentives, these supporting only 40% of stock targets.[41]

In the early 1980s, there was an explosion of *garimpos* in the north of the municipality of Cumarú do Norte.[42] Most banking and associated financial services developed at this time. The livestock economy did not benefit much from gold mining, but the *garimpo* boom brought infrastructure and associated services to the city of Redenção. When gold mining collapsed in the late 1980s, most of the *garimpeiros* moved to Redenção, putting pressure on public services. A portion of these immigrants invaded some large landholdings which became agrarian reform settlements in the mid-1990s.[43]

The 'Real Plan' implemented by the administration of Fernando Henrique Cardoso (FHC) (1995–2003) in the mid-1990s reduced the atmosphere of insecurity characteristic of the 1980s and promoted new investment in cattle ranching. Furthermore, the FHC administration promised agrarian reform and in so doing invigorated the movement of people into southern Pará.[44] Cattle ranchers had access to resources from the Constitutional Fund of the North (FNO), and from specific programmes targeted at smallholders such as the Special Credit Program for the Agrarian Reform (PROCERA) and the National Program for Strengthening Family Agriculture (PRONAF).[45] About 4.5% (US$ 35 million) of total FNO monies from 1989 to 2002 was allocated to the municipalities of the Redenção area. Over half of this was used to acquire 90,000 breeding stock. About 17% was used for pasture establishment and maintenance and equipment. Only 9% was used to finance dairy production, the rest going to support other activities.[46]

4. CATTLE RANCHING, LAND TENURE AND POWER RELATIONS

Much of the development of the Redenção area can be explained by the interactions taking place between demand for land, expansion of land markets, and the development of cattle production systems. However, a parallel political process has arisen with the arrival of smallholders.

Main cattle production systems

The rural economy in the Redenção area has traditionally been dominated by extensive cattle ranching, and agriculture has been important only since the expansion of smallholder settlements due to the fact that they combine subsistence agriculture with cattle raising. The dominance of extensive cattle ranching was linked to the availability of cheap land and the interest of investors and squatters to legitimise land ownership through conversion of forest to pasture and development of cattle production. Although SUDAM projects implemented modern cattle production techniques, traditional cattle ranchers arriving from southern states (Minas Gerais, Goiás and Paraná) reproduced their customary extensive systems of cattle production with a self-reproducing herd and little selection of animals. This was due to the low price of land, difficulties in finding qualified labour, and isolation from the main markets.

The cattle-raising system changed over time for two reasons. The first was the development of roads that allowed cattle producers to reach more distant markets in which they had to compete in terms of quality and price with suppliers from other regions. The quality of herds was improved by replacing mixed-breed cattle with introduced certified pure Nelore breeds, a type of zebu, and discarding cows with lower pregnancy rates. The second trigger to change was the gradual degradation of pasture productivity due to inappropriate grasses, over-grazing and compaction of soils.[47] Pasture management was improved by rotation.

According to official statistics, the number of cattle in the Redenção area has increased from 776,000 head in 1990 to 1.1 million in 2002, and 1.9 million in 2006.[48] This was about 12.6% of total bovine population in the state of Pará in 1990, and 11.2% in 2006. Although the reported cattle population declined in the first half of the 1990s, the pace of growth began to accelerate from 1996 to a rate of growth of 11.2% per year by 2002, rising to 15.1% per year between 2003 and 2006. Nothing suggests that this rate of expansion will decline in the future.

Milk production was almost nonexistent until the late 1990s but expanded with the proliferation of small-scale landholdings as a result of land invasions. By the middle of the first decade of the twenty first century, the Redenção area produced around 5 to 7% of all milk produced in the state of Pará in the middle of the first decade of the twenty-first century. Dairy production often occurs in small-sized dual-purpose cattle herds, with relatively low productivity. A few

smallholders have adopted specialised cattle production for beef, and a significant number only grow annual crops due to their lack of capital to purchase cattle.

Land markets and trends in the fragmentation of tenures

As mentioned earlier, most of southern Pará was privatised through planned sales in the 1960s conducted by the Colonization and Land Department of the state of Pará. Some individuals served as brokers, taking advantage of connections with the public agency and linkages with companies interested in acquiring land. While some investors acquired their titles in this way, others merely squatted on the land, particularly some medium-scale ranchers who took advantage of the land rush to obtain land easily.[49] Most of the cattle ranchers were able to legitimise their ownership of land by acquiring titles from the state government, though some still persist in a semi-legal condition.[50]

The sale of land in southern Pará promoted the concentration of land in the hands of a few speculators who arrived first. They began to sell land to corporations, interested in obtaining SUDAM incentives in the 1960s and 1970s. As mentioned, there were about 52 of these projects operating in this area (Figure 2). Individual *glebas* were also sold to families or individual investors. It is reasonable to assume that land speculation decreased as subsidies shrank.

TABLE 1. Cleared *glebas* acreage according to selected periods (thousand ha) (a)

	Until 1986	**1986-92**	**1992-96**	**1996-02**	**Total**
SUDAM projects	486.2	125.8	91.3	164.9	868.2
No-SUDAM projects	821.6	363.1	485.1	688.6	2,358.4
Total period	1,307.8	488.9	576.4	853.6	3,226.6
In percents	40.5	15.2	17.9	26.5	100.0

Source: Elaboration by author based on data from SUDAM and estimates of deforestation based on LANDSAT imagery.

Figure 3 shows the major waves of land clearing, which can be equated with occupation of land over the last forty years. While there was an intense wave of settlement up until the 1980s, only 40% of the area allocated as *glebas* was cleared by the end of this period. In this same period, almost a half of all *glebas* occupied by SUDAM projects had in part been cleared for pasture establishment. It is important to note that an area of 821,000 hectares was *glebas* settled without SUDAM support in the same period, almost double the area occupied by SUDAM projects in that period. Most of the land occupied was located around the main road that crosses the zone in a north-south direction, from which cattle ranching expanded further but gradually to the areas less connected to the main road network.

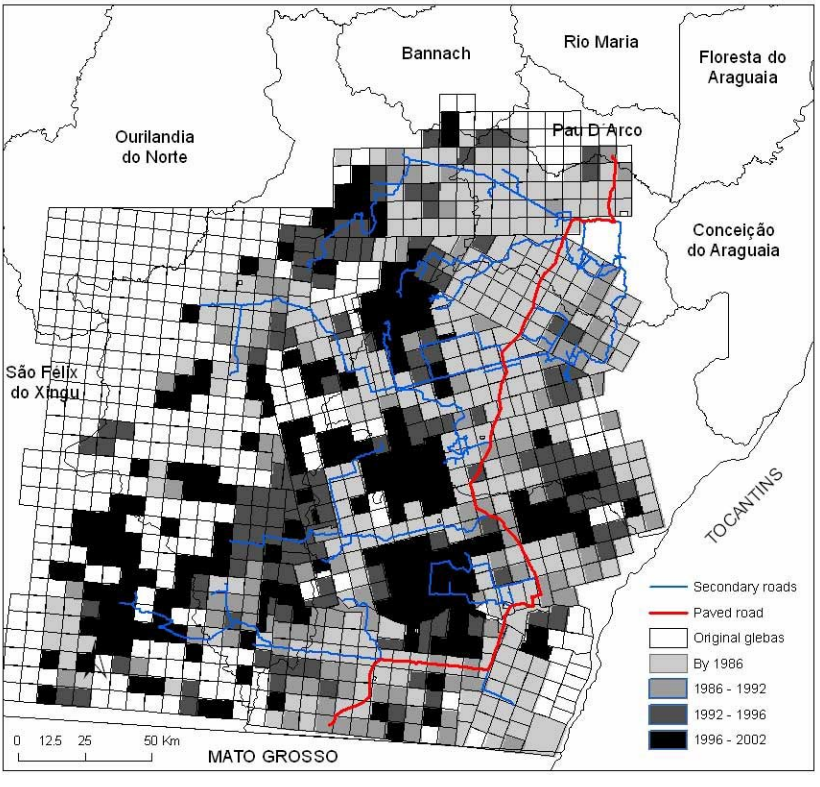

FIGURE 3. Timing of initial forest clearing, 1986–2002.

Note: Considers a *gleba* (a land unit of 4,356 ha) as initially deforested only when 10% or more of it was cleared.

Source: Elaboration by author based on data from SUDAM and estimates of deforestation based on LANDSAT imagery.

The dynamic of land occupation after the mid-1980s was as intense as that in the earlier years. In the period from the mid-1980s to 2002, about 60% of the total *glebas* were occupied (Table 1). Occupation moved westward, running perpendicular to the main road. Figure 3 shows large areas in the centre of the study area that were not effectively occupied until the late 1990s, a major part of which were SUDAM ranches that were partially abandoned in the 1980s and invaded by squatters and landless people. Much of this central area became INCRA settlements. The ranch *Rio Cristalino* (formerly owned by Volkswagen) is a special case since it was invaded by a large number of small- and large-scale squatters, and it is still under dispute, facing expropriation by INCRA.[51]

Anecdotal evidence suggests that a new wave of investors in cattle ranching arrived in the early 1990s from the northeastern states of Brazil. These new investors purchased some ranches that were for sale due to financial difficulties, and began to establish profit-sharing arrangements with local cattle ranchers to fund the acquisition of better quality animals. The increasing demand for land from this new wave of outside investors reinvigorated the cattle ranching economy and contributed to keeping land prices at relatively high levels. While a major concentration of land ownership occurred with the establishment of corporatist ranches during the mid-1970s, a counter-trend towards the fragmentation of land ownership developed as the frontier matured. In 1978,

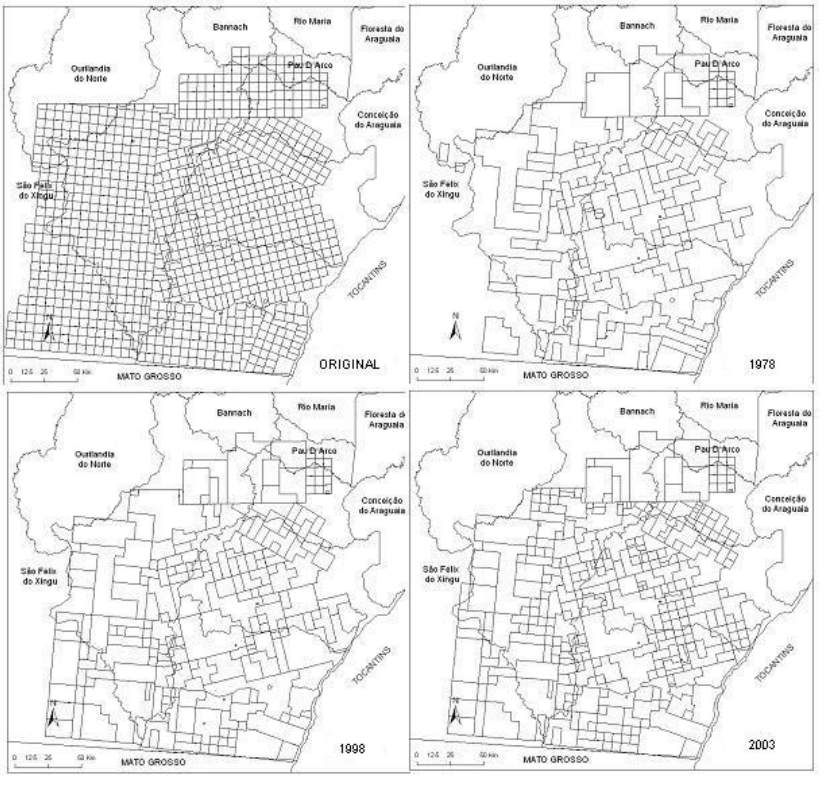

FIGURE 4. Evolution of land ownership in the Redenção area

Source: Original grid obtained from ITERPA registers. 1978 map elaborated by *Setentrional – Agrimensura e Topografia Ltda*. based on field information from P. Eleres for the period 1973/75. The 1998 map was made available by staff of *Agropecuária Versátil*and is based on their field information. The 2003 map was elaborated by the author based on INCRA registers, interviews with landholders, and information provided by real estate brokers operating in Redenção.

the average medium/large ranch was about 23,500 ha, and the largest around 200,000 ha. Twenty years later, the average area was 18,000 ha, and the maximum about 150,000 ha, a downward trend that continued into the early twenty-first century (Table 2 and Figure 4). There has been a trend towards incorporating new *glebas* into ranching, but through smaller-sized ranches, in parallel to the fragmentation of ranches.

TABLE 2. Evolution of medium and large landholdings.

	Planned (a)	**1978 (b)**	**1998 (c)**	**2003 (d)**
Number	1,068	148	210	338
Mean (ha)	4,309	23,557	18,077	12,462
St. dev. (ha)		± 30,960	± 26,379	± 18,728
Maximum (ha)		199,895	153,840	97,494
Minimum (ha)		2,936	1,123	855

Notes: a) Original grid obtained from ITERPA registers; b) 1978 information derived from a map elaborated by *Setentrional – Agrimensura e Topografia Ltda*. based on field information from P. Eleres taken in the period 1973/75; c) information for 1998 is based on a map made available by staff of *Agropecuária Versátil* based on their own field information; d) information for 2003 is based on a map elaborated by the author based on INCRA registers, interviews with landholders, and information provided by real estate brokers operating in the city of Redenção.

The fragmentation of large estates parallels an increase in the price of land. This was a result of development of infrastructure and a greater demand for land. It is also likely that fragmentation of tenures is associated with economies of scale, and also that large-scale cattle ranches are under siege by movements of landless people.

Allocation of land by sealed tenders precluded smallholders from the frontier during the initial period of development. Land invasions began in the early 1990s, but in the late 1980s, three small colonies – *Arraiapora I and II*, and *Capitinga* – were created with the support of the land agency of the State of Pará (ITERPA). In turn, the federal land agency (INCRA) became more active in the study area in the early 1990s, but it was not until the FHC administration that the formal process of land expropriation and the formalisation of land invasions began in earnest (Table 3). Almost two thirds of the area affected by these processes was previously held by ranchers that had received SUDAM resources. These ranchers were bought out with debt securities, some receiving compensation far above market prices.[52] Expropriation was thus potentially profitable and some ranchers promoted invasion of their landholdings.

TABLE 3. INCRA settlements in the Redenção area according to creation date.

	1985–89	1990–94	1995-2000	Total
No. settlements	3	2	25	30
Thousand hectares	65.5	34.8	386.6	487.0
No. of families installed	212	230	5,644	6,086
No. of families capacity	716	1,040	8,676	10,432
% area under ex-SUDAM projects	100.0	100.0	55.6	64.8

Source: Author's calculations based on land registers from INCRA – SR 027

In the invaded areas, INCRA granted 50 ha lots to each household. Several families were able to claim more than one lot in the name of different family members. Some squatted or otherwise acquired land that exceeded the maximum allowed, triggering a partial concentration of land ownership within the INCRA settlements. Today, the average size of rural properties within these settlements was estimated to be 76 ha (± 53 s.d.).[53] The infrastructure available in INCRA settlements varies greatly, with some enjoying some access to services and others being relatively isolated without all-weather roads.

According to the Agricultural Census of 1995/96 carried out by the Brazilian Institute of Geography and Statistics (IBGE), there were about 4,000 establishments in this region embracing an area of 2.3 million ha. A major portion of them (65.9%) were of less than 100 hectares, whereas 2% of establishments covered 63% of the area. Table 4 and Figure 5 show my estimates of land distribution based on land registers obtained from both the federal (INCRA) and state (ITERPA) land agencies. According to ITERPA, about 60% of the Redenção area is occupied by cattle ranches, while 10% is INCRA settlements projects (*Projetos de Assentamento*, PA). A small proportion of land is occupied by small farmers settled to the east of the city of Redenção. Another 10% is part of the indigenous jurisdictions of Kayapó to the north and Badjônkôre to the south. These indigenous territories have been encroached by loggers in the past, especially for mahogany extraction, and some frontier expansion is currently taking place within the indigenous jurisdiction to the north.[54]

TABLE 4. Types of landholdings in the Redenção area in 2002.

	INCRA settlements	Cattle ranches	Small farmers	No data (a)	Other areas (b)	Indigenous areas (c)	Total
Thousand ha	483	2,802	103	523	344	480	4,735
Per cent	10.2	59.2	2.2	11.0	7.3	10.1	100.0

Notes: a) Constitute areas within the property grid in which was not possible to obtain information about landholding limits (grey areas in Figure 5), yet much of this areas has already been occupied mostly by semi-legal or illegal means, b) constitute areas located outside of the original property grid (white areas in Figure 5), c) embraces the Kayapó indigenous territory to the north, and Badjônkôre to the south. Based on field interviews to people acting as real estate brokers, land registers from INCRA, and FUNAI

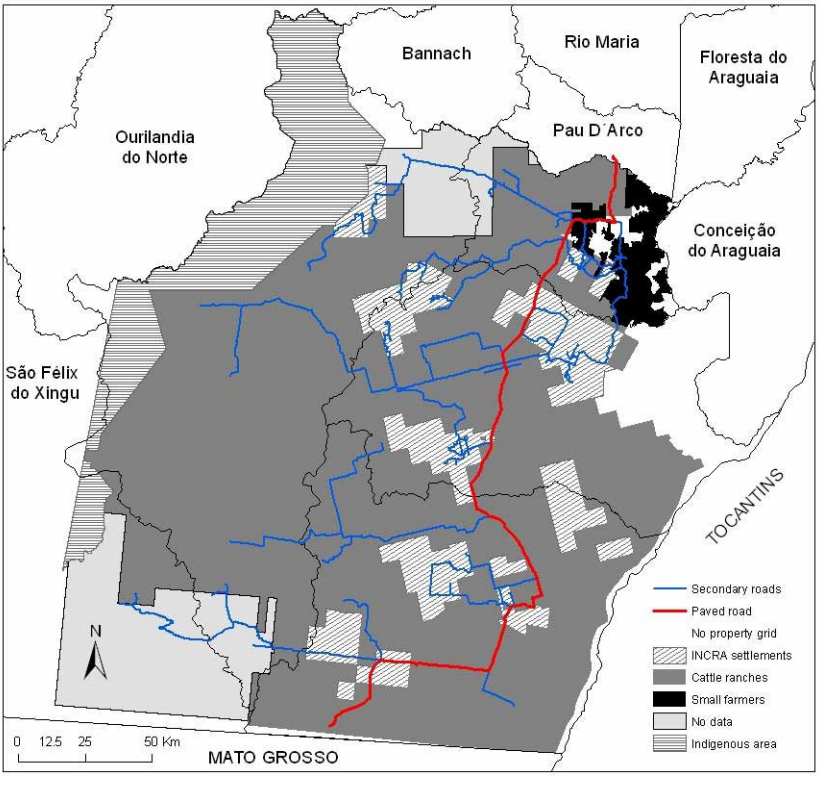

FIGURE 5. Land distribution in the Redenção area, 2002

Source: Based on information from INCRA, and information obtained in the process of compiling Figure 4.

Cattle industry and market restructuring

The market dynamics for cattle products were strongly linked to both road development and installation of processing industries, specifically slaughterhouses and dairies. During the first years of settlement until approximately the mid-1970s, most live cattle were sold in Belém,[55] competing with stock from Paragominas and Marajó. At that time, transportation to Belém was via Conceição de Araguia to reach the Belém–Brasília highway, and was difficult. The opening of the Redenção–Marabá road in the second half of the 1970s improved access, with cattle being transported from Marabá along the Tocantins River to Belém.[56]

In the 1980s, before the widespread establishment of slaughterhouses, commerce in live cattle was monopolised by merchants, although a slaughterhouse was set up in 1980 near Santana de Araguaia that operated only to 1985 due to operational problems. The market situation in the study area changed when

a slaughterhouse was set up in Redenção in 1996, and the slaughterhouse of Santana de Araguaia was purchased and re-opened by the same industrial group. In parallel, government measures that prohibited marketing of non-refrigerated meat led to a rapid expansion of the market for frozen meat, with slaughterhouses as key players.[57] As a result, these two slaughterhouses began to purchase most of the meat in the region, reducing transport costs and allowing access to distant markets mainly in the northeast and south of Brazil.[58]

To the extent that the cattle population expanded, so did the number of slaughterhouses that were set up in the region. In southern Pará, six more slaughterhouses were established from 1999 to 2004. This did not lead to improved prices for live cattle because it stimulated an increasing supply, and slaughterhouses started to demand higher quality animals. Most of these slaughterhouses are preparing to export meat once the barriers limiting it – linked to the Foot and Mouth Disease (FMD) free zone recognition – are removed, which will likely take place in the near future. Half of them already have a license to export beef. Export restrictions for beef do not apply to de-boned meat, but not all slaughterhouses have the technology to process and export this type of meat.

Milk production is increasing steadily, matching the expansion of smallholders in INCRA settlements. Rapid growth has taken place in the area surrounding the municipality of Xinguara where there has been an explosive increase in dairy processing plants, though most are of small capacity. About 13 new plants were set up in the area from Redenção to Marabá since the mid-1990s. Much of the production from these plants is marketed in the northeastern states.[59] There is only one dairy plant operating in Redenção. It failed previously, was reopened, and is currently administered by a co-operative. There are collection centres in Redenção for a large-scale dairy plant based in Conceição do Araguaia. Anecdotal evidence suggests that there is a large number of informal dairy plants that are not registered and evade tax obligations. It is likely that milk production will continue to expand in the future.

Politics, state regulations and local power relationships

The ascendance of cattle ranching in this and other regions in the Amazon was not accidental. Local and regional interests played an important role in shaping policy goals. During the military regime, aims of national sovereignty and regional economic growth were served by collusion between dominant elites and corporations in which the latter developed ranching operations in the Amazon in order to derive financial benefit from the sale of public land and the public resources flowing to the Amazon.[60] However, there were moments in the early 1970s in which social demands led the government to privilege populist instruments to populate and develop the Amazon through small-scale agriculture.[61]

In southern Pará in the early stages of the frontier development, there was little influence of the traditional elite *paraense*, as greater dominance was exerted

by influential groups attached to corporations primarily based in the south of Brazil. For instance, the Association of Amazonian Entrepreneurs (AEA), based in São Paulo, was composed of corporate ranchers from southern Pará. The AEA lobbied government for policies favouring large-scale occupation based on the notion that this was the only rational means of occupying the region.[62] The incentives to ranching provided during the military regimes benefited such corporations. In exchange for fiscal incentives, the government transferred to these corporations the responsibility for infrastructure –mainly road building– that the government was not able to address.[63]

While corporations were important players in debating public policies with federal government agencies, they neglected local politics. Local ranchers organised rural associations (*sindicatos rurais*) to represent their interests against regularisation of land by state and federal governments, and to defend their lands against growing pressure from local peasant movements. In the 1980s, three ranchers' associations were created in the Redencão area, namely in Redenção, Xinguara and Rio Maria.[64] These associations became powerful actors in the local political arena and in negotiating policy instruments with government, though their main concerns were the land disputes that arose with the emergence of a strong movement of landless people. The rural associations remain as advocates of conservative paradigms of rural development based on cattle ranching and as strong opponents to government initiatives for agrarian reform.

The policy arena became more complex when the landless movement entered the regional scene. A tradition of violence around contested land claims in southern Pará persists[65] because land tenure remains highly skewed.[66] When the state or its institutions do not work for, or do not make decisions that satisfy the cattle ranchers, violence is used to impose their individual or group interests. Violence has in some cases followed land invasions when cattle ranchers attempt to repel encroachers. Yet, a greater presence of public institutions in the region, mainly linked to agrarian reform programmes, and the eradication of slave labour, have stimulated rancher associations to negotiate with federal agencies.

Influential groups of ranchers and other local elites have also been able to erode mechanisms for enforcement of the land-use and environmental regulations, though that is changing slowly over time. Issued in 1995, the regulations aim to reduce deforestation by specifying that rural landowners should set aside 80% of the forest on their landholding as a Legal Reserve[67]. Since then, this has been the most contentious issue in the environmental policy for the Brazilian Amazon among medium- and large-scale landholders.[68]

The state environmental agency (IBAMA) has difficulty exerting effective control and cattle ranchers continue to clearcut forest without constraints.[69] In the State of Pará and elsewhere, government has tried to establish alternative mechanisms to enforce compliance with the Legal Reserve requirements, but with little success. Entrepreneurial landholders continuously attempt to change the law to allow more flexible land use. Although environmental law specifies

that rural landowners can revegetate cleared land to meet their Legal Reserve obligations and avoid environmental penalties, this is rarely accomplished in practice.[70] Compliance with environmental regulations is against the interests of smallholders as well as large-scale landholders.

5. THE IMPRINT OF FRONTIER DEVELOPMENT ON THE LANDSCAPE

Development of the frontier has had strong implications for the landscape as the expansion of cattle ranching in the region has been the primary cause of conversion of forest to other land uses. The rate of conversion has increased over time. The rate of conversion of forest to pasture was not great until the mid-1980s notwithstanding incentives for the development of corporate ranches. It began to grow in the 1990s and reached a peak around 2004, after which it started to slow down. Thus, it is reasonable to assume that market-driven development of cattle ranching has played a large role in deforestation in the Redenção area, and likely in the whole southern Pará region.

In 1986, about 84% of the study area was forest, almost 4 million ha, a small portion near Conceição do Araguaia was *cerrado*, and about 9% (416,000 ha) was pasture that had been converted from forest. The situation has changed dramatically since then. In 2002, about a third of the total area had been converted to pasture (1.4 million ha), with 61% remaining as forest (2.9 million ha), the area of pasture area having increased by a factor of 3.3 since 1986. Most deforested land was converted to pasture. Although forest regrowth was about 200,000 ha in the second half of the 1990s, it decreased to 79,000 ha in 2002. These numbers counter the idea that cattle ranching leads to abandonment of pasture and reforestation since much of the converted pasture remains in use.

TABLE 5. Land use in the Redenção area, 1986–2002.

	In thousand hectares					**Percentage**				
	1986	**1992**	**1996**	**2000**	**2002**	**1986**	**1992**	**1992**	**2000**	**2002**
Water	29	11	11	16	13	0.6	0.2	0.2	0.3	0.3
Forest	3,994	3,538	3,324	3,005	2,895	84.4	74.7	70.2	63.5	61.1
Never forest	283	326	217	241	224	6.0	6.9	4.6	5.1	4.7
Pasture	416	661	981	1,269	1,424	8.8	14.0	20.7	26.8	30.1
Regrowth	-	199	201	202	79	-	4.2	4.3	4.3	1.7
Clouds	12	-	0	0	100	0.3	-	0.0	0.0	2.1
Total	4,735	4,735	4,735	4,735	4,735	100.0	100.0	100.0	100.0	100.0

Source: Author's estimates based on LANDSAT TM and ETM+ imagery analysis.

Note: 'Clouds' indicates areas that could not be assessed because cloud cover obscured the image.

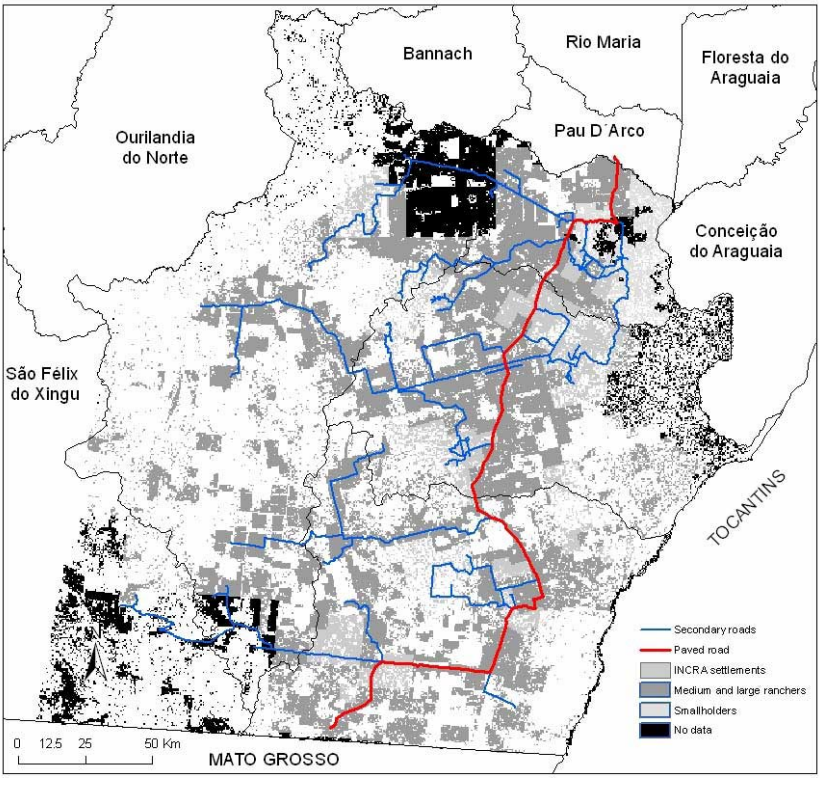

FIGURE 6. Accumulated deforestation by landholding type, 2002.
Source: Author's estimates based on LANDSAT TM and ETM+ imagery analysis, and land tenure information provided in Figure 5.

The annual rate of deforestation from the early 1970s to 1986 was about 26,000 to 34,000 ha/year, though some pasture expansion took place in the *cerrado*. Rates of deforestation increased to 53,000 hectares/year for the period 1986 to 1992, to 93,000 hectares/year for the period 1992 to 2000, and to 150,000 hectares/year from 2000 to 2002. In relative terms, the annual rates of deforestation grew from 1.37% in 1986-92 to 5.27% in 2000-02. Since then, deforestation has been in the order of 114,000 to 119,000 ha/year and the rate is decreasing, but these are a relatively high proportion of the remaining forest cover (Table 6).

Temporal trends in deforestation in the Redenção area are similar to those observed for the State of Pará and the Brazilian Legal Amazon as a whole.[71] In these two cases, the annual rates of deforestation were relatively low until the

TABLE 6. Deforestation in the Redenção area by agent, 1986-2006

	Selected periods (a)					
	1986–92	**1992–96**	**1996–2000**	**2000–02**	**2003–04**	**2005–06**
Annual deforestation (in thousand ha)						
Small farmers (b)	4.2	2.9	17.6	30.6	19.8	21.4
Cattle ranchers	39.2	72.4	56.9	77.1	72.1	70.8
Not identified (c)	10.0	18.2	20.0	42.1	22.8	27.1
Redenção area	53.4	93.6	94.5	149.7	114.8	119.4
State of Pará	455.2	608.8	543.8	641.1	775.9	561.8
Brazilian Amazon	1,407.9	2,070.5	1,652.4	1,921.0	2,633.1	1,639.9
Annual deforestation rate (in %) (d)						
Small farmers	0.9	0.7	4.8	10.4	12.8	20.7
Cattle ranchers	1.8	3.6	3.2	4.9	5.9	6.8
Not identified	0.8	1.6	1.9	4.3	3.2	4.2
Redenção area	2.0	3.9	4.7	7.6	5.5	6.7
State of Pará	0.4	0.6	0.5	0.7	0.8	0.6
Brazilian Amazon	0.4	0.6	0.5	0.5	0.8	0.5

Notes: a) the years corresponding to 1986 to 2002 are based on the author's estimates from LANDSAT TM and ETM+ imagery analysis, while the years from 2003 to 2006 are based on information provided by PRODES/INPE, b) includes smallholders outside the city of Redenção, and smallholders located in INCRA sponsored settlements, c) includes areas with no property grid information and the land corresponding to the indigenous territory located in the study area, d) deforestation rates are calculated for each class placing the annual deforestation for the period in the numerator, and the total remaining forest within the landholdings owned for each group in the denominator.

mid-1980s (0.4%), and they doubled until the early 2000 when reached about 0.8% in 2003-04. In 2005-06, these rates shrank to 0.6% in the State of Pará, and 0.5% for the whole Amazon region. Although the reasons for this reduction are not clear, the Brazilian government suggests that state actions such as credit constraints and greater monitoring have had a positive impact.

Much of the deforestation in the Redenção area has been driven by medium- and large-scale cattle ranching (see again Table 6) rather than smallholders. In this regard, there has been a lot of controversy about the contribution of SUDAM-sponsored projects to deforestation. In the study area, SUDAM-sponsored projects were responsible for about 37% of all land cleared by 1986 (see again Table 1). However, SUDAM projects also prompted deforestation in indirect ways, mainly through creating roads that subsequently attracted significant numbers of medium-scale investors to neighbouring areas.

By the mid-1980s, 70% of accumulated deforestation was caused by medium- and large-scale cattle ranching. An additional 20% of deforestation occurred in areas for which land tenure is uncertain but which most likely were large-sized

ranches, demonstrating that deforestation was driven overwhelmingly by medium- and large-scale ranchers in this region. Deforestation fostered by small-scale agriculture grew from 5% of the cumulative total in 1986 to 10% in 2002 and 17% in 2005. Many smallholders at the beginning of the settlements did not convert forest to pasture or crops because many INCRA smallholder settlements were in areas already converted to pasture on ranches that were previously large (mainly ex-SUDAM ranches). Nonetheless, increasing affluence led to an expanded contribution of smallholders to deforestation. Furthermore, the rapid growth of deforestation rates in INCRA settlements is due to there being little forest cover left in such lands.

There is little likelihood that rates of forest removal will reduce in the future as markets for beef cattle are expanding and infrastructure and modernised beef production systems are in place. Indeed, the modernisation of ranching and fragmentation of tenures have not ameliorated deforestation thus far. For example, a large portion of the land in the southwest of the region where access is more difficult due to the poor quality of the roads, has been already converted to pasture. A few ranchers have converted some pasture to soybean production, mainly near the border with Mato Grosso, but it is uncertain how quickly this will develop in the future.

6. CONCLUSIONS

In this work, I have examined the conditions that shaped the development of typical corporatist frontiers as represented by the southeast portion of southern Pará. This is a region dominated by medium- and large-scale cattle ranching, though there is an increasing presence of small farmers. Livestock production developed because private interests were able to obtain cheap land and incentives from the government. The incentives were intended to prompt the occupation of the Amazon for economic and geopolitical goals. Thus, military and corporatists interests colluded to motivate the change in question.

Most SUDAM-sponsored livestock projects failed to establish sustainable cattle ranching, although the primary objective of those that were sponsored was not necessarily to do so; some obtained land for speculative purposes. However, occupation of the frontier stimulated medium-scale entrepreneurs, mostly cattle ranchers from Minas Gerais, Paraná and São Paulo, to establish cattle ranches due to ease of access to land. Although this group did not benefit from SUDAM incentives, it did benefit from subsidised credit. In parallel, logging facilitated expansion of the frontier, but once the availability of mahogany was exhausted most loggers became cattle ranchers to secure land ownership. The expansion of cattle ranching, however, faced several constraints in the 1980s, including poor roads, distance to markets, and weak development of market chains.

Most of these constraints were overcome in the 1990s due to a more stable macroeconomic environment that depressed land speculation and created more incentives to invest. A new wave of investors arriving from the northeast injected capital into the region, invigorating land markets and promoting the fragmentation of large estates. Furthermore, growing investment in the cattle industry led to a restructuring of beef markets, making it easier for cattle ranchers to sell animals of improved quality. Demand led to an expansion of cattle herds which, in turn, stimulated expansion of processing capacity in the late 1990s. A similar phenomenon took place with dairy production because dairy plants set up in major urban centres favoured the expansion of milk production in smallholder settlements.

Land invasions became important in the early 1990s and have changed the land tenure situation and influenced local politics. Much of the invading population was attracted to the region as rural workers for forest clearing, logging, and by the *garimpos*, but they moved to the city as these endeavours collapsed. Invasions have been stimulated by landless people along with squatters and informal loggers. Land reform has legitimised this process, but it has been limited to regulating the dynamics of existing invasions rather than promoting a planned process of re-allocation of agricultural establishments with low productivity to landless people.

The landscape has undergone drastic change in southern Pará driven by conversion of forest to pasture. Medium and large ranchers, who hold a larger proportion of land in the study area, deforest more in absolute terms. Nevertheless, smallholders deforest a higher proportion of the land they occupy. This is explained by increasing affluence within INCRA settlements, and the relatively small-sized lots these settlers have access to.

Public policy has played a key role in defining the spatial and socio-economic configuration of this cattle ranching frontier. In this regard, economic incentives along with infrastructure development attracted new investments in the cattle industry, which in turn contributed to the consolidation of medium and large cattle ranches, and with it a drastic transformation of the landscape by conversion of forest to pasture. Nevertheless, policy shifts, infrastructure development, and increasing exposure to regional beef markets have altered the agrarian economy and forced cattle ranchers to compete in more demanding markets by improving pasture and herd management. However, the gains from market development in terms of arrival of slaughterhouses and the ability to sell in distant markets has provided new incentives for ranchers to continue deforestation to expand their pastures. Better infrastructure – e.g., electricity and roads – and increasing opportunities to make a living in the countryside, have also stimulated greater affluence and thus intensified land tenure struggles.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the receipt of research funding from the Center for International Forestry Research (CIFOR), Bogor, Indonesia, and the support of the Institute of Environmental Research for Amazônia (IPAM), Belem, Brazil. I would like to thank Billie Turner, Dianne Rocheleau, Robert G. Pontius, and Sven Wunder for their comments on a previous version of this paper. I also want to thank to David Kaimowitz, Jean F. Tourrand, Marie G. Piketty, and Benoit Mertens for their collaboration when I was carrying out fieldwork. I am also grateful to those smallholders, cattle ranchers and ranch managers who patiently gave their time to answer my questions.

NOTES

[1] Ronald R. Rindfuss et al., 'Developing a Science of Land Change: Challenges and Methodological Issues', *Proceedings of the National Academy of Sciences* 101, no. 39 (2004): 13976–13981, Garik Gutman et al., *Land Change Science: Observing, Monitoring and Understanding Trajectories of Change on the Earth's Surface*, *Remote Sensing and Digital Image Processing Series, Vol. 6* (New York: Springer, 2004), Billie L. Turner et al., *Integrated Land-Change Science and Tropical Deforestation in the Southern Yucatan: Final Frontiers* (New York: Oxford University Press, 2004).

[2] Jeffry A. Frieden et al., eds., *Modern Political Economy and Latin America: Theory and Policy* (Westview Press, 2000), Raymond Bryant and Sinéad Bailey, *Third World Political Ecology* (London: Routledge, 1997).

[3] Deforestation data from INPE is available in the website: http://www.obt.inpe.br/prodes/

[4] Benoit Mertens et al., 'Crossing Spatial Analyses and Livestock Economics to Understand Deforestation Processes in the Brazilian Amazon: The Case of Sao Felix Do Xingu in South Para', *Agricultural Economics* 27, no. 3 (2002): 269–294.

[5] Hans P. Binswanger, 'Brazilian Policies that Encourage Deforestation in the Amazon', *World Development* 19, no. 7 (1991): 821–829.

[6] Susanna Hecht, 'The Economics of Cattle Ranching in Eastern Amazonia', *Interciencia* 13, no. 5 (1988): 233–240.

[7] David Kaimowitz, 'Frontier Theory and Practice' (unpublished draft, Bogor, Indonesia: 2002).

[8] Robert Schneider, 'Government and the Economy on the Amazon Frontier. World Bank Environment Paper No. 11 .' (Washington D.C.: The World Bank Group, 1995).

[9] Susanna Hecht, 'The Logic of Livestock and Deforestation in Amazonia', *Bioscience* 43, no. 10 (1993): 687–695.

[10] Susanna Hecht and A. Cockburn, *The Fate of the Forest: Developers, Destroyers and Defenders of the Amazon* (London: Verso, 1989).

[11] Kaimowitz, 'Frontier Theory and Practice'.

[12] David Cleary, 'After the Frontier: Problems with Political Economy in the Modern Brazilian Amazon', *Latin American Studies* 25 (1993): 331-349, Anthony Hall, 'Environment and Development in Brazilian Amazonia: From Protectionism to Productive Conservation', in *Amazonia at the Crossroads: The Challenge of Sustainable Development*,

ed. Anthony Hall (London: Institute of Latin American Studies, University of London, 2000), Daniel Nepstad et al., 'Frontier Governance in Amazonia', *Science* 295 (2002): 629–630, Robert Schneider, 'Government and the Economy on the Amazon Frontier'. World Bank Environment Paper No. 11.

[13] Susanna Hecht, 'Soybeans, Development and Conservation on the Amazon Frontier', *Development and Change* 36, no. 2 (2005): 375–404, Pablo Pacheco, 'Populist and Capitalist Frontiers in the Amazon: Dynamics of Agrarian and Land-Use Change' (PhD dissertation, Clark University, 2005).

[14] Kaimowitz, 'Frontier Theory and Practice'.

[15] Schneider, 'Government and the Economy on the Amazon Frontier'.

[16] Mohan Munasinghe, *Environmental Impacts of Macroeconomic and Sectoral Policies* (Washington DC.: ISEE-World Bank-UNEP, 1996).

[17] Cynthia S. Simmons, 'Local Articulation of Policy Conflict: Land Use, Environment and Amerindian Rights in Eastern Amazonia', *The Professional Geographer* 54, no. 2 (2002): 241–258.

[18] Susanna Hecht, 'Environment, Development and Politics: Capital Accumulation and the Livestock Sector in Eastern Amazonia', *World Development* 13, no. 6 (1985): 663–684.

[19] Thomas Rudel, 'Changing Agents of Deforestation: From State-Initiated to Enterprise Driven Processes, 1970–2000', *Land Use Policy* 24, no. 1 (2007): 35-41.

[20] Hecht, 'The Economics of Cattle Ranching in Eastern Amazonia'.

[21] Sergio Margulis, 'Causes of Deforestation of the Brazilian Amazon'. Report No. 22, (Washington, D.C.: World Bank, 2004).

[22] Eugenio Arima and Christopher Uhl, 'Ranching in the Brazilian Amazon in a National Context: Economics, Policy, and Practice', *Society and Natural Resources* 10, no. 5 (1997): 433–451.

[23] Jonas Bastos da Veiga et al., 'A Amazônia Pode Virar uma Grande Região de Pecuária Bovina Sustentável?', (Belem, Brasil: Empresa Brasileira de Pesquisa Agropecuaria (unpublished draft), 2001).

[24] David Kaimowitz and Arild Angelsen, 'Will Livestock Intensification Help Save Latin America's Tropical Forests?'*Journal of Sustainable Forestry* 27, no. 1–2 (2008):6–24.

[25] Jonas Bastos da Veiga et al., 'Milk Production, Regional Development and Sustainability in the Eastern Amazon', (Belém, Brasil: CIRAD-Empresa Brasileira de Pesquisa Agropecuaria, 2001).

[26] Douglas Southgate, *Tropical Forest Conservation: An Economic Assessment of the Alternatives in Latin America* (Oxford: Oxford University Press US, 1998).

[27] Kaimowitz and Angelsen, 'Will Livestock Intensification Help Save Latin America's Tropical Forests?',

[28] The region known as southern Pará constitutes a relatively large territory that embraces the southeastern portion of the State of Pará in the Brazilian Amazon. It ranges from the municipality of Maraba in the north to the border with the State of Mato Grosso in its extreme south.

[29] Octavio Ianni, *A Luta Pela Terra: Historia Social da Terra e da Luta Pela Terra numa Área da Amazonia*, 2da ed. (Petropolis, RJ: Vozes, 1979).

[30] Jonas Bastos da Veiga et al., *Expansão e Trajetórias da Pecuária na Amazônia* (Brasilia: Editora UNB, 2004).

[31] The most common land unit in southern Pará is the *alqueire goiano* which equates to 4.84 ha. According to land legislation of the state of Pará, the maximum unit that a private investors could claim from the state to be granted private ownership by buying it was 900 *alqueires*, or 4,356 ha.

[32] Hecht, 'The Logic of Livestock and Deforestation in Amazonia'.

[33] da Veiga et al., *Expansão e Trajetórias da Pecuária na Amazônia*.

[34] PROTERRA was available for both investment and land purchases. Investment credits were lent with 6 years grace period, interest rates of 10–14%, 12 years to amortise fixed investment, and 8 years for semi-fixed investment with 4 years grace. Land credits were 12% of interest rate, 20 years to amortise with 6 years grace-period.

[35] Susanna Hecht, 'Cattle Ranching Development in the Eastern Amazon: Evaluation of Development Strategy' (Ph.D dissertation, University of California, 1982).

[36] Ibid.

[37] Clando Yokomizo, 'Incentivos Financeiros e Fiscais na Pecuarizacão da Amazônia. Texto Para Discussão No. 22', (Rio de Janeiro, Brazil: Instituto de Planejamento Econômico e Social (IPEA), 1989).

[38] Cattle ranching, through subsidised SUDAM projects, helped to develop most of the primary road infrastructure. Due to the large occurrence of mahogany amidst Redenção and Xinguara, pressures emerged to open a road towards Marabá in the early 1970s. By then, most timber and cattle had to be transported from Redenção to Conceição do Araguaia to take the Belém-Brasília highway passing through the state of Tocantins (then part of Goias) and Maranhão to get to the Belém market in the northeast portion of Pará. The Redenção-Marabá road (PA 150) was constructed between 1973 and 1975, and extended to Santana de Araguaia between 1977 and 1982, offering a more direct connection with the Belém market. This road was paved in the early 1990s.

[39] First-generation grasses on recently formed pastures were mainly *colonião* (*Panicum maximum*), and Brachiaria (*Brachiaria decumbens*), which are high productivity varieties, but are vulnerable to weeds and invader species. Much of the areas planted with this pasture variety degraded severely after ten or fifteen years of use in the mid-1980s. As a result, large areas became unproductive for cattle breeding, and had to be abandoned since it was not profitable to recover these areas for production.

[40] The most popular grass variety introduced in the Amazonia, due to its resistance to climatic conditions, is Braquiarão (*Brachiaria brizantha*), though some other *Brachiaria* varieties have also been adopted to avoid pasture degradation. *Braquiarão* is vigorous, provides good ground cover to suppress weeds, and resists spittlebugs, which severely affected the previously used grasses varieties. Nigel Smith et. al., *Amazonia: Resiliency and Dynamism of the Land and its People* (New York: United Nations University Press, 1995)

[41] Unfortunately, there is only fragmented information about implemented projects by ranch. This information comes from SUDAM registers included in DESMAT, a dataset combining socio-economic data to model deforestation at the municipal level developed by IPEA.

[42] The *garimpos* that emerged in the first half of the 1980 decade in the south of Pará were diverse. The largest was Serra Pelada, closer to Marabá. The best known *garimpos* installed near Redenção were Cumarú, Forquilha, Maria Bonita and Malvinas e Garrapato.

[43] Pacheco, 'Populist and Capitalist Frontiers in the Amazon: Dynamics of Agrarian and Land-Use Change'.

[44] Philip M. Fearnside, 'Land-Tenure Issues as Factors in Environmental Destruction in Brazilian Amazonia: The Case of Southern Para', *World Development* 29, no. 8 (2001): 1361–1372.

[45] FNO, PROCERA and PRONAF constitute subsidised credit lines specifically targeted to promote small-scale agriculture. A portion of these resources is also intended to consolidate and promote agricultural development in the projects of agrarian reform implemented by the state land agency, the National Institute of Colonization and Agrarian Reform, INCRA.

[46] Pacheco, 'Populist and Capitalist Frontiers in the Amazon: Dynamics of Agrarian and Land-Use Change'.

[47] Smith et al., *Amazonia: Resiliency and Dynamism of the Land and its People*.

[48] IBGE. 'Pesquisa Pecuária Municipal (PPM)' (Rio de Janeiro, Brasil, 2007).

[49] da Veiga et al., *Expansão e Trajetórias da Pecuária na Amazônia*.

[50] It is almost impossible to identify the real situation of land titling in southern Pará as the land transaction registers held in the notaries are not public. The act of registering a transaction in the notary renders it legal even if it is based on fraudulent titles.

[51] According to anecdotal evidence, the Volkswagen company created one of the largest cattle herds in the region on a single ranch (around 140,000 head). After selling most of the cattle and exhausting the ranch's forest reserve, they sold it to its current owner, the Matsubara group from Paraná, in the mid 1990s. This group promoted the invasion of the ranch by squatters as a way to facilitate its sale to INCRA as part of the program of a market-based agrarian reform. However, a contentious process impeded INCRA from acquiring the area, and now most of this ranch is illegally occupied by squatters. To complicate matters, uranium has been discovered in this area, which led the Ministry of Science and Technology to declare it as 'nuclear monopoly area', restricting occupation by outsiders.

[52] Fearnside, 'Land-Tenure Issues as Factors in Environmental Destruction in Brazilian Amazonia: The Case of Southern Para'.

[53] Pacheco, 'Populist and Capitalist Frontiers in the Amazon: Dynamics of Agrarian and Land-Use Change'.

[54] Ibid.

[55] Walmir Hugo dos Santos, 'Matadouros – Frigorificos: O Abate para Carne em Belém', (Belém: Ministerio da Agricultura, SUDAM, Governo do Estado do Pará, ACAR-Pará, 1976).

[56] Veiga et al., *Expansão e Trajetórias da Pecuária na Amazônia*.

[57] René Poccard-Chapuis et al., 'Cadeia Produtiva de Gado de Corte e Pecuarização da Agricultura Familiar Na Transamazônica. Documentos No. 106', (Belém: Empresa Brasileira de Pesquisa Agropecuaria, 2001).

[58] Rene Poccard-Chapuis, 'Les Reseaux de la Conquete Filiere Bovine et Structuration de L´Espace sur les Fronts Pionniers D´Amazonie Oriental Bresilienne' (Université de Paris X – Nanterre, 2004).

[59] Poccard-Chapuis et al., 'Cadeia Produtiva de Gado de Corte e Pecuarização da Agricultura Familiar na Transamazônica. Documentos No. 106.'

[60] Hecht, 'Cattle Ranching Development in the Eastern Amazon: Evaluation of Development Strategy', John Browder and Brian Godfrey, *Rainforest Cities, Urbanization, Development and Globalization of the Brazilian Amazon* (New York: Columbia University Press., 1997).

[61] Emilio Moran, 'Private and Public Colonization Schemes in Amazonia', in *The Future of Amazonia: Destruction or Sustainable Development?*, ed. D. Goodman and A. Hall (New York: St. Martin's Press, 1990), Emilio Moran, *Developing the Amazon* (Bloomington: University of Indiana Press., 1981).

[62] Malori J. Pompermayer, 'Strategies of Private Capital in the Brazilian Amazon', in *Frontier Expansion in Amazonia*, ed. Marianne Schmink and Charles Wood (Gainesville, FL: University of Florida Press, 1984).

[63] Hecht, 'Environment, Development and Politics: Capital Accumulation and the Livestock Sector in Eastern Amazonia.'

[64] Marcionila Fernandes, *Donos de Terras: Trajetórias da União Democrática Ruralista, UDR* (Belem, Pará: UFPA, NAEA, 1999).

[65] Marianne Schmink and Charles Wood, *Contested Frontiers in Amazonia* (New York: Columbia University Press, 1992).

[66] Cynthia S. Simmons et al., 'The Changing Dynamics of Land Conflict in the Brazilian Amazon: The Rural-Urban Complex and Its Environmental ' *Urban Ecosystems* 6, no. 1–2 (2002): 99–121.

[67] The 1965 Forest Code stipulated that at least 20% of any property area covered by forest should be kept as forest – thus allowing the owner to clear up to 80% of its area. In the Amazon, 50% of each property in areas covered by native forest had to be designated as Legal Reserve. In 1995, the Brazilian government used a Presidential Transitory Act to strengthen the Forest Code, raising the Legal Reserve area for the Amazon region from 50 to 80% of the property in an attempt to reduce deforestation.

[68] Hall, 'Environment and Development in Brazilian Amazonia: From Protectionism to Productive Conservation.'

[69] Ane Alencar et al., 'Desmatamento Na Amazônia: Indo Alem da Emergência Crônica', (Belem, Brasil: IPAM, WHRC, 2004).

[70] Bernardo Mueller and Lee J. Alston, 'Legal Reserve Requirements in Brazilian Forests: Path Dependent Evolution of de Facto Legislation' (paper presented at the Anais do XXXV Encontro Nacional de Economia, Sao Paulo, 2007).

[71] The Amazon Basin of Brazil has been defined by government decree in 1953, and it is referred as the Brazilian Legal Amazon (BLA). It covers an area of 5,000,000 km^2 embracing the six 'North' states (Acre, Amapá, Amazonas, Pará, Roraima and Rondônia), plus part of three others (Tocantins, north of the 130° parallel; Mato Grosso, north of the 160° parallel; and Maranhão, west of the 44° meridian). In 1977, the entire State of Mato Grosso was included in the BLA by the complementary law n°31 (art. 45). The main reason for the creation of the Legal Amazon was to define an area for the administration of economic development, rather than to delimit a region according to a uniform ecosystem. That is the reason why the BLA includes, besides forested land, extensive areas of natural savanna (*cerrado*), and open forest in the transition zone between closed forest and *cerrado*.