Forest policy enforcement at the Amazon frontier: the case of Mato Grosso, Brazil

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Paris / Heidelberg, January 2005 Sheila A. Wertz-Kanounnikoff

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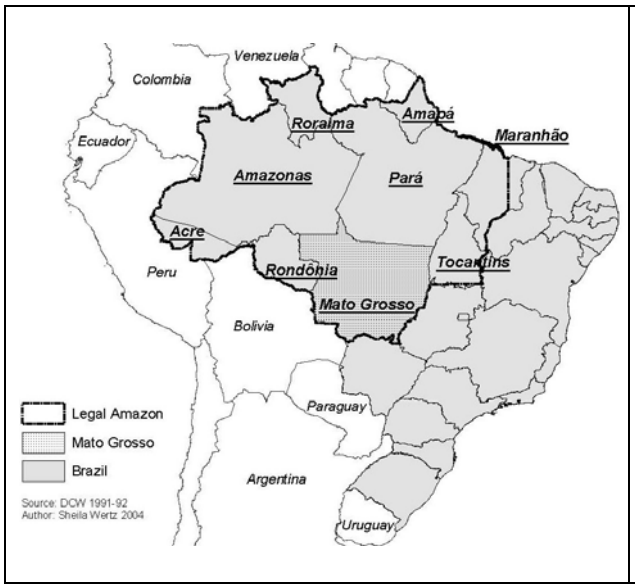
Abbreviations

APP	*Areas de Preservação Permanente* (areas of permanent preservation)
FAMATO	*Federação Mato Grossense de Agricultura y Pecuária* (Association of Agriculture and Livestock of Mato Grosso)
FEMA	*Fundação Estadual do Meio Ambiente de Mato Grosso* (Mato Grosso State Foundation of the Environment)
IBAMA	*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* (Brazilian Institute for the Environment and Renewable Natural Resources)
IBGE	*Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute of Geography and Statistics)
IMEA	*Instituto Mato-Grossense de Economia Agricola de Economia Agricola* (Mato Grosso Institute for Agronomy)
INCRA	*Instituto Nacional de Colonização e Reforma Agrária* (National Institute for Colonization and Agrarian Reform)
INPE	*Instituto Nacional de Pesquisas Espaciais* (Brazilian National Institute for Space Research)
LAU	*Licença Ambiental Unica* (unified environmental license)
MMA	*Ministério do Meio Ambiente* (Brazilian Ministry of the Environment)
PLANAFLORO	*Plano Agropecuário e Florestal de Rondônia* (Rondônia Natural Resources Management Projects)
POLAMAZÔNIA	*Programa de Polos Agropecuários e Agrominerais da Amazônia* (Program for Agricultural, Livestock and Mineral Poles in Amazônia)
POLOCENTRO	*Programa de Desenvolvimento dos Cerrados* (Cerrado Development Program)
POLONOROESTE	*Programa de Desenvolvimento Integrado do Noroeste do Brasil* (Northwest Integrated Development Program)

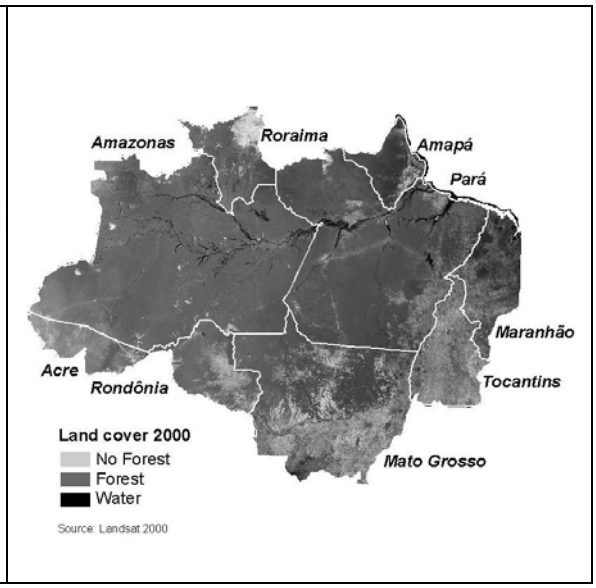
PPG7	*Programa Piloto para Conservação das Florestas Tropicais do Brasil* (Pilot Program to Conserve the Brazilian Rain Forests)
PROARCO	*Programa Integrado de Monitoramento, Prevenção e Controle de Desmatamento, Queimadas e Combate a Incêndios Florestais* (Emergency Amazon Fire Prevention and Control Project)
PRODEAGRO	*Projeto de Desenvolvimento Agroambiental de Mato Grosso* (Mato Grosso Natural Resources Management Project)
RL	*Reserva legal* (legal reserves of natural vegetation cover on private lands)
SEPLAN	*Secretaria do Estado do Planejamento e Coordenação Geral* (Mato Grosso State Secretary for Planning and General Coordination)
SLAPR	*Sistema de Licenciamento Ambiental em Propriedade Rural* (Environmental licensing system of rural properties)
UNDP	UN Development Program

1 Introduction

Large-scale agricultural colonization of the Legal Amazon – an administrative unit comprising nine Brazilian states that contain parts of the Amazon rainforest – started in response to the regional development and economic growth strategies of the military government after 1964. This resulted in massive conversion of tropical forests to agricultural land, especially in the frontier states Pará, Rondônia and Mato Grosso. In the Amazon region, the frontier - usually characterized by an abundance of land and a sparsity of people and capital (Schneider 1995) – straddles the south-eastern parts of the region where also much of the regional deforestation activity is concentrated. The extent of forest conversion in the Legal Amazon is monitored by the Brazilian Institute for Space Research (INPE) which reports a mean deforestation rate of 18,000 km^2 per year (about half the size of Belgium) since 1974, cumulating total Amazon deforestation to about 653,000 km^2 in 2003 (INPE 2004). Map 1 situates the Legal Amazon within the administrative context of Brazil, and Map 2 depicts the Legal Amazon and its remaining forest cover in 2000.



Map 1: The Legal Amazon



Map 2: Land cover of the Legal Amazon

But when does deforestation become a problem? From an ecological viewpoint, deforestation is an influence on the ecosystem. Depending on the scale of influence, the

ecosystem can either cope with or adapt to the new conditions. Whether deforestation is perceived as "problematic" is lastly a decision made by human beings. Economists essentially view deforestation as problematic (inefficient) if its social costs (e.g. climate change, biodiversity loss) exceed its social benefits (e.g. regional development), i.e. if it harms human welfare. However, ignorance and uncertainty regarding ecosystem functioning, and methodological concerns challenge the economic valuation of social costs and benefits of deforestation. Despite these difficulties, and under the assumption of a justified legal doctrine, one can consider at least any deforestation which occurs in non-compliance with the existing legal framework (e.g. in conservation units) as problematic.

Tabulations from the Brazilian agricultural census 1995/96 indicate that many private lands in the Legal Amazon are out of compliance with the Brazilian Forest Code. By law, private lands have to keep a defined proportion with native vegetation (*legal reserve*). Until 1996, the legal reserve requirement was 50% for properties located in the northern region of the country, comprising seven out of nine states of the Legal Amazon. Yet according to the agricultural census 1995/96, the aggregate share of native vegetation on private lands in the northern region of Brazil was 43% (IBGE 1998). Regardless of the additional requirement of conserving *permanent preservation areas* on private lands (areas along water bodies, on steep slopes or hill tops), the gap between the actual native vegetation cover in 1995/96 (43%) and the legally required share (50%) indicates deficient compliance with the Brazilian Forest Code, at least in the northern region of Brazil.[1] Hence, the combination of insufficient enforcement of environmental laws and lacking economic returns from forest preservation resulted in large-scale and often illegal deforestation of the Brazilian tropical forests.

In 1999, a new approach to illegal deforestation control was initiated by the Mato Grosso State Foundation of the Environment (FEMA) by adopting a new environmental licensing

[1] Presumably, non-compliance with the Forest Code increased upon further restriction of the legal reserve requirement for the Legal Amazon in 1996 (approved as law-like Presidential Decree in 2001).

system of rural properties (SLAPR). The SLAPR consists of licensing and enforcement activities, and obliges private landholders to register their holdings at FEMA. The licensing process requires updated property titles and land use plans that comply with forest use laws. Actual compliance with the licensed land use plan is monitored with remote sensing technology, and accountability is ensured via a close collaboration between public agencies. In economic terms, the SLAPR is a command-and-control instrument that promotes land titling and the enforcement of the duty of private properties to comply with forest laws as mean to control private deforestation.

Decreasing deforestation rates between 1999 and 2001 were viewed as evidence for program success, and the SLAPR became widely recognized at both the national and international level. The outcome was of even greater significance in the context of an agrarian growth region such as Mato Grosso where, unlike in other Amazon states (e.g. Acre or Amapá), environmental objectives were traditionally of only little political priority. In turn, replication initiatives started in other Brazilian states, and in 2004, the Brazilian Government declared the SLAPR as part of its *Action Plan to Prevent and Control Deforestation in the Legal Amazon*. In addition to its new role in Brazilian environmental policy-making, the SLAPR of Mato Grosso presents a relevant case study for the following reasons:

- Mato Grosso experienced land use developments that, although with great velocity, are only starting in other Amazon states, notably in Pará.
- The biodiversity of Mato Grosso, extremely peculiar and rich, is largely threatened by deforestation. In fact, about 40% of total Amazon deforestation occurs in Mato Grosso.
- The *property rights theory* views the absence of well-defined and enforced property rights as important cause for deforestation. The SLAPR promotes land titling and the enforcement of existing property regimes, notably the compliance with private forest regulations, and addresses thus an important cause of deforestation.

Therefore, *the aim of this thesis is to assess, with empirical analysis methods, the effectiveness of the SLAPR to control deforestation on private rural properties in Mato Grosso*. Specifically, the objectives are to

(i) improve evidence of the SLAPR effectiveness in enforcing environmental regulation on private rural properties as a mean to control deforestation in Mato Grosso,

(ii) gain insights into the political economic conditions that shaped the implementation and outcome of the SLAPR, i.e. on the motivation and power relation of its stakeholders.

This thesis adopts an interdisciplinary research approach by integrating economic and geographic methods into the empirical research. To address the first objective, spatially disaggregated data on deforestation and other ecological and socio-economic variables for the study area Mato Grosso are integrated into an econometric analysis. The integration of spatially-explicit variables in econometric analysis of land use change remains a new field as economists hardly develop spatially-explicit land use change model while geographers tend to integrate spatial variables in an ad-hoc manner without addressing the economic rationale for a given land use pattern. Hence, the analysis approach to the first objective contributes to the new line of spatially-explicit models of land use change by seeking to integrate spatial variables based on an economic rationale. To address the second objective, an "extended version" of the political support approach is used as reference for the qualitative SLAPR stakeholder analysis. The motivation therefore refers to the positive approach (in contrast to the normative approach of traditional economic policy analysis) to analyze the behavior of and between political actors and the political process itself. Moreover, the qualitative inductive approach presents a complement to the deductive approach of the first research part. The stakeholder analysis is based on interviews, conducted during a three-month fieldwork phase in Mato Grosso, and qualitative content analysis techniques.

This thesis is organized as follows. Chapter 2 provides the background to the study area. It starts with a brief description of the ecological and socio-economic context of rural Mato

Grosso, and continues with an outline of the state's colonization process, as background to today's land use and deforestation pattern. The chapter then focuses on the evolution of the Brazilian environmental policy, specifically in the Brazilian Amazon as background to the environmental policy context of Mato Grosso. It ends with a presentation of the Mato Grosso SLAPR, which is the thesis' analysis subject.

Chapter 3 presents the first research part, notably a quantitative analysis approach to gain improved evidence on the SLAPR effectiveness in controlling deforestation in Mato Grosso. The objective is to assess the effects of increased forest policy enforcement on private land use by adopting an innovative application of the difference-in-difference approach to geographic data. Specifically, geographic information at spatial sample points of 1-km intervals is used to estimate the probability of deforestation within a probit regression model.

Chapter 4 contains the second research part, notably a qualitative analysis approach to assess the SLAPR effectiveness from a stakeholder perspective. The objective is to improve the understanding of the analysis results of Chapter 3 by focusing on the political actors of the SLAPR, their interests and power relations. Therefore, primary data from non-structured, non-standardized interviews with political actors of the SLAPR, conducted between February and April 2004, were analyzed using qualitative content analysis techniques.

Chapter 5 discusses the identified political economic and institutional determinants of the SLAPR outcome of the preceding chapters (Chapter 3 and 4) in view of evidence from other studies on the subject. It ends with a reflection of the SLAPR as a potential deforestation control model for the Brazilian Amazon.

Chapter 6 summarizes the analysis results of this thesis and concludes with possible further lines of research.

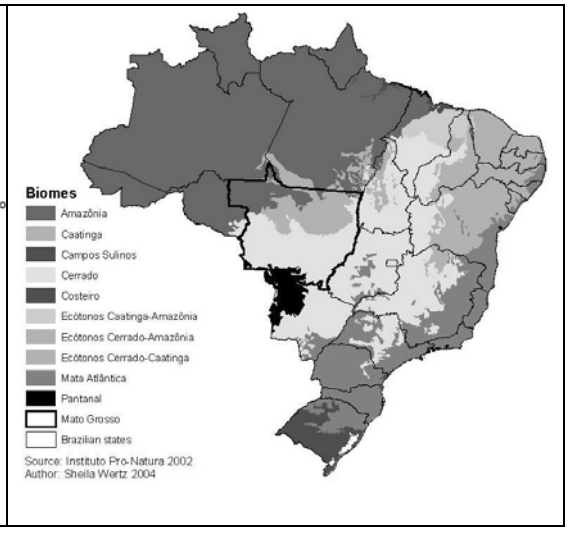
2 Background to the study area Mato Grosso

This chapter provides the background to the study area of this thesis. It starts with a brief description of the ecological and socio-economic context of rural Mato Grosso, and continues with an outline of the state's colonization process between the 1960s and 1980s, which greatly framed today's land use and deforestation pattern. Then, the evolution of the Brazilian environmental policy is presented as background to the environmental policy context of Mato Grosso. Finally, the chapter presents the environmental licensing system of rural properties (SLAPR) in Mato Grosso, which is the subject of analysis of this thesis.

2.1 Ecological and socio-economic context of Mato Grosso

With about 906,000 km^2 – this is about the size of France and Germany – Mato Grosso is the third largest federal state of Brazil situated in the Center-West region of the country (Map 3). The state capital is Cuiabá. Mato Grosso shares a national border with Bolivia to the southwest and state borders with Rondônia to the west, Amazonas and Pará to the north, Tocantins and Goiás to the east and Mato Grosso do Sol to the south.

Map 3: Mato Grosso within Brazil's context



Map 4: Ecoregions of Brazil

Mato Grosso belongs to the Legal Amazon – an administrative unit of the nine Brazilian states comprising parts of the Brazilian Amazon forest, notably Acre, Amapá, Amazonas,

Mato Grosso, Pará, Rondônia, Roraima, most of Tocantins, and half of Maranhão (Map 3). The Legal Amazon covers about 5 million km^2, more than 50% of Brazil's land area (Kaimowitz et al. 2004). The ecological and socio-economic context of rural Mato Grosso is presented next.

2.1.1 Ecological context of Mato Grosso

The ecological context of Mato Grosso is defined by the state's geographic location and regional climatic conditions. Situated between 52° and 61° west, and 8° and 18° south, Mato Grosso lies in the southern tropical hemisphere. It plays an important role in the Legal Amazon, notably for its territorial extension and its regional diversity with three ecoregions[2] (Map 4): Amazon and Amazon-Cerrado transition forests, *Cerrado* savanna and *Pantanal* wetlands. The forests are located to the north and cover about half of the state (52%). The remaining area to the south is almost entirely covered by the Cerrado (41%), with a small fraction (7%) to the furthest south belonging to the Pantanal wetlands (FEMA 2001a). A brief characterization of the ecoregions follows next.

Amazon forests

Nearly half of Mato Grosso is covered by moist forests that are concentrated in the north and composed of the Amazon and Amazon-Cerrado transition forests. About 2% of the Brazilian Amazon forest lies in north-west Mato Grosso (Map 4), covering about 10% of the state's territory. To the west and south, there is the Amazon-Cerrado transition forest covering around 40% of the state territory. The vegetation consists of rain and moist forests that are influenced by the local humid to semi-humid climate with dry and rainy seasons. The rainy season lasts from October to April, while it is mostly dry throughout the rest of the year. The soils are deeply corroded and poor in nutrients. The Amazon provides various domestic and

[2] Ecoregions are defined as geographically distinct assemblage of natural communities that share a large majority of their species and ecological dynamics, share similar environmental conditions and interact ecologically in ways that are critical for their long-term persistence (Dinerstein et al. 1995).

global forest benefits, especially carbon sequestration and biodiversity conservation (Ozanne et al. 2003). Nevertheless, deforestation occurs for agriculture, ranching, mining and road building. Further threats include small-scale logging, wildlife exploitation, introduction of exotic species, and hydroelectric projects (Dinerstein et al. 1995).

Cerrado

The Cerrado spreads across 1,700,000 km^2 of the central Brazil plateau, in the south-eastern part of the country. After the Amazon, the Cerrado is the second largest Brazilian biome accounting for about 20% of the country's land area (Map 4). About 20% of the entire Cerrado lies in Mato Grosso. The Cerrado receives abundant rainfall from October to April. The rest of the year is very dry, and many plant species in the Cerrado are well adapted to drought conditions. Cerrado soils are typically deeply corroded nutrient poor soils. Most of the Cerrado vegetation is adapted to fire, which is important as it balances grass and woody vegetation and assists in nutrient recycling and germination. Moreover, gallery forests are found throughout the region, although they are technically not considered part of the typical Cerrado formations (Blumenschein 2001).[3]

The Cerrado biome contains a high degree of biodiversity and is of peculiar importance to the neighboring biomes, especially in Mato Grosso. With more than 6,000 plant species the Cerrado flora is one of the most diverse in the world (Felfili and Felfili 2001). In addition, the Cerrado of Mato Grosso fulfills a peculiar function, since it is located between the Amazon forest and the Pantanal wetlands providing a bridge for flora and fauna, especially birds, to migrate between the neighboring biomes. However, the Cerrado is threatened by agricultural expansion, charcoal production, water projects, road construction and pollution by agro-toxics and mercury (Dinerstein et al. 1995). Due to easy access, lower deforestation

[3] The various Cerrado vegetation formations are distinguished by stock, density and occurrence of specific plant types: (i) *Campo limpo* as pure grass savanna, (ii) *Campo sujo* as grass savanna with infrequent shrubs and low trees, (iii) *Campo cerrado* as grass-shrub-tree savanna and (iv) the *Cerradão*, a forest formation with trees up to 12 meters height (Blumenschein 2001).

costs and higher suitability for large-scale agriculture compared to the Amazon biome, it was mostly Cerrado vegetation that has been deforested in Mato Grosso to open up new agricultural use land. Only in recent years, the Cerrado was recognized as an ecosystem worthy for conservation (Röper 2001).

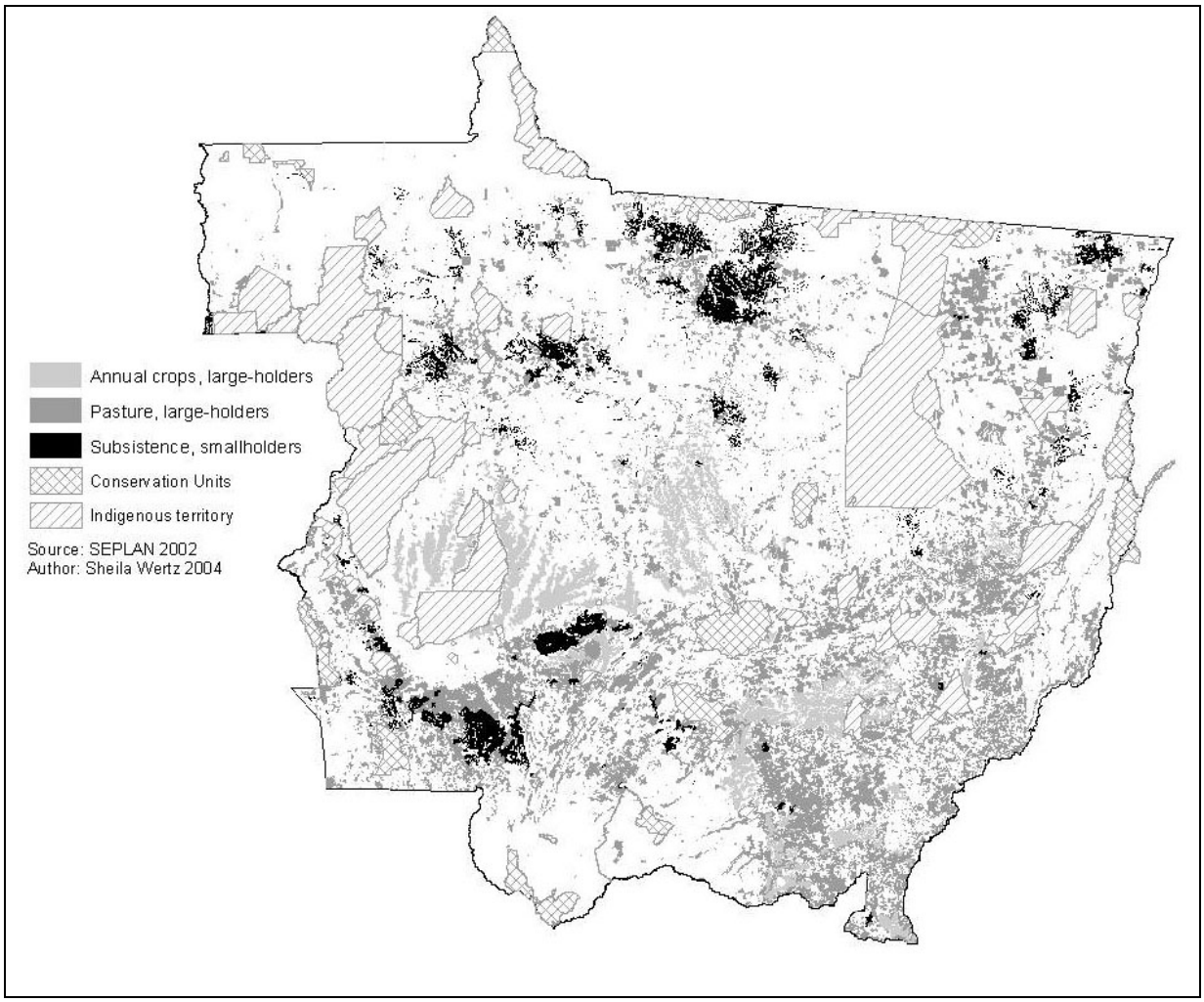
Pantanal

The size of the Pantanal is estimated of about 200,000 km^2 and represents one of the world's largest wetland complexes (Por 1995). Part of the Pantanal is located to the south-west of Mato Grosso (Map 4). The ecosystem Pantanal is highly dependent upon precipitation and the rivers that flow from the highlands. Due to the local climate pattern with two distinctive periods of precipitation, a cyclic hydrological regime arose with long periods of flooded terrain. Most of the precipitation (80%) falls from October to March (Dolabella 2000) flooding over 80% of the region (Dinerstein et al. 1995). It is comprised of a mosaic of flooded grasslands and savannas, gallery forests and dry forests, and species from the Amazon, from the Atlantic forest, along with Chaco vegetation can be found there (Por 1995). Unlike in other parts of Mato Grosso, accelerated regional development after the 1970s, did not have the same extent of human impact on the eco-system, as development was hindered by its cyclical flooding (Dolabella 2000). Still, the Pantanal is threatened by agricultural expansion, charcoal production, water projects, road construction and pollution by agro-toxics (Dinerstein et al. 1995). A further threat consists of the Paraná-Paraguay-waterway project which would link the Pantanal of Mato Grosso with the Atlantic Ocean in Argentina (Piaia 2003).

2.1.2 Socio-economic context of Mato Grosso

Mato Grosso is the third largest federal state of Brazil and has a population of about 2.5 million of which 80% reside in urban areas, 20% in rural areas (SEPLAN 2002). Large-scale agrarian colonization of the state entailing extensive conversion of tropical forests into

agricultural uses in Mato Grosso started with the government programs of the 1960s. According to INPE estimates since the 1970s, on average about 40% of total yearly deforestation in the Legal Amazon occurs in Mato Grosso (INPE 2004).



Map 5: Land use in Mato Grosso (SEPLAN 2002)

The economy of Mato Grosso is based on agrarian production and logging activities (Piaia 2003). In 1995, 24.9% of the state area was used for agricultural purposes, primarily for large-scale cattle breeding (57.7%), and annual crop plantations (18.8%), especially soybean. Map 5 depicts the spatial land use pattern of 1995.[4] Mato Grosso plays an important role in domestic and international agrarian production. Since the 1990s, Mato Grosso is one of

[4] The most recent land use data for Mato Grosso bases on the fieldwork of the socioeconomic-ecological zoning project in 1995/96 (SEPLAN 2002), and the national agricultural census of 1995/96 (IBGE 1998).

Brazil's largest soybean producers, and Brazil the second largest soybean producer in the world (Pasquis 2004; Théry 2000). Similarly, cattle production expanded rapidly in the Amazon, especially in Mato Grosso, making Brazil the world's second largest cattle producer in the 1990s (Théry 2000, 196).

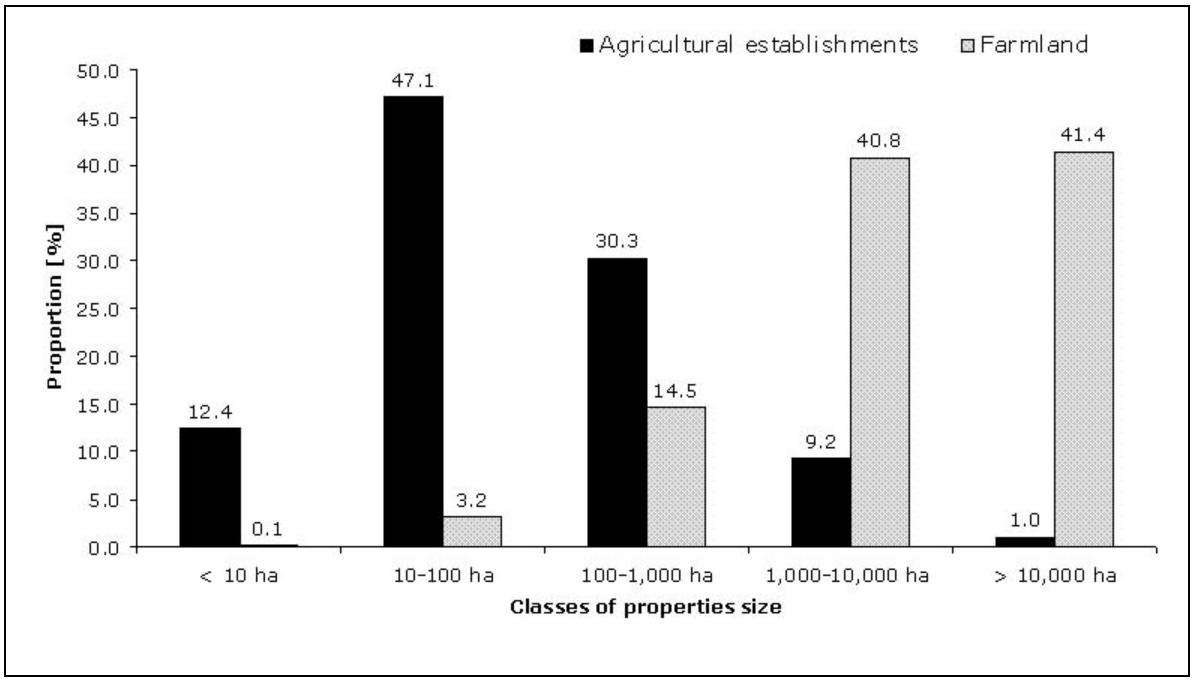


Figure 1: Land concentration in Mato Grosso (IBGE 1998)

As indicated by the share of large-scale agriculture shown in Figure 1, the tenure system of Mato Grosso is characterized by land concentration. In 1995, 82.2% of the total farm land in Mato Grosso was controlled by 10.2% of the agricultural establishments with properties of at least 1000 ha (IBGE 1998). As background to the origins of current land distribution, land use and deforestation dynamics in Mato Grosso, the colonization process of Mato Grosso is presented next.

2.2 Colonization process of the Brazilian Amazon and Mato Grosso

Until the 1970s, Mato Grosso was hardly colonized and populated. Only small parts of the rural areas had been used for subsistence agriculture or traditional extensive cattle ranching. Further areas in northern Mato Grosso had been colonized during the boom phases for rubber. In terms of urban settlement, there remained those from the time when the

bandeirantes[5] arrived in Mato Grosso (especially in the 18th century) to consolidate borderlines or to extract minerals such as gold or diamonds (Coy 1993). Most of Mato Grosso's hinterland was only scarcely populated and mostly indigenous territory (Coy 1993). Although there had been economic and geo-political interests in colonizing the Legal Amazon before (e.g. "March to the West"-strategy in 1930s and 1940s), it was only under the military regime that large-scale Amazon colonization and deforestation started. The major colonization phases of the Legal Amazon are described next.

Opening up of the Amazon frontier by the military regime (1960s)

When the military regime seized power in 1964, Brazil was marked by stagnant agrarian production, export decline and growing social tensions. Stagnant agrarian production resulted from lacking credits and capital investments, high import tariffs elevating the cost of agricultural inputs, and high export taxes (Campari 2002). Moreover, the inelastic domestic demand for agricultural products could not be balanced on international markets due to an overvalued national currency that made Brazilian agrarian products relatively expensive on the international market (Blumenschein 2001). This was aggravated by rising social tensions from agricultural modernization in southern Brazil due to reduced land access for tenant farmers and sharecroppers, and agricultural options for local rural poor (Campari 2002). Social effects of the agrarian problem include rural poverty, rural-to-urban migration and peasant activism. Additionally, droughts in northeast Brazil enhanced social tensions and lead to a greater demand for an agrarian reform.

The government strategy to the agrarian problem was to correct for market distortions, and to orient agrarian policy towards agricultural industrialization and export (Campari 2002; Blumenschein 2001). In turn, agrarian subsidies and export incentives were provided and the Brazilian currency devaluated. A complementary strategy was to open up the Amazon

[5] *Bandeirantes* (literally: flag bearers) refers to the "explorers and adventurers who swept over Brazil in the search of wealth in the name of the Portuguese crown" (Hecht and Cockburn 1989, 235).

frontier (Operation Amazonia). The motive therefore was linked to the military ideologies of "national security" and "national integration".[6] Colonization was induced by facilitated land purchase and tax relieves for investments in the Legal Amazon that were provided by the Superintendence for Amazon Economic Valorization (SUDAM).[7] Further incentives (e.g. land concessions) were provided by local governments (Campari 2002; Blumenschein 2001). The adopted Amazon development strategy was also supported at international level. Especially ranching was advocated as the main development alternative for the Amazon (Hecht and Cockburn 1989)[8].

The consequences of the adopted policies were twofold. Rapid economic growth of the Brazilian economy was one result of the reforms adopted by the military regime after 1964. Numerous agro-industrialists and urban entrepreneurs were attracted to agriculture in order to diversify their investment portfolio, to take advantage of tax credits or simply to conduct land speculation (Campari 2002). In fact, the colonization process of Mato Grosso is characterized by such private colonization (with individual financiers) which began in the 1930s (Castro et al. 2002; Coy 1993).[9] However, modernization and mechanization of the agrarian sector in southern Brazil also resulted in reduced employment opportunities for potential migrants. Numerous rural labor forces were dismissed, and further migrants arose from the process of rising real-estate prices which induced small-holders to sell their lands in

[6] Both ideologies expressed distress about the Amazon region that originated from its large size, scanty population and non-patrolled international borders, and with a history of annexation and conflict between them (Hecht and Cockburn 1989).

[7] SUDAM incentives include capital grants of 75% of the implementation costs, tax holidays of more than 15 years if the money was used for Amazon projects, subsidized credits with several years grace periods that resulted in negative interest rates because inflation exceeded the interest, duty-free heavy machinery imports, and land concessions or land sales at nominal prices (Hecht and Cockburn 1989).

[8] This was especially supported by a report published by the Food and Agricultural Organization (FAO) and the Economic Commission for Latin America (ECLA). It summarized the international perspective on the expansion of the Brazilian cattle herd emphasizing the economic opportunity for the Brazilian Amazon to invest into cattle ranching. The report became very influential and justified frequently the great push toward ranching throughout Latin America in the 1960s (Campari 2002).

[9] In northern Mato Grosso, numerous land sales were conducted by Mato Grosso's Department of Land and Colonization (DTC) during the 1950s and early 1960s. Although most of the sold lands remained uncultivated, the privatization of land reserves affected the future form of colonization as it guaranteed land availability for large-scale ranching and private colonization (Coy 1993).

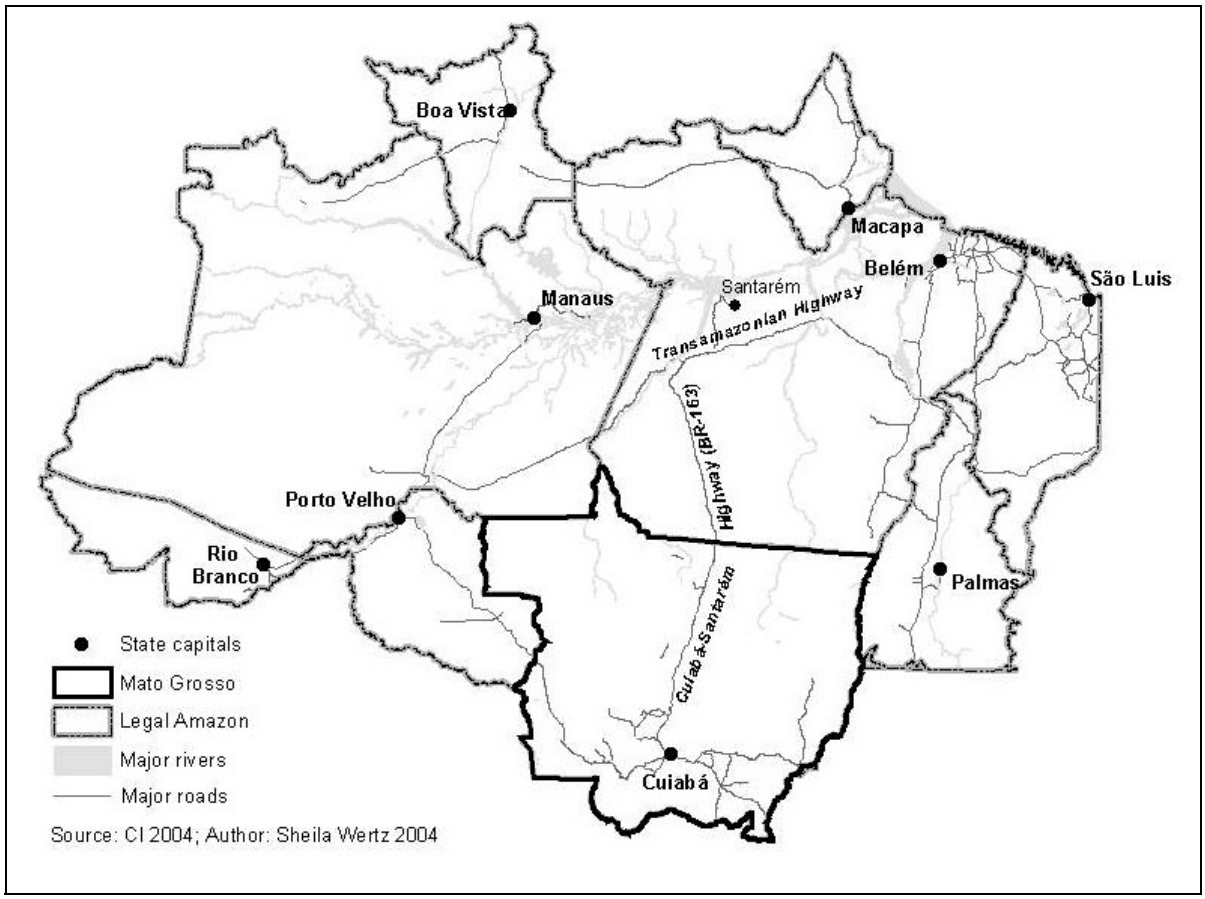
the south to eventually migrate to the new agricultural frontier (Ozório de Almeida and Campari 1995). Moreover, social conflicts arose from the expanding livestock operations in the Legal Amazon. The rising inflow of foreign investors with granted land titles resulted in land conflicts with indigenous groups and peasants in the Amazon who were subsequently, often violently, removed from their lands (Hecht and Cockburn 1989). Further problems arose as smallholders did not qualify for SUDAM incentives (Schneider 1995). The only source of support for smallholders was the National Institute for Colonization and Agrarian Reform (INCRA), created to direct small-farmer colonization by mediating in land disputes and awarding land titles. Yet INCRA lacked sufficient financial and personal resources resulting in a situation of unequal economic opportunities for small-farmers relative to the SUDAM supported entrepreneurs.

National integration program with agrarian colonization (early 1970s)

While Brazil enjoyed an economic growth miracle at the beginning of the 1970s, social conditions remained problematic. Ongoing agricultural mechanization in southern Brazil continued to entail reduced employment of numerous labor forces, and severe droughts and famine in the northeast aggravated persisting social tensions and claims for Agrarian Reform.

To relieve social tensions in the south and north-east, the *National Integration Program (PIN)* was launched in 1971 to promote infrastructure developments to open up lands for the landless, i.e. to bring “men without land” to the “land without men” while avoiding the need for agrarian reform (Théry 2000). Important infrastructure projects of the PIN were the expansion of the Transamazônian highway (east-west connection) and the Cuiabá-Santarém highway linking Mato Grosso in the south with Pará in the north (Map 6). State-directed agrarian colonization projects managed by INCRA were allocated along new federal highways, and private land purchase along these roads was induced with subsidized credits

(Blumenschein 2001; Coy 1993). In Mato Grosso, state-directed smallholder colonization by INCRA started in 1978 (Castro et al. 2002). Especially the expansion of the Cuiabá-Santarém highway induced a push towards the colonization of central Mato Grosso as many areas only became accessible via the new road.



Map 6: Major roads in the Legal Amazon in 1990s

In the late 1970s, however, it became clear that the state-directed agrarian colonization program did not meet its objectives (Théry 2000). Reasons include inadequately equipped public institutions[10], and low participation in state-directed programs (along the Transamazonian Highway) while there was massive uncontrolled spontaneous migration (Redwood 2002). Production potentials were far lower than expected due to missing market access, low soil fertility, and lacking know-how of feasible production systems (Coy 1993).

[10] E.g., INCRA was unable to respond to the demand for demarcation, recording claims, formal surveying, titling, and provision of other promised services and inputs such as infrastructure, education and healthcare, seeds and fertilizers. In fact, these deficiencies remain valid at least until 2004 (Alencar et al. 2004).

As result, state-directed colonists impoverished and remained "stranded" at the Amazon frontier, often in land conflict with private large-holders who were also present in the region (Théry 2000).[11] Moreover, the settlement of colonization projects along the roads affected indigenous communities via habitat destruction, displacement into reserves, introduction of foreign illnesses, and loss of cultural heritage (Coy 1993). Finally, road construction facilitated access for colonists and squatters to new forest areas entailing uncontrolled clear-cut of the Amazon forest (Mello 2003).

Modernization with growth-oriented development poles (mid 1970s)

Upon the economic crises in the mid-1970s, the military government reevaluated its agrarian policy and announced large regional development programs for the Amazon (POLAMAZÔNIA) and the Center-West region (e.g. POLOCENTRO) (Théry 2000). With these programs, the focus shifted back to growth-oriented development policy promoting capital-intensive investments in selected development poles across the Legal Amazon. Extraordinary fiscal incentives associated with relatively low risks created a stimulus for forest conversion to agricultural land. The government granted generous incentives for land acquisition as a form of compensation to those who were helping to incur the costs of regional development (Campari 2002). Speculation was driven in part by the hope of future returns to agricultural production, the further value of natural resources, or simply because Amazon land became artificially cheap (due to credit and tax incentives) which made it worth keeping as a store of value (Campari 2002). Moreover, the location of development poles signaled to the entrepreneurs the best sites for speculative gains (Théry 2000). In turn, private colonization projects, ranching and speculative landholdings expanded rapidly in the

[11] The prevalence of large, mostly unused land tracts, together with the large number of landless peasants left stranded at the Amazon frontier entailed land invasions and conflicts. INCRA seeks to settle these conflicts, often by expropriating the disputed farms, paying compensation to the land owner and establishing settlement projects on the disputed land. Until today, it has remained common practice for large-holders to induce invasion of their farms by landless poor, so that they receive compensation from the government which is a multiple of the true value of the land (Campari 2002).

Legal Amazon. In Mato Grosso, private firms from southern Brazil started already during the construction of the new federal highway, to purchase (the mostly unused) land from previous land owners to implement private settlement projects (Coy 1993).[12]

However, the growth-oriented strategy of regional development poles entailed social and environmental impacts. Ecologically disadvantageous large-scale deforestation occurred for the establishment of spatially extensive ranching projects for speculation (Kohlhepp 1993). Social inequality rose as small farmers did not have access to agricultural subsidies and credit policy as large farmers did (Hecht and Cockburn 1989). Access to subsidies or credits required some form of land title which increased the demand for titled land. In turn, untitled farmers sold their lands and continued moving with the agricultural frontier. Extensive support for entrepreneurs and insufficient assistance for small-holders were reflected in the tenure structure of the Legal Amazon, i.e. with the prevalence of very large properties (*latifundias*), often left uncultivated as "ghost ranches".

Basic-needs programs for integrated rural development (early 1980s)

The new phase of rural development was largely initiated upon the pressure for a different development strategy by the World Bank (Kohlhepp 1993). In turn, the World Bank financed program POLONOROESTE was implemented in 1981 to conduct road improvements, integrated rural development, and environmental and indigenous peoples' protection in Mato Grosso and Rondônia (Redwood 2002). Unlike former government imposed top-down development programs, it was aimed for a greater participation of the local population (Kohlhepp 1993).

In response to the economic crises and claim for agrarian reform, the government announced the national agrarian reform plan in 1985. Although it meant expropriation of some landholdings in southern Brazil, mostly federal land was employed for redistribution in the

[12] Most of that land had been bought previously by capitalists from southern Brazil during the 1950s and 1960s. In the 19070s, it was sold again primarily to private colonization firms (Coy 1993).

Amazon. But due to fear of possible expropriation, a wave of deforestation occurred, as it was harder to expropriate land if it was in some notional form of use.

Yet difficulties in the implementation of POLONOROESTE resulted in aggravated social conflicts between the various land use actors in the Amazon (i.e. rancher, small-holders, squatters, gold-miners, loggers and indigenous groups), entailing land use conflicts, violence, destruction of indigenous habitat, oppression of indigenous groups, and extensive forest clearance (Kohlhepp 1993). Lastly, the agrarian reform plan contributed to massive deforestation in the Amazon of the 1980s (Campari 2002).

Modernization with big projects and export-oriented agriculture (1980s)

In the 1980s, Brazil was marked by a sharp economic crisis and the transition to democracy. The economic crisis was characterized by escalating high external debts and hyper-inflation. In response to the economic crisis, the government objective consisted of keeping food prices low, exports high and inflation controlled (Hecht and Cockburn 1989). One approach to meet the objectives consisted of extremely high investments into big projects for mining and smelting (e.g. Grande Carajás), hydro-electricity and other industries in the Amazon. Moreover, a minimum price policy for soy bean, rice and corn was adapted to replace agrarian subsidies (Blumenschein 2001). Especially export-oriented soybean production was seen as an important foreign exchange earner since the world debt crisis in 1982 (Kohlhepp and Blumenschein 1999). Upon the development of a soybean variety suitable to the Cerrado's agro-climatic conditions, the Brazilian Center-West became the primer economic region, and soybean cultivation expanded rapidly during the 1980s.

Nonetheless, the economic crises, and the social and environmental conflicts persisted in the 1980s. Tax mechanisms and fiscal incentives from earlier Amazon programs were counteracting the new economic growth impulses and high investments in big projects raised the foreign debts (Mello 2003; Hecht and Cockburn 1989). Besides, environmental and

social conflicts in the Amazon persisted due to road construction and big projects for mining and smelting, hydro-electricity and other industries which implied relocation of indigenous groups and deforestation (Kohlhepp 1993).

The 1980s were also characterized by the transition to democracy. The first democratic election in 1985 and profound transformations as result of institutional changes culminated in a new federal constitution in 1988. The new constitution set for greater decentralization of responsibilities, a considerable redistribution of revenues, and an increase in the power of the state and municipal governments (Théry 2000). Thus federal colonization incentives were substituted by state and municipal stimuli inducing further intra-regional migration (Ozório de Almeida and Campari 1995).

Globalization and sustainable development (1990s)

A stabilization of the national economy was achieved by the introduction of the *Plano Real* in the mid-1990s (Théry 2000).[13] Further deregulations of the federal credit sector, and opening of the Brazilian economy to world markets contributed to the end of public impulses for the Brazilian agricultural sector (Blumenschein 1989). In fact, past government incentives to agricultural development in the Legal Amazon were substituted by market incentives in the 1990s. Moreover, the investment programs "Brasil em Ação" (1996-2002) and "Avança Brasil" (2000-2003) aimed at supporting the region's integration into national and international markets (Alencar et al. 2004).

The formerly strongly present federal government is hardly present in the Legal Amazon of the 1990s. Since the new constitution of 1988, regional development is defined by local and regional institutions, although under influence of national and international non-governmental organizations and further global actors (Coy and Neuburger 2002).

[13] Although Brazil enjoyed the greatest gross domestic product of all Latin American countries until 1999, it has experienced almost no economic growth since then due to the Brazilian currency devaluation in 1999 and the loss in the rate of exchange prior to the elections in 2002 (Kohlhepp 2003, IBAMA 2002).

Moreover, after a wave of rural migrants to the Legal Amazon in the late 1960s and early 1970s, a significant movement (from within and outside the Legal Amazon) to the Amazon frontier started again in the mid-1990s (Alston et al. 1999). As response to the social and environmental effects from the Amazon frontier expansion since the 1970s, sustainable development measures were increasingly considered in the 1990s. In this context, important contributions were enabled by the *Pilot Program to Conserve the Brazilian Rain Forests (PPG7)* which is described in the next paragraph.

2.3 Evolution of the Brazilian environmental policy

First legal measures to forest protection in Brazil were realized for economic motives rather than ecological motives (Margelhães 2002). The Forest Code of 1934 was the first legal provision explicitly regulating forest use in Brazil, including private lands. It was later substituted by the Forest Code of 1965. To enforce the environmental legislation, the Brazilian Institute for Forest Development (IBDF) was created in 1967 and affiliated to the Ministry of Agriculture. The Special Secretary for the Environment (SEMA) was created in 1973 and affiliated to the Ministry of the Interior (Magalhães 2002). SEMA's mission to conserve the environment was however greatly challenged by insufficient financial and political-administrative support (Mello 2003), which by the late 1970s, lead to strong public criticism of large-scale environmental destruction pressuring the Brazilian government to consider environmental aspects in their strategies (Margelhães 2002). The latter was guiding in the rise in Brazilian environmental legislation as it sought to modify the former Amazon colonization model by shifting the purpose of environmental conservation for purely economic to ecological motives (Magalhães 2002).

One of the most significant advances in Brazilian environmental policy was realized in the 1980s. The advances include the definition of the first National Environmental Policy for Brazil in 1981, and the creation of the National Environmental System (SISNAMA) and the

Advisory Group for Environmental Policy (CONAMA) in 1984. With the latter it was aimed at ensuring societal participation in environmental policy decision-making and count on inter-institutional cooperation (Mello 2003). Further newly introduced environmental policy instruments included environmental quality standards, zoning, environmental impact analysis (EIA/RIMA) and environmental licensing (Mello 2003; Magalhães 2002). Still, attempts to consider environmental aspects in public policies for the Amazon (e.g. POLONOROESTE) were largely unsuccessful (Redwood 2002), due to insufficient funds during the economic recession in the 1980s (Mello 2003). In the late 1980s, supported by deforestation indices of the Brazilian National Institute for Space Research (INPE) capturing the extent of Amazon deforestation, there was vehement domestic and international criticism (especially by media and non-governmental organizations) on Brazilian public policies for Amazon colonization (World Bank 2003; Mahar 1989). In addition to public pressure, market restrictions for Amazon timber obliged the Brazilian government to address environmental policy-making for the Amazon (Mello 2003).

Increasing environmental awareness in the late 1980s motivated countries and the international community to consider environmental conservation in legal and political doctrines (Bothe 1990). In Brazil, a new constitution was implemented upon the end of the military regime in 1988 that, for the first time, explicitly included environmental conservation measures.[14] Notably, the new constitution defines the individual right for a healthy environment, the duty of public attorneys to ensure the prosecution of environmental law-offenses, and the duty for rural properties to ensure their social function by adopting resource-sparing land use activities (Magalhães 2002). To monitor and ensure law compliance, the constitution reformed the State Attorney's Office (Ministerio Publico) at federal and state level (Mello 2003). Also in 1988, the government program "Our Nature"

[14] However, Brazilian efforts in environmental policy around 1990 must also be viewed in light of increasing funds for topical forest conservation and the 3rd World Conference on the Environment hosted in Rio de Janeiro in 1992, and the implied potential for their international recognition (Kohlhepp 1993).

was implemented to correct deficiencies in the existing environmental legislation and policy (Magalhães 2002).[15] Although not all recommendations were implemented, the program allowed for greater government attributions to the environment, including the creation of the Brazilian Institute for Renewable and Non-renewable Natural Resources (IBAMA) to substitute the inefficient former environmental agency IBDF (Mello 2003). Moreover, a Secretary of the Environment with ministry status (SEMAM) was created in 1990 and, in 1992, transformed into the Ministry of the Environment (MMA) with the objective to coordinate activities related to the National Environmental Policy. Improvements in the environmental legislation include the explicit duty for private landholders to comply with the legal reserve requirement of the Forest Code 1965 (Agrarian Policy Law 1991), the introduction of the rural property tax in 1994, tax relieves for private forest reserves, and the implementation of the Environmental Crimes' Law in 1998 (Magalhães 2002). Decentralization of federal competencies also referred to environmental policy-making which strengthened state and municipal environmental agencies (Mello 2003). With respect to the Brazilian Amazon, the following sustainable development programs were implemented in the 1990s:

- Since 1993: The state-level natural resource management programs *Prodeagro* in Mato Grosso and *Planafloro* in Rondônia. Both programs were financed with World Bank loans, and presented first attempts to sustainable natural resource management by focusing on agro-ecological zoning with civil society participation (Redwood 2002). However, difficulties in the implementation resulted in unsatisfactory program results (World Bank 2003).
- Since 1992: The *Pilot Program to Conserve the Brazilian Rain Forest (PPG7)* to slow deforestation and forest fires, and to protect biodiversity. The program is financed by the

[15] However, Hecht and Cockburn (1989) view "Our Nature" as a mean to secure national sovereignty over the Amazon while considering environmental concerns only "for the foreigners to see".

G7-countries[16], the European Union, the Netherlands and Brazil, and administered by the World Bank. PPG7 is a partnership between the Brazilian Government, Brazil's civil society, the international community and the World Bank.

- Since 1998: The project *Proarco* was implemented with a World Bank loan to prevent and control large-scale wildfires in the southern part of the Legal Amazon (Amazon deforestation belt) and to assist federal and state environmental agencies in the Amazon to implement an education and public awareness campaign and to provide training for fire prevention and control (World Bank 1998).

Despite sustainable development efforts, social and environmental problems persisted in the Amazon of the 1990s. After very dynamic development by small- and medium sized agricultural colonization in the 1970s and 1980, especially in Rondônia, Mato Grosso and Southeast Pará, similar agrarian problems as in the colonist's area of origin during the 1960s and 1970s were observed in the Legal Amazon of the 1990s (Coy and Lücker 1993). This resulted in intra-regional migration, i.e. colonist already in the Amazon move within the Amazon region to the agricultural frontier (Théry 2000; Ozorio de Almeida and Campari 1995) which entailed further deforestation activity (World Bank 2003). Further environmental impacts, especially deforestation upon the construction of new roads, are expected from the federal government's large-scale Amazon investment programs "Brasil em Ação" (1996-2002) and "Avança Brasil" (2000-2003) (Mello 2003). Although both programs advocate sustainable development and the reduction of regional disparities, experts fear that they rather continue classic modernization policy (through investment support, infrastructure development and land distribution) with severe environmental impacts through deforestation and forest fires (Laurence et al. 2004; Coy and Neuburger 2002; IPAM 2000).

[16] G7 countries are Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

Despite substantial environmental policy reforms and although the Brazilian environmental legislation is often quoted as being very sophisticated (Alancar et al. 2004; Margalhães 2002), law and policy enforcement remains very low (Campari 2002; Irigaray 2002). Campari (2002) criticizes that policy-making in Brazil is too often understood as defining legislation. Irigaray (2002) attributes missing enforcement to overregulation and claims that the environmental legislation could only persist since it was never enforced. Mello (2003) points to the persisting interest conflicts with respect to regional development policy, especially between environmental, economic and social objectives, but also between federal and state government institutions, that challenge environmental policy-making in the region. Yet missing enforcement of the Brazilian environmental policy is also attributed to insufficient financial resources for environmental agencies, due to domestic economic crises since the 1970s (Pasquis 2004). Missing financial resources are further counter-productive as Brazilian environmental policies base primarily on cost-intensive command-and-control instruments (Lustosa et al. 2003). However, a new direction was initiated with the environmental licensing system of rural properties (SLAPR) in Mato Grosso which is described in turn.

2.4 Environmental licensing system of rural properties (SLAPR) in Mato Grosso

Before presenting the environmental licensing system of rural properties (SLAPR) in Mato Grosso, the state's environmental policy context is briefly introduced first. The state environmental agency of Mato Grosso was first implemented in 1983 as State Foundation for Pantanal Development (FUNDEPAN) and, in 1987, replaced by today's FEMA (FEMA 2004a; Barreto 2002). In the 1990s, the state's environmental policy-making context was shaped by the following internationally supported environmental conservation programs:

- 1992-2002: The natural resource management project Prodeagro (World Bank 2003).

- Since 1996: Although PPG7 activities started in 1992, Mato Grosso was excluded until 1996 as the state benefited already from Prodeagro funds (FEMA 2003b).
- Since 1998: The fire prevention program Proarco is active in the northern municipalities of Mato Grosso at the Amazon deforestation arc.

All three programs and further funds from FEMA and the State Treasury supported the implementation of the *environmental licensing system of rural properties (SLAPR)* in 1999 (FEMA 2002b).[17] It bases on a "federative pact" between IBAMA and FEMA where, among other functions, the responsibility to control deforestation on larger properties was handed over to the state (World Bank 2003). The federative pact was signed in 2000 and renewed as "technical cooperation" in 2003 and 2004. It is part of the efforts to decentralize federal authority to the states since the new constitution of 1988. Furthermore, it bases on the Brazilian Forest Code of 1965, Brazilian Environmental Crimes Law of 1998, the Mato Grosso State Environmental Code of 1995 and further state decrees. Additionally, FEMA introduced a *simplified environmental license for rural properties (LAU)* to replace the usually required three licenses with one (FEMA 2001b). Traditionally, according to federal law, every enterprise has to obtain three licenses prior to operation, i.e. the preliminary license, the installation license and the license for operation. As these licenses were not perceived adequate for agrarian enterprises, FEMA introduced the LAU in 1995.

To control deforestation on private landholdings, the SLAPR consists of various activities to ensure enforcement, licensing, monitoring and sanctioning of rural properties. They are briefly described next.

The enforcement activities of the SLAPR consists of personal visits of FEMA officials to large-holdings in identified target area to notify rural landholders (initially large-holders) on their obligation to license their properties at FEMA (FEMA 2001b). The initial enforcement

[17] Specifically, the international funding for the SLAPR originated from Prodeagro (20.6%), PPG7 (18.1%) and Proarco (17.5%) (Leite 2002).

effort was targeted to areas with high deforestation incidences, namely in the north-western part of the state and along major highways (FEMA 2003a). Furthermore, properties in southern Mato Grosso were targeted as they were known to be mostly out of compliance with the environmental legislation.

The licensing activities of the SLAPR consist of the requirement that private rural properties comply with environmental regulation. Therefore, an updated property title and a land use plan (inclusive deforestation plans) that complies with existing environmental legislation must be submitted to FEMA. Specifically, compliance with the following regulations is required (Leite 2002):

- **Legal reserve (RL)-requirement**, i.e. a defined proportion on each private property that must remain under natural vegetation cover. The share to be preserved is defined by the biome in which the property is located which is 80% in the Amazon and 30% in the Cerrado (Forest Code 1965, Provisional Measure No. 2166-67/01).[18] In Mato Grosso, an additional state law defines a legal reserve proportion of 50% in the Amazon-Cerrado transition biome (Mato Grosso Complementary State Law No. 38/95).
- **Permanent preservation areas (APP)-requirement**, i.e. areas along water bodies, on steep slopes and on hill tops (Forest Code 1965)

To get licensed, the legally required forest reserves, permanent preservation areas, areas available for deforestation, and already degraded areas need to be mapped on a satellite image. Any missing or degraded legally required forest reserves or permanent preservation areas must be compensated. Any missing parts of the required legal forest reserves must be compensated by purchasing land in state conservation units and donating these to the state (FEMA 2001b). Any degraded legal reserve parts can be compensated by natural regeneration. Any missing or degraded permanent preservation area (APP) must be restored

[18] The legal reserve definition dates from the Forest Code 1965, when the RL-requirement was 50% in the Amazon and 20% in the Cerrado. It was altered in 1996 and put into a law-like decree in 2001.

by planting native species or allow natural regeneration (FEMA 2001b). Furthermore, any disputes over property delineation (e.g. overlap with protected areas or indigenous territories) must be resolved prior to licensing. The elaboration of land use proposals, as well as subsequent implementation, can only be executed by FEMA trained professionals (forestry engineers) and consultancy firms (Leite 2002). Upon complete documentation, FEMA issues the five-year valid LAU, and a one-year valid deforestation permit.

The monitoring activities of the SLAPR consist of the interpretation of annual satellite images and field inspection (FEMA 2002b). To increase efficiency, FEMA contracted a private company (Tecnomapas) to monitor deforestation in Mato Grosso and to manage the database with spatial information (i.e. location, digital land use plan) on the registered properties.[19] Specifically, compliance of a given property is monitored by overlaying geographically referenced incremental deforestation data on the licensed land use plan using geographic information system (GIS) techniques. The adopted technology presents a crucial feature of the system as it is supposed to allow faster, cheaper and more objective land use monitoring than traditional methods based on rather time-intensive and costly procedures.[20] In turn, FEMA can verify whether any incremental deforestation was authorized, and thus legal, or without authorization and thus illegal. Where illegal deforestation activity on licensed properties is monitored, a fine is automatically send out to the offender. Illegal deforestation is fined between 1000-1500 Reais per hectare (ca. 300-400 Euros, in 2004), in addition to possible jail sentences for committed "environmental crimes" (Fearnside 2002).

Finally, the sanction mechanism of the SLAPR is ensured via a close collaboration between FEMA and the State Attorney's Office, where FEMA can directly hand over cases of non-compliance to the State Attorney's Office for legal prosecution (FEMA 2001a).

[19] Deforestation monitoring is further enhanced by data resolution of 1ha resulting from applying digital image interpretation techniques with Landsat-TM satellite images (Fearnside 2002).

[20] Yet, no detailed information on the costs of the SLAPR was available to the author by the time of writing.

Yet at least until 2004, property registration at FEMA remains an ongoing process. While enforcement started on properties greater 1,000 ha (FEMA 2001b), properties of any size are now registered in the SLAPR. Until February 2004, 6,105 properties totaling 200,000 km^2 or about 22% of the state territory was registered at FEMA (Tecnomapas 2004). Furthermore, elements of the SLAPR develop continuously. As a complementary monitoring element, for example, FEMA seeks the participation of the civil society in the monitoring of illegal deforestation by providing actual deforestation information on the Internet (FEMA 2004b).

Still already the deforestation decrease of 32% (relative to total land area) between 1998-99 and 2000-01 was interpreted as first indication of program success (FEMA 2001b). This was widely recognized at both national and international level, and induced initiatives to replicate the system to the other Amazon states (Fearnside 2002).

3 Enforcing property rights to control deforestation: An econometric analysis of the SLAPR in Mato Grosso

The relevance of the Mato Grosso SLAPR consists on its approach to promote land titling and the enforcement of the duty of private rural land titles to comply with private forest use regulations as a mean to control private (illegal) deforestation. This approach is supported by the property rights theory which views the absence of well-defined and enforced property rights as important cause for rapid deforestation.

However, detailed studies on the effectiveness of the SLAPR in controlling deforestation are still lacking. FEMA attributed the 32% decrease in the rate of deforestation per total area from 2% in the two year period 1998-99 to 1.35% in the two-year period 2000-01 to increased enforcement (FEMA 2002a, 19). From his municipal-level study of FEMA's bi-annual deforestation rates for 1998-99 and 2000-01, Fearnside (2002, 2003) also concludes the recorded decreasing deforestation rates between 1998-99 and 2000-01 in municipalities with high enforcement activity relative to municipalities with low enforcement activity as indication for program effectiveness. Yet the effectiveness of the FEMA program is not unambiguously observed: In 2002, FEMA monitors a 31.9% increase in deforestation (0.89%), and estimates from INPE for Mato Grosso depict an 8.5% decrease in 1999-2000, a 20.9% increase in 2000-01, a 1.6% decrease in 2001-02 and a 27.2% increase in 2002/03. Part of the diverging results can be attributed to the methodology of deforestation monitoring by FEMA and INPE (Fearnside and Barbosa 2004): On a yearly basis, INPE monitors deforestation in primary forests (i.e. only in previously never deforested areas while deforestation of mature secondary growth is not monitored) across the Amazon but unlike FEMA, INPE does not monitor deforestation of savanna vegetation *Cerrado,* except for the tree formation *cerradão*. Hence, reported deforestation rates appear ambiguous and forgoing

studies focused primarily on the comparison of aggregated absolute deforestation rates (relative to total land area) to assess program effectiveness.

Seeking for improved evidence on program effectiveness, the objective of this chapter is to analyze the effects of increased enforcement of environmental regulation, that is the *permanent preservation area (APP)* and the *legal reserve (RL)*-requirement, on land use. Therefore, a variant of the difference-in-difference approach is used in the geo-statistical and econometric analysis.[21] This chapter starts with a brief introduction to the property rights theory and its link to Amazon deforestation to emphasize the relevance of the SLAPR approach, and continues with a description of the applied methodology before presenting the analysis.

3.1 Theoretical context

The property rights approach bases on the hypothesis that individuals tend to behave rational as they seek to maximize the utility from their property rights (Richter and Furubotn 2003). According to Bromley (1991, 2) a *property right* is "a claim to a benefit stream that the state will agree to protect through the assignment of duty to others who may covet, or somehow interfere with, the benefit stream".[22] Property rights can be distinguished by their owner structure (state, private, or common property regime), and by their legal specification, i.e. the rules under which those rights and duties are exercised (property or liability rule) (Bromley 1991). Typical reasons for insufficient property rights enforcement are missing authority systems, high transaction costs or when enforcement is undertaken by agents whose own utility function influences the outcomes.

[21] The statistical analysis in this chapter is closely related to Chomitz and Wertz-Kanounnikoff (2004). It differs in the following ways: Firstly, it also controls for the initial target area of enforcement in 2000-01 and secondly, it explicitly controls for program effects within permanent preservation areas.

[22] In the literature, there are two major definitions of property rights: One limits property rights to legally secured claims such as physical property and contractual claims (North 1990; Bromley 1991). A wider definition also considers claims that are not secured by law, e.g. tradition (Richter and Furubotn 2003).

From the perspective of the property rights' theory, environmental problems arise from inexistent, incomplete, or non-enforced property rights regimes. Likewise, lacking property rights induce deforestation based on the rationale "if I don't do it, someone else will", such as occurs in the case of "open access regimes" (Bromley 1991). On the other hand, from an efficiency viewpoint, property rights should emerge only when the social costs of enforcing them are lower than the social gains of having property rights. At the Amazon frontier, where transaction costs are high, it is not yet efficient to have property rights. Yet anticipating the time when property rights will be established, pioneers go early and (inefficiently) use deforestation as a way of establishing claims leading to the "race for property rights" (Schneider 1995).

Ideally, property rights regimes are well-specified, context-specific, and enforceable. When addressing environmental problems, policy must therefore not only focus on the establishment of property rights regimes, but also carefully consider the social and ecological context in which property regimes are to be placed, and the extent to which they are enforceable (Bromley 1991). The Mato Grosso SLAPR promotes land titling and the enforcement of already existing property regimes of primarily large-holdings. The latter bases on the presumption, that lenient property rights enforcement in the past, i.e. during the period of large-scale colonization of the Amazon (Chapter 2), contributed to the current environmental problems in Mato Grosso. The SLAPR can therefore be viewed as effort that seeks to reduce the effects of unclearly defined and enforced property rights on deforestation.[23]

[23] However, a challenge in the enforcement of private rural property rights in Mato Grosso, and presumably in the entire Legal Amazon, refers to the ownership duty to comply with the private forest use regulations. The acceptance of the private forest use regulations, notably the legal reserve requirement, depends on whether the regulations had been institutionalized prior to the time of property purchase. At least since 1965, compliance with private forest use regulations presents a *property duty*. If, however, the property had been purchased prior to the institutionalization of the private forest use regulation, it presents, from the landholder's viewpoint, an "expropriation" of parts of the property by the state. Still, as private colonization in Mato Grosso started especially during the 1960s and 1970s, one can assume that most land purchases occurred after the institutionalization of the legal reserve requirement.

3.2 Methodology

This paragraph describes the applied conceptual approach and method to the analysis of program effectiveness, the data and the data sampling techniques.

Conceptual approach

Did the announcement of the SLAPR affect landholder behavior? The analytic problem is that it is difficult to detect the signal of program impact amidst the noise of natural temporal and spatial variability in deforestation. Deforestation rates can vary substantially between years and places, due to economic and climatic trends. For instance, deforestation is more likely when soil moisture is low, because this decreases the cost of clearing and increases the likelihood of accidental or escaped forest fires (Nepstad et al. 1999). Therefore, as suggested by Chomitz and Wertz-Kanounnikoff (2004), a variant of the difference-in-difference approach (widely used in program analysis) is used to assess program effects between the following three types of deforestation:

(a) non-authorizable deforestation (e.g. deforestation in legal reserves or permanent preservation areas),

(b) authorizable but non-authorized deforestation (the actions could be consistent with the regulations but the landholder did not get a deforestation permit),

(c) authorized deforestation (i.e. in compliance with the regulations).

The assumption is that if the announcement of the SLAPR was indeed successful, it would have a differentially large impact on (a), as opposed to (b) or (c), and would entail a shift of (b) to (c). The *difference in difference* or *double difference approach* consists hereby in (i) the differentiation of deforestation types (a), (b) or (c), i.e. the *first difference*, and (ii) the comparison of the rates of each of the deforestation types before/after program implementation, i.e. the *second difference.*

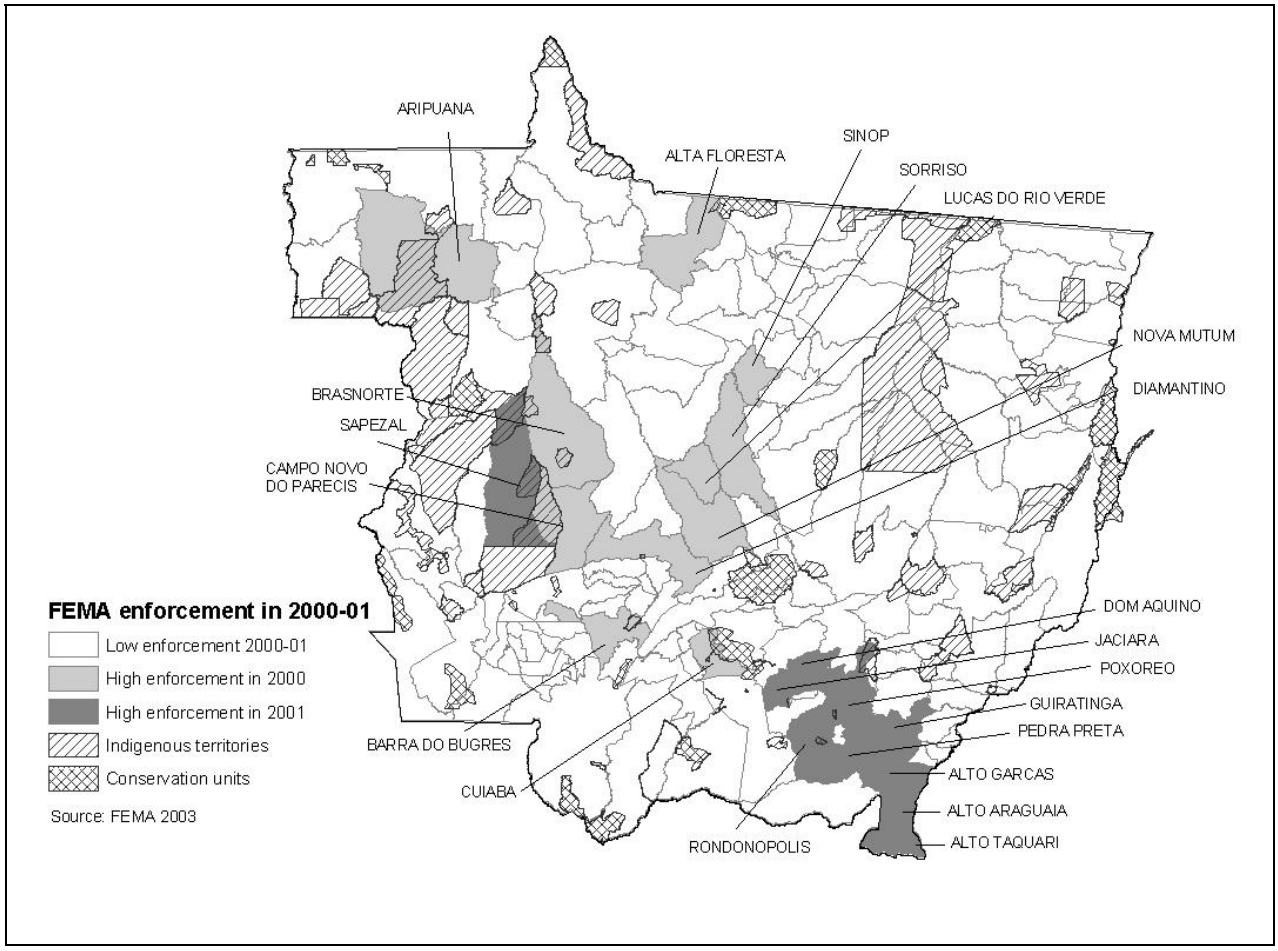
As detailed (spatial) data on licensed properties were not available for the analysis, it was not possible to precisely identify deforestation of type (a), (b) or (c). Based on the assumption about where these different types of deforestation are likely to be more prevalent, the following hypotheses were defined:

1. If the FEMA program is effective and the permanent preservation areas (APP) requirement is enforced, deforestation will decrease relatively more in APPs.
2. If enforcement is effective and the legal reserve (RL) requirement is enforced, deforestation rates will decrease more rapidly on properties already out of compliance with the RL requirement.
3. If enforcement is effective and targeted to areas near roads, deforestation will decrease relatively more in areas near roads.
4. If enforcement is effective and targeted towards large-holders, large-scale deforestation (clearings greater than 200 ha) will decrease relatively more than small-scale deforestation (below 200 ha).
5. If enforcement is effective and targeted to selected municipalities, deforestation will decrease relatively more in targeted municipalities.

Although the program was implemented in 1999 and targeted FEMA enforcement started in 2000, it was presumably only after 2002 that enforcement covered the entire state (FEMA 2002a).[24] Hence, only data of 2002 and later will depict state-wide effects of enforcement. Data of 1999 or 2000-01 may, except for the areas with increased enforcement efforts, only depict first reaction on the announcement of increased enforcement. Map 7 visualizes the municipalities with the highest enforcement efforts in 2000 and 2001. In 2000, enforcement was targeted to municipalities situated at the arc of deforestation in northern Mato Grosso (FEMA 2002a): Alta Floresta, Aripuanã, Barra do Burgres, Brasnorte, Campo Novo dos

[24] In addition, properties of any size could, on a voluntary basis, also get licensed at FEMA.

Parecis, Cuiabá, Diamantino, Lucas do Rio Verde, Nova Mutum, Sinop and Sorriso. In 2001, enforcement efforts were primarily targeted to municipalities at the consolidated agricultural frontier in south-east Mato Grosso (FEMA 2002a): Alto Araguaia, Alto Garças, Alto Taquiari, Dom Aquino, Guiratinga, Jaciara, Pedra Preta, Poxoréo, Rondonópolis and Sapezal.



Map 7: Targeted FEMA enforcement in 2000-01 in Mato Grosso

To assess forest cover change in response to the SLAPR, FEMA deforestation rates from periods prior to program implementation (1996-97; 1998-99) are compared with post-program FEMA data (2000-01; 2002). Hereby, the following specifications hold:

- Since the SLAPR targets private rural properties and virtually no recorded deforestation was found in protected areas (which suggests that some aspects of land use enforcement are effective) the analysis extent was limited to non-protected areas of Mato Grosso.

- Because FEMA targeted enforcement to large holdings (clearings below 200 ha remained under IBAMA control), the dynamics of large-scale deforestation (clearings greater 200 ha) versus small-scale deforestation (clearing below 200 ha) were compared.
- Since initial enforcement focused on selected municipalities, the analysis distinguishes further between high and low enforcement areas, where *high enforcement* refers to the combined set of targeted municipalities in 2000 and 2001.

Analysis method

Quantitative statistical methods are used for hypothesis testing. As described in Atteslander (1995), the application of statistical methods bases on the implementation of qualitative statements. Here, five hypotheses are defined to test for any program effects in Mato Grosso. Since each hypothesis has a spatial relationship, the analysis bases on a sample of land points for Mato Grosso, where each point contains the point-specific geographic attribute information (land use characteristics). Each point is referenced by x/y-coordinates and the land use information of each point is categorical. With the objective to identify program effects on individual land use behavior (deforestation behavior), point-level spatial variables are integrated in the econometric analysis. The motivation is to assess, over time, the probabilities that a given point gets deforested before and after the implementation of the FEMA enforcement program. The integration of spatially-explicit variables in econometric analysis of land use change remains a young domain. In a review of land use models, Irwin and Geoghegan (2001) note that economists hardly develop spatially-explicit land use change model while geographers, on the other hand, tend to integrate spatial variables in an ad-hoc manner without addressing the economic rationale for a given land use pattern. In this context, the here presented analysis of land use change contributes to the line of spatially-explicit models of land use change by seeking to integrate spatial variables based

on an economic rationale. Due to the categorical nature of the sample data, a probit regression model was used. The analysis was done using the statistical software STATA.

Data

The original and derived data sets (digitally coded maps) that are used in the analysis are summarized in Table 2. The data was processed using the geographic information systems ArcView, ArcInfo and ArcGIS. The applied data projection was Universal Transversal Mercator (UTM), Zone 21 South, South American Datum 1969.

An important variable in the study distinguishes high and low natural vegetation cover. The aim was to be able to distinguish between deforestation likely to be consistent with the legal reserve requirement versus deforestation in areas where properties are likely already to be out of compliance with the requirement.[25] Lacking a map of property boundaries, a proxy was constructed. Using the SEPLAN land cover map, the proportion of natural vegetation within a square of 25 x 25 pixels of 100 m resolution – an area of 625 ha that corresponds to the mean property size in Mato Grosso (IBGE 1998) – was computed for each pixel. The definition of "high" and "low" bases on the official legal reserve definition which is 35% in the Cerrado and 80% in Amazon.[26] An additional 50% legal reserve in the Transition biome is valid in Mato Grosso (Mato Grosso Complementary State Law No. 38/95). The spatial delineation of the biomes bases primarily on the RadamBrasil vegetation map (1977-1981), which is complemented by the SEPLAN land cover map and topographic maps by the Brazilian Institute of Geography and Statistics (IBGE/DSG) (Leite 2002).

Data inconsistencies between FEMA and SEPLAN datasets present a challenge to accurate deforestation assessment in Mato Grosso. The available deforestation data identifies areas on which forest cover was lost, but does not identify pre-existing forest cover. The SEPLAN

[25] Recall that the actual compliance status is not observed.

[26] The legal reserve requirement of the Brazilian Forest Code of 1965 was first revised in 1996 (Presidential Provisional Decree 1.511/96) and converted into a law-like decree in 2002 (Provisional Measure 2001).

land use/land cover map bases primarily on 1995 satellite imagery with some additional images from 1996, and fieldwork conducted in 1997 with updates from 1999 (SEPLAN 2004a). As the SEPLAN map integrates information from different years, there are inconsistencies between the SEPLAN map and FEMA deforestation data. The share of FEMA deforestation taking place on areas identified as agricultural in 1995-97 by SEPLAN is 25.5% in 1996-97, 19.4% in 1998-99, 13.2% in 2000-01 and 9.5% in 2002. To overcome the inconsistencies, the spatial analysis extent was limited to the SEPLAN natural vegetation cover, presumably of 1995. Yet for aggregate deforestation rates, two approaches are used:

- **Relative rate (forest cover change):** FEMA deforestation in period t divided by the changing forest cover (base forest cover is the SEPLAN forest cover in 1995 minus cumulative FEMA deforestation since 1995).
- **Absolute rate:** FEMA reported deforestation in period t/ divided by invariant land area (regardless of forest cover and therefore constant over time).

Further inconsistencies were found in the FEMA deforestation data. For some areas, the same area was deforested several times, e.g., although an area was deforested in 1996-97, it was deforested again in 1998-99 or 2000-01. The absolute proportion of so named *duplicate deforestation* in non-protected forested areas in Mato Grosso, i.e. which was recorded in year x (row variable) and again recorded in year y (column variable), is depicted in Table 1. To correct for this data problem, the data was adjusted to only consider the deforestation that was monitored in the first time period, (i.e. of 1996-97 in the above example).

Duplicate deforestation [sqkm]	1998-99	2000-01	2002
1996-97	60	381	148
1998-99	-	347	134
2000-01	-	-	4

Table 1: Proportion of duplicate deforestation in the FEMA deforestation data

Name	Date of map content	Date of publication	Scale	Source	Description of the map content	Map in Appendix
Incremental deforestation in Mato Grosso	1996-97, 1998-99, 2000-01, 2002	2004	1: 250,000	Mato Grosso State Foundation of the Environmental (FEMA)	Human induced loss of any natural vegetation in Mato Grosso (unlike INPE, FEMA also considers deforestation in the Cerrado biome). Until 2001, deforestation was measured bi-annually (two years). Since 2002, deforestation is measured annually.	Map 8
Ecoregions of Mato Groso	1977-1981	2001	1: 1,000,000	Derived from the vegetation map of the RadamBrasil Project by FEMA	Vegetation map with three biomes (i.e. Amazon, Transition, Cerrado) as classified by FEMA (Instrução Normativata No. 2/2001) identify the required legal reserve proportion for a given property in Mato Grosso.	Map 9
Permanent preservation areas (APP) of Mato Grosso	unknown	2003	1: 250,000	Mato Grosso State Foundation of the Environmental (FEMA)	APP around waterbodies (rivers and lakes). The width of the waterbody defines the width of the APP buffer (Forest Code 1965).	Map 10
Protected areas of Mato Grosso		2003	1: 250,000	Mato Grosso State Foundation of the Environmental (FEMA)	Indigenous territories and conservation units	Map 11
Land use/land cover of Mato Grosso	1995	2002	1: 250,000	State Secretary of Planing and Coordination (SEPLAN)	Actual land use and land cover bases on satellite imagery primarily of 1995 and some of 1996, and fieldwork conducted in 1997 and some updates in 1999. The map was elaborated as part of the socio-economic ecological zoning exercise (ZSEE) in Mato Grosso.	Map 12
Natural vegetation cover of Mato Grosso	1995	-	1: 250,000	Derived from land use/ land cover map (own calculation)	Natural vegetation cover corresponds to the land cover (without any human activity as of 1995) of the SEPLAN land use/land cover map.	Map 13
High/low natural vegetation cover in Mato Grosso	1995	-	1: 250,000	Derived from natural vegetation cover map (own calculation)	Mean natural vegetation cover on a 25x25 pixel neighborhood (corresponding to a mean property size in Mato Grosso of 625 hectareas) was calculated for each pixel on the 100 meter rasterized natural vegetation cover 1995. The resulting mean values were ove	Map 14
Elevation of Mato Grosso	2002-2003	2003	90 meter	US Geological Survey (USGS)	Digital elevation model for Mato Grosso from the Shuttle Radar Topography Mission (SRTM)	-
Slope of Mato Grosso	2002-2003	-	90 meter	Derived from elevation grid (own calculation)	Slope was calculated from elevation grid.	Map 15
Roads of Mato Grosso	unknown	2003	1: 250,000	Mato Grosso State Foundation of the Environmental (FEMA)	Primary (paved) and secondary (unpaved) roads in Mato Grosso	-
Distance to roads in Mato Grosso	unknown	-	1: 250,000	Derived from road map (own calculation)	Bird distance to the nearest road calculated for each pixel of the 100 meter rasterized road map.	Map 16
Agricultural suitability of Mato Grosso	1995	2002	1: 250,000	State Secretary of Planing and Coordination (SEPLAN)	Agricultural suitability was defined by SEPLAN as part of the socio-economic ecological zoning exercise (ZSEE) in Mato Grosso.	Map 17

Table 2: Catalog of original and derived data for the econometric analysis

Data sampling

The information for the analysis was derived from digital maps using geographic information system (GIS) techniques. Sampling was performed by overlaying a 1-km rectangular grid over the state of Mato Grosso, yielding 905,995 sample points. The resulting sample point layer was overlaid on each of the assembled digital maps (Table 2) to extract location-specific characteristics for each point (e.g. deforested or non-deforested in year x) surrendering categorical variable information. Protected areas were excluded from the analysis, since on a yearly average 1996-2002, less then 0.15% of deforestation (with the SEPLAN natural vegetation cover as denominator) occurred within protected areas. This, in fact, suggests that some enforcement effectiveness in protected areas. Water and urban points were also excluded, leaving 745,718 sample points for analysis. To reduce spatial autocorrelation in the econometric analysis, sub-samples from the original set of sample points were created by selecting sets of every ninth point (i.e. every third x-coordinate and every third y-coordinate). Several combinations of ninth-point samples were extracted using the modulo-function on the xy-coordinates of the original samples points.

3.3 Tests for spatial program effects on deforestation in Mato Grosso

Prior to hypothesis testing, it is the aim is to test for any effect at aggregate level by comparing relative and absolute average yearly deforestation rates across biomes. Figure 2 depicts for each biome the relative and absolute deforestation rates for 1996-2002 in Mato Grosso. Relative annual deforestation rates refer to the geometric average yearly forest cover change with adjusted SEPLAN natural vegetation cover as denominator (left figure). Absolute annual deforestation refers to the average yearly deforestation rate where the denominator refers to the total biome land area (right figure).

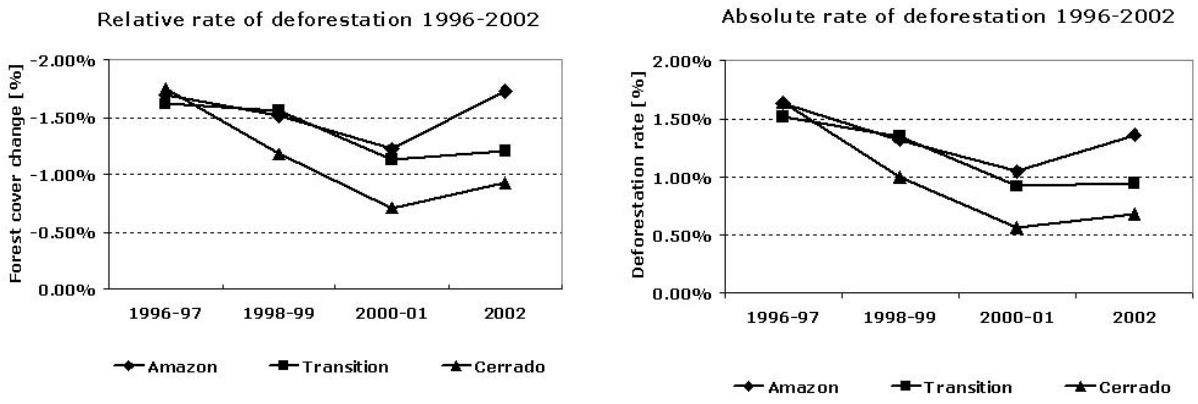


Figure 2: Relative and absolute deforestation rates 1996-2002 in Mato Grosso (FEMA 2004)

The resulting graphs depict ambiguity regarding any enforcement effect. Already prior to the FEMA enforcement program, in biennia 1996-97 and 1998-99, absolute and relative deforestation rates decline across all biomes. Deforestation rates continue to decrease after program implementation in 2000-01, but then start increasing again in 2002 (when FEMA began to report single-year observations), especially in the Amazon.

Yet isolated state-level before/after comparisons are problematic because of year to year variation in external factors such as climatic variables, economic variables and restrictions related to animal diseases (foot and mouth disease, mad cow disease) or plant cultivation (genetically modified organisms). Therefore, aggregate deforestation rates across the Amazon were compared to assess the relative deforestation change in Mato Grosso relative to other Amazon states. Figure 2 depicts INPE absolute annual deforestation for Mato Grosso, Pará and the cumulated deforestation from the other Amazon states, i.e. Acre, Amapá, Amazonas, Maranhão, Rondônia, Roraima and Tocantins.[27]

According to Figure 3, Mato Grosso deforestation was decreasing in 1999-00 and increasing in 2000-01 (INPE deforestation years refer to 12-month periods straddling calendar years). [28]

[27] Recall that INPE estimates exclude deforestation of Cerrado vegetation and pre-existing secondary forest.

[28] The methodology to deforestation monitoring differs between INPE and FEMA. Instead of assessing these differences in methodology and outcome, the objective is rather to compare the relative deforestation change in Mato Grosso as compared to the other Amazon states.

During the same period, the opposite pattern was observed in Pará, while there was no deforestation change in the remainder of the Amazon. Year 2001-02 suggests slight evidence for enforcement effectiveness in Mato Grosso where deforestation decreased while a strong overall increase was observed in the remaining Amazon. In 2002-03, however, overall Amazon deforestation decreased while in Mato Grosso, deforestation increased drastically. Whilst the differentially lower increase of 2001-02 deforestation in Mato Grosso could be linked to FEMA enforcement, there is no apparent effect on deforestation in 2002-03 where deforestation in Mato Grosso increases 23% while it drops in the other Amazon states, i.e. 19.3% in Para and 15.7% in the other Amazon states (INPE 2004).[29]

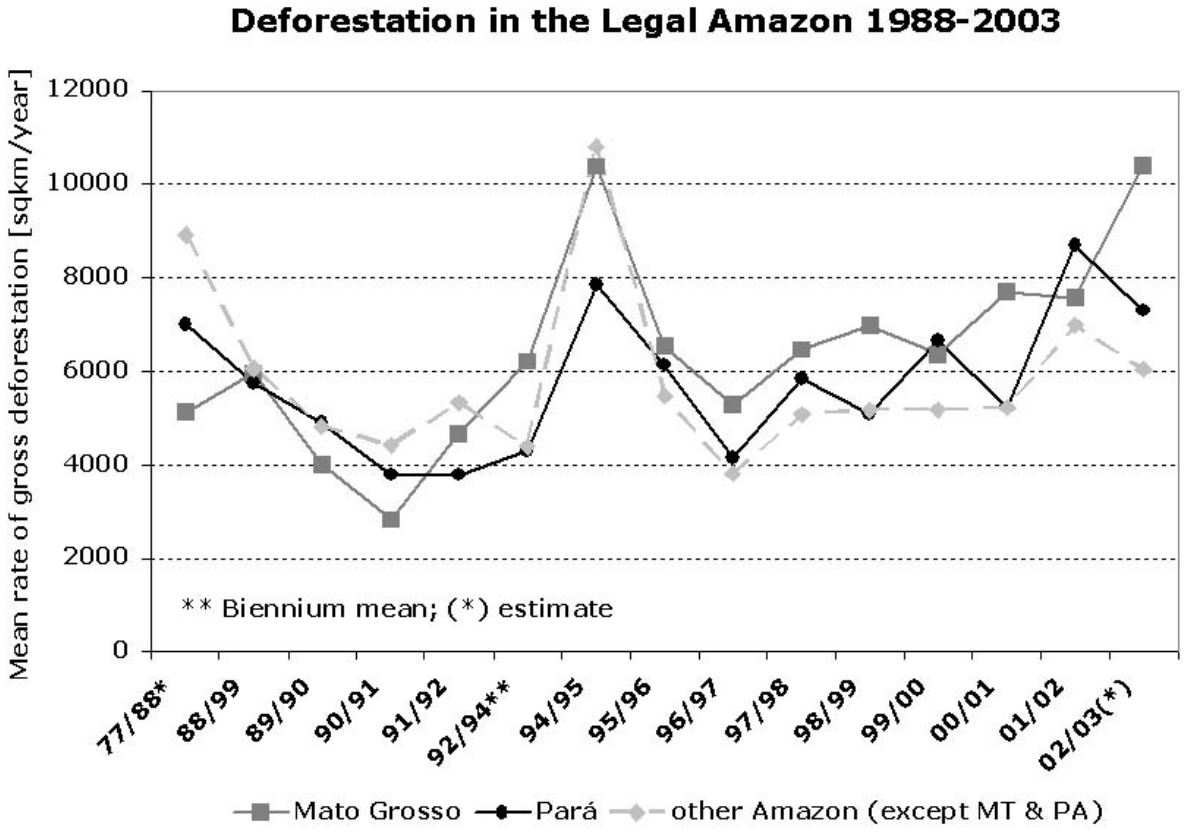


Figure 3: Deforestation in the Legal Amazon 1988-2003 (INPE-Prodes 2004)

[29] However, deforestation decrease in 2002 could also be linked to the climatic phenomenon "El Niño"

3.3.1 Spatial effects from the "permanent preservation areas" (APP) requirement

To test for compliance with the APP requirement, the idea is to assess if deforestation dropped in APP relative to non-APP areas. Specifically, deforestation change was compared within APPs, versus just outside of APPs (i.e. within a 300 m buffer around APPs), and versus completely outside of the APPs and their 300 m buffer before and after initialization of the SLAPR. This was done separately for each non-protected biome areas.

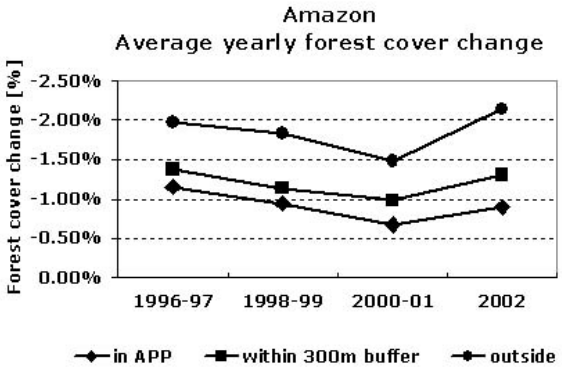


Figure 4: Amazon forest cover change inside/outside APPs (FEMA 2003b)

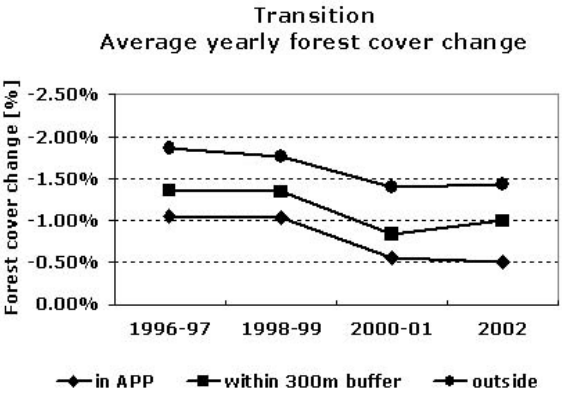


Figure 5: Transition forest cover change inside/outside APPs (FEMA 2003b)

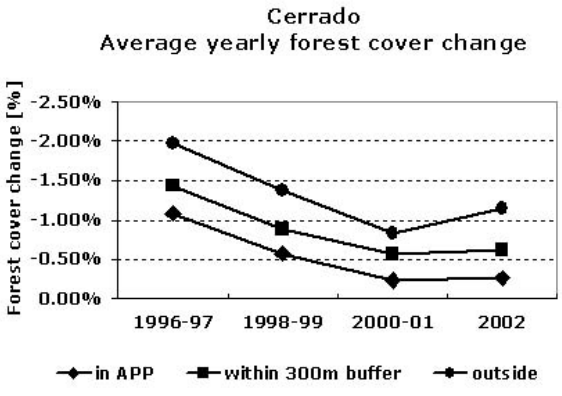


Figure 6: Cerrado forest cover change inside/outside APPs (FEMA 2003b)

There is no strong evidence for a differential effect of enforcement on deforestation within APP relative to outside APP. Only in 2002, in the Amazon and Cerrado biome (Figure 4 and Figure 6), forest cover change outside and close to APP increases relatively stronger than inside. A relatively stronger increase in forest cover change is also depicted in the 300 m buffer around APP of the Transition biome (Figure 5).

Yet there is a differential effect comparing forest cover change in large-scale deforestation (clearings greater than 200 ha) relative to small-scale deforestation (below 200 ha). In all biomes, large-scale deforestation started already to decline before program implementation (1996-97, 1998-99) and continued until 2000-01. Figure 7 depicts forest cover changes (relative denominator) in large- versus small-scale deforestation inside versus outside APP's across biomes. The comparison finds:

- In the Amazon, until 2000-01, large-patch deforestation decreases relatively stronger than small-patch deforestation. In 2002, overall forest cover change rebounds, although the increase in large-patches is less than in small patches. The ratio of large to small deforestation declines markedly over the period.
- In the Transition, large-patch deforestation declines until 2002, while small patch deforestation increases in 1998-99, declines in 2000-01 and increases in 2002.
- In the Cerrado, until 2000-01, large-patch deforestation decreases relatively stronger than small-patch deforestation. Overall forest cover change remains constant in 2002, except for the small-patch deforestation in non-APP areas, which grows again.

Hence, although forest cover change increases again in 2002, there is no evident difference in forest cover change inside versus outside APP. There does appear to be a greater decline in forest cover change in large-patch deforestation (greater 200 ha) compared to small patch deforestation. The decline of large-patch deforestation in non-APP areas, however, may not necessarily be attributable to increased APP compliance as in areas with highly fragmented

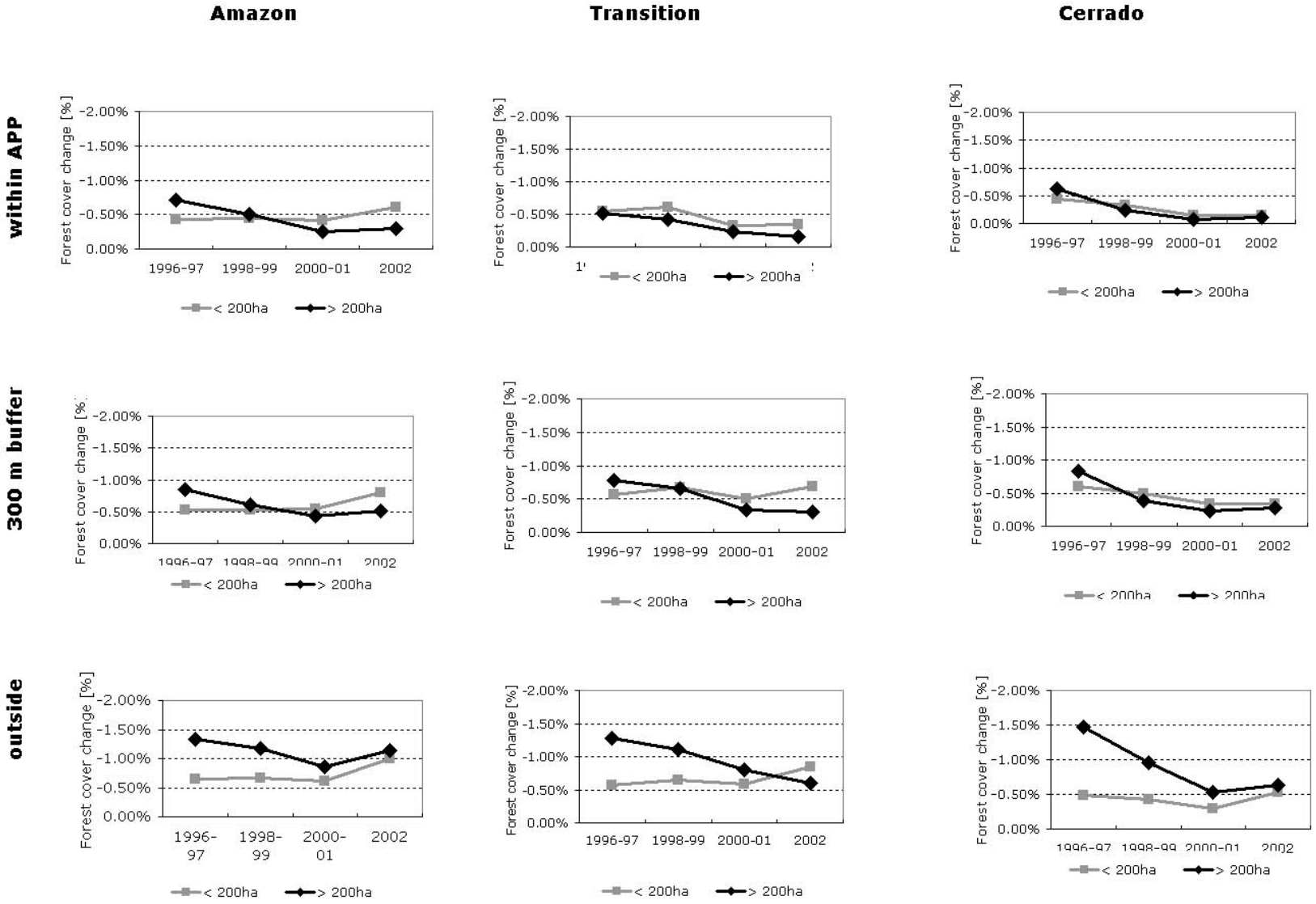


Figure 7: Forest cover change 1996-2002 in deforestation patches smaller/greater 200 ha inside/outside APP across biomes (FEMA 2003b)

forest cover, the rate of large-scale deforestation must fall over time, regardless of program impact, because candidate forest patches become increasingly scarce.

3.3.2 Spatial effects from the "legal reserve" requirement

With increased enforcement of environmental legislation, landholders are assumed to be more likely to comply with the legal reserve requirement. The size of a legal reserve depends on the biome in which the property is located.[30] The hypothesis is that with increased enforcement deforestation will be depressed more in properties already out of compliance relative to complying properties. Because a map of property boundaries was not available for the analysis, a proxy for current compliance was created (Chapter 3.2). Table 3 depicts the absolute and relative distribution of high/low natural vegetation cover per total and per forested area across biomes. The biome share with high/low cover is depicted in the second row (row percentage). The share of high/low cover by biome is shown in the third row (column percentage).

		High natural vegetation cover		Low natural vegetation cover		Total	
Biome	Unit	Land area	Forest area	Land area	Forest area	Land Area	Forest area
Amazon	[km²]	231,006	230,533	117,103	43,415	348,109	273,948
	[%]	66.4	84.2	33.6	15.8	100.0	100.0
	[%]	45.6	48.2	49.5	84.5	46.8	51.7
Transition	[km²]	87,472	82,938	31,627	4,569	119,099	87,507
	[%]	73.4	94.8	26.6	5.2	100.0	100.0
	[%]	17.3	17.3	13.4	8.9	16.0	16.5
Cerrado	[km²]	188,187	164,927	87,871	3,369	276,058	168,296
	[%]	68.2	98.0	31.8	2.0	100.0	100.0
	[%]	37.1	34.5	37.1	6.6	37.1	31.8
Total	[km²]	506,665	478,398	236,601	51,353	743,266	529,751
	[%]	68.2	90.3	31.8	9.7	100.0	100.0
	[%]	100.0	100.0	100.0	100.0	100.0	100.0

Table 3: Spatial distribution of high/low natural vegetation cover across biomes (own calculations)

[30] The Provisional Measure (2001) requires an 80% reserve in the Amazon, and 35% reserve in the Cerrado. A Mato Grosso Complementary State Law (1995) requires an additional 50% reserve in the Transition biome.

The following figures depict, by biome, the relative average yearly deforestation rates in high versus low cover areas for the periods 1996-97, 1998-99, 2000-01 and 2002.

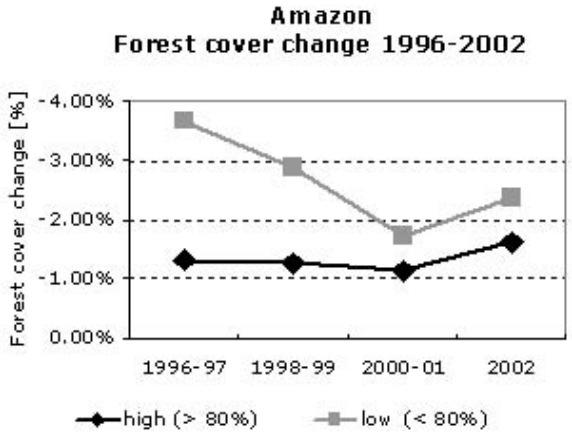


Figure 8: Amazon forest cover change in high/low forest cover (FEMA 2003b)

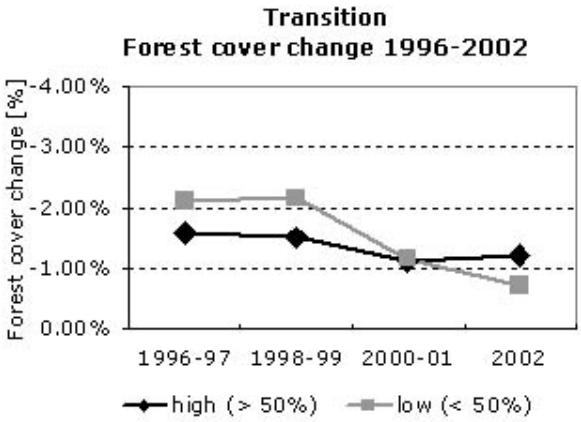


Figure 9: Transition forest cover change in high/low forest cover (FEMA 2003b)

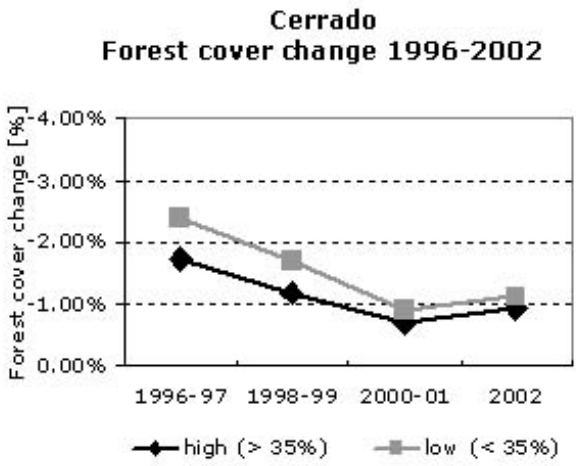


Figure 10: Cerrado forest cover change in high/low forest cover (FEMA 2003b)

There is indeed some evidence for program effect related to the legal reserve requirement, especially in the Amazon (Figure 8). Until 2000-01, deforestation rates in low cover areas in

the Amazon and Transition (Figure 8 and Figure 9) drop relatively stronger than rates in high cover areas. Yet this decline, which began prior to program implementation, is probably more connected to the low proportion of remaining forest cover than to program effectiveness. Still, the apparent strong decrease in high cover deforestation (relative to low cover) in the Amazon, where the proportion of remaining forest cover is 78.8%, may possibly be attributed to the FEMA program. The econometric analysis below measures the size and statistical significance of this decline. However, without the actual delineation of the property boundaries, it is difficult to assess compliance with the legal reserve requirement, especially for the Transition and Cerrado biome.

Differential effects of program effectiveness can further be assessed by comparing deforestation dynamics in large versus small patches. Figure 11 depict rates of large-patch deforestation versus small-patch deforestation (denominator: total biome land area) in high versus low cover areas across biomes.

Comparing the change in small versus large patch deforestation, there is slight evidence for effectiveness enforcing the legal reserve requirement. Except for high cover Amazon and low cover Transition, large-patch deforestation tends to decrease more rapidly than small patch deforestation, at least until 2002. Yet it started already prior to program implementation and is most likely connected to the low proportion of remaining forest cover.

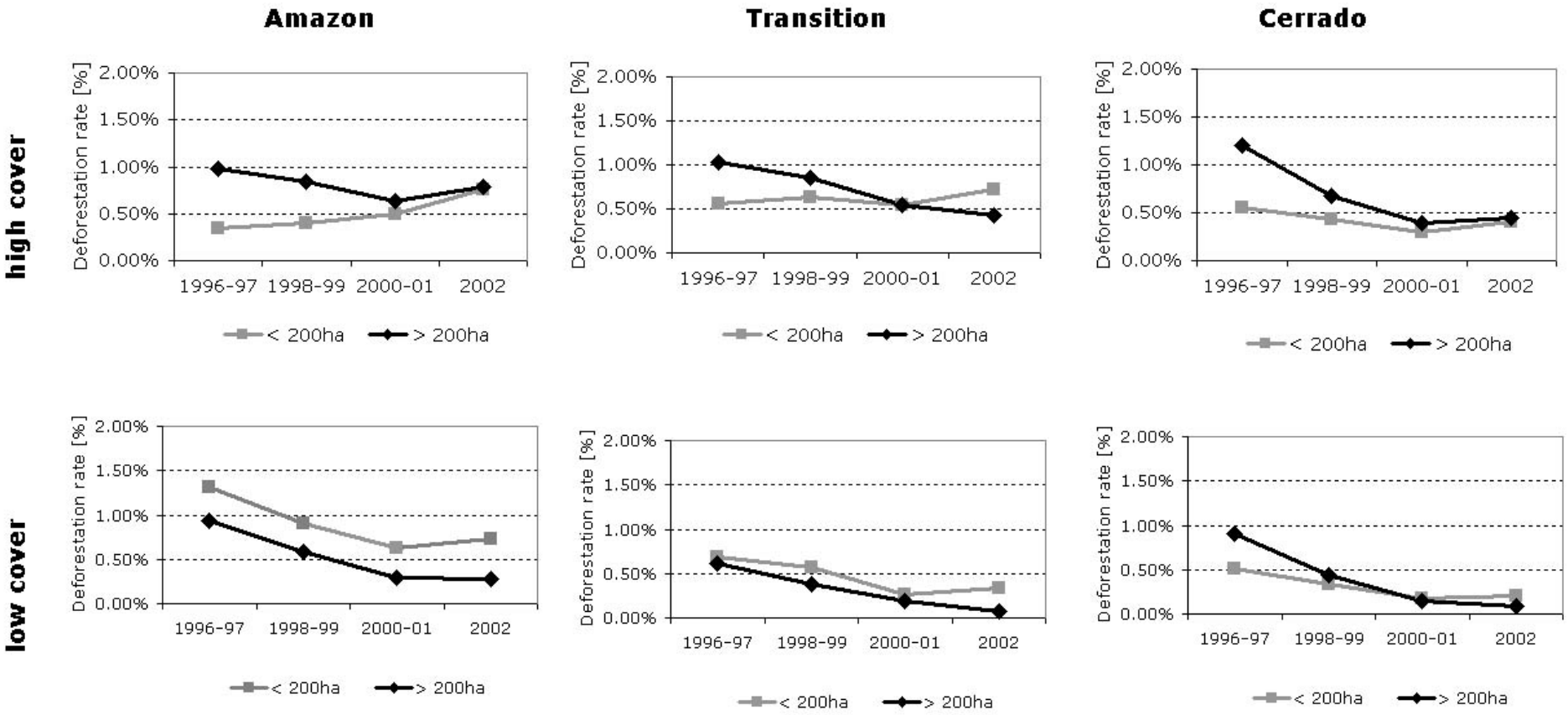


Figure 11: Deforestation rates in high/low cover areas by biome (FEMA 2003b)

3.3.3 Spatial effects related to road proximity

Enforcement activities are likely to be more strict near roads; or landholders may believe that road proximity is associated with greater surveillance. The program may thus be associated with a deforestation decrease close to roads relative to far from roads. To examine this, forest cover change, separated by size class, was tabulated across road distance classes.

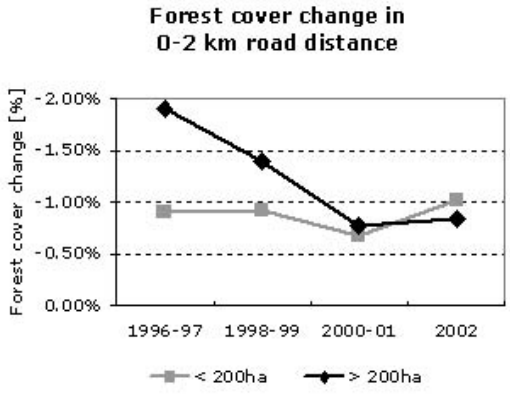


Figure 12: Forest cover change in 0-2km distance from roads (FEMA 2003b)

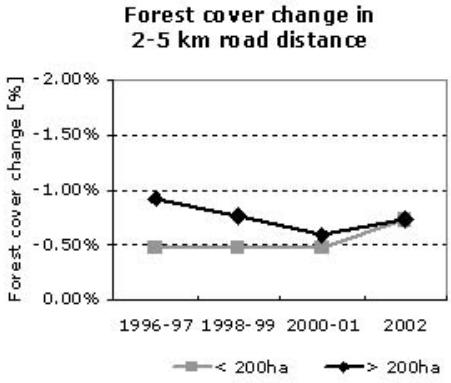


Figure 13: Forest cover change in 2-5 km distance from roads (FEMA 2003b)

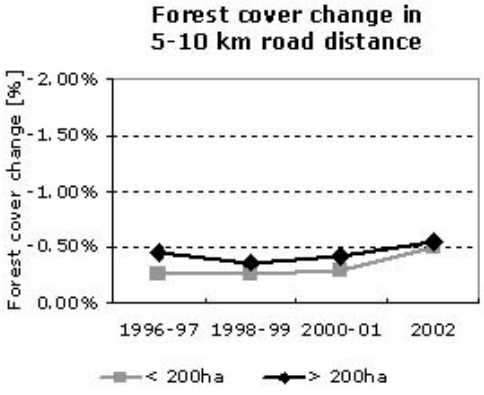


Figure 14: Forest cover change in 5-10 km distance from roads (FEMA 2003b)

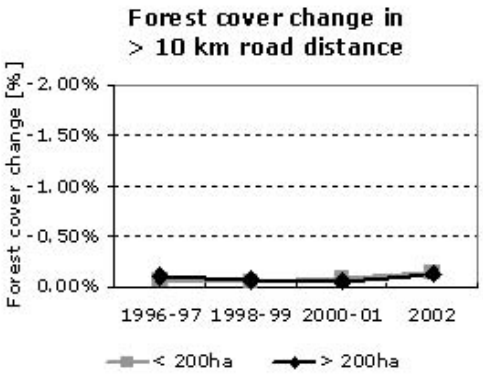


Figure 15: Forest cover change in > 10 km distance from roads (FEMA 2003b)

There is some sign for program effectiveness on large-scale deforestation. According to Figures 12-15, large-scale deforestation declines more rapidly, especially in 0-2 km road distance, than small-scale deforestation. This pattern disappears when moving further than 5 km from roads. Again, fragmentation of the forest within 2 km of roads will eventually result in a decline of large-patch deforestation relative to small. Still, overall near-road deforestation appears to decrease relative to deforestation distant from roads.

3.3.4 Effects on the size of deforestation patch

In their environmental licensing program, FEMA sought to control illegal deforestation on large-holdings (FEMA 2001b). The argument was that large-holders contribute relatively more to deforestation in Mato Grosso than small-holders. The program is thus expected to depress large-scale deforestation (i.e. related to large individual clearings) relative to small-scale deforestation. Indeed, the relative proportion of large-scale deforestation (bar value, in percent per year), especially above 1000 ha, decreased drastically in 2000-01 (Figure 16). This suggests an effect on large-scale deforestation which might be linked with FEMA enforcement.

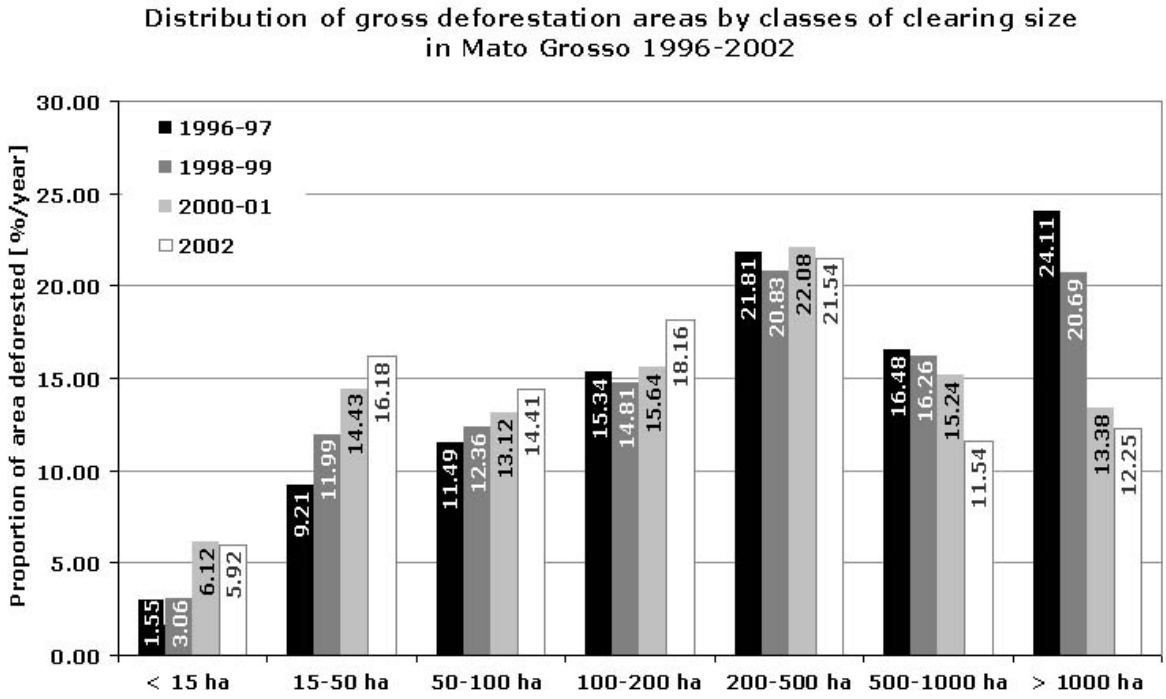


Figure 16: Mean gross deforestation [%/year] in Mato Grosso by classes of size 1996-2002 (FEMA 2004)

The question arises whether Mato Grosso experiences a relatively greater decline in large-scale deforestation than other Amazon states. To test this, available consistent INPE scenes for 1998-00, 2001 and 2002 for an area of 10 km on both sides of the border were assembled (Map A). Figure 17 and Figure 18 depicts the distribution of deforestation size at the state border area. It suggests that after the FEMA program goes into effect, landholders in Mato Grosso shift from deforesting a few large patches to many smaller ones. This is depicted by the remarkable increase in 200-500 ha deforestation. Such a pattern is not apparent in Para suggesting possible landholder reaction to FEMA enforcement in Mato Grosso. Yet the total proportion of gross deforestation at the border area is very small. Table 4 depicts total gross deforestation for 1998-2000, 2001 and 2002 within the 10 km border area in Mato Grosso and Para.

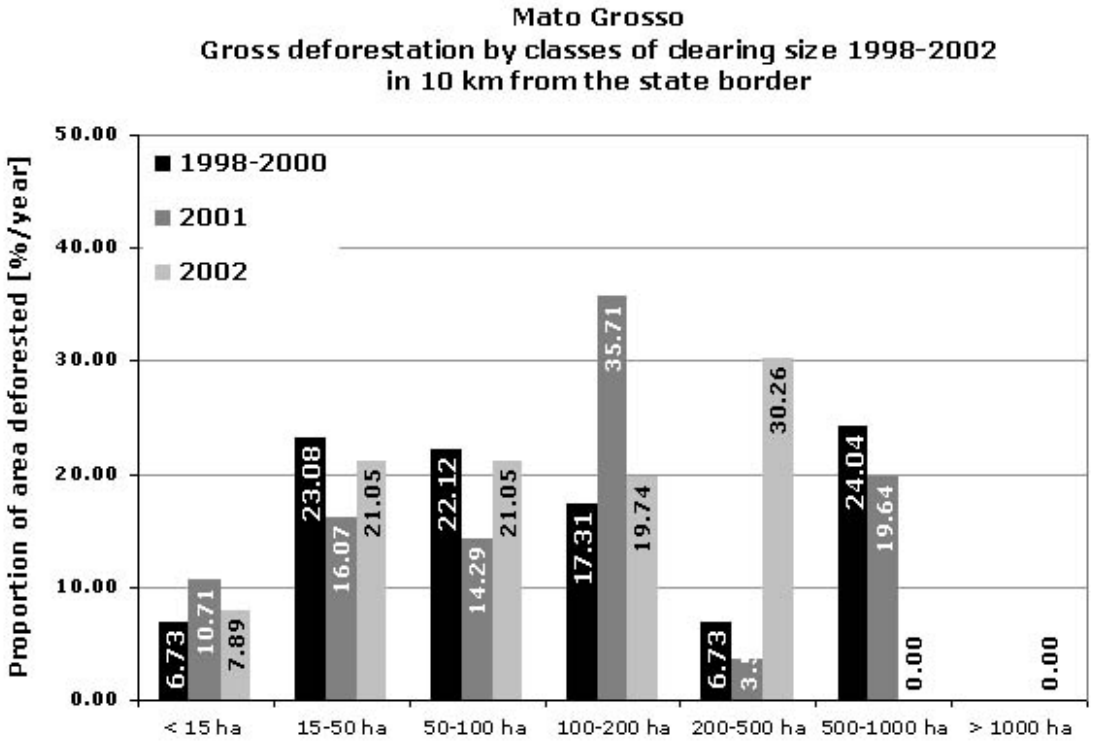


Figure 17: Mato Grosso gross deforestation by classes of clearing size 1998-2002 at Para border (INPE 2004)

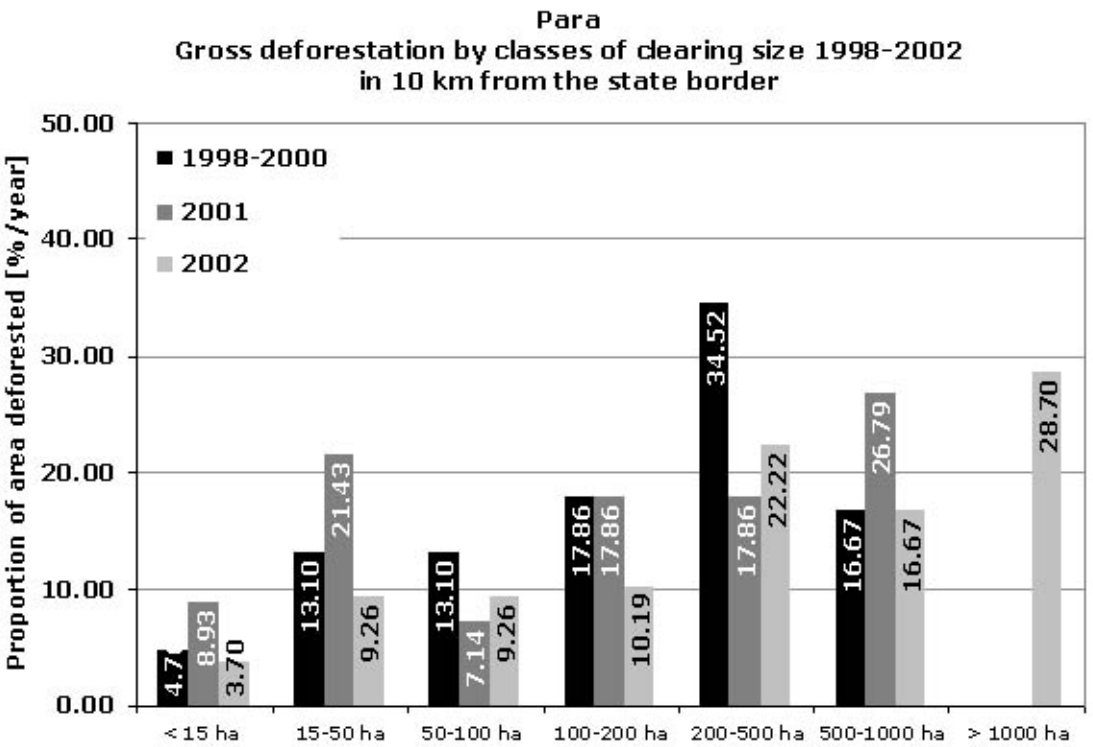


Figure 18: Para gross deforestation by classes of clearing size 1998-2002 at Mato Grosso border (INPE 2004)

	1998-2000	2000-01	2002
Mato Grosso	104 km^2	56 km^2	76 km^2
Para	84 km^2	56 km^2	108 km^2

Table 4: Gross deforestation 1998-2002 in 10km at Mato Grosso-Para state border (Source: INPE 2004)

3.3.5 Spatial effects in the initial enforcement target area

Upon the implementation of the environmental licensing system of rural properties in Mato Grosso, FEMA targeted first enforcement efforts to selected municipalities in the state. In 2000, municipalities along the state's major transport axes were targeted. In 2001, municipalities at the consolidated agricultural frontier, primarily in the south-eastern part of the state, were targeted. The selection of the 2000 enforcement target bases on the spatial concentration of high deforestation rates in these municipalities. The selection of the 2001 enforcement target refers to the locally persistent non-compliance of the APP- and legal reserve requirement. To assess the effect of targeted enforcement on the local land use (deforestation) pattern, deforestation rates were compared in high versus low enforcement areas. High enforcement refers to the combined set of targeted municipalities in 2000 and 2001 (Map 7, Chapter 3.2).

To control for the FEMA interest in targeting large-holders, large- versus small-scale forest cover change is distinguished. Figure 19 indicates that large-scale deforestation (clearings greater 200 ha) decreases already prior to program implementation in 1998-99 and 2000-01, yet in 2002, large-scale deforestation continues decreasing in high enforcement areas while it increases in low enforcement areas in 2002. There is no difference in the dynamics of small-scale deforestation between high and low enforcement areas. This is consistent with the greater post-program response (expressed by deforestation behavior) in high enforcement areas.

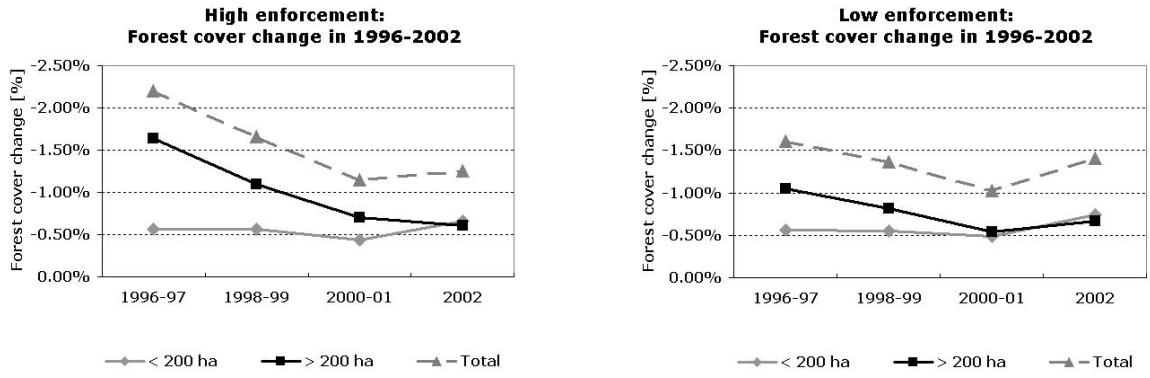


Figure 19: Forest cover change 1996-2002 in high/low enforcement areas in Mato Grosso (FEMA 2003b)

To test for a difference in forest cover change in areas of high versus low natural vegetation cover, small- versus large-scale deforestation are tabulated by high and low natural vegetation cover and for high and low enforcement areas. As depicted in Figure 20, large-scale deforestation (greater 200 ha) in high enforcement areas continue to decrease in 2002 (left graphs), while it increases in low enforcement areas (right graphs). Small-scale deforestation increases in 2002, especially in areas with low natural vegetation cover (lower graphs). The dominance of small-scale deforestation in areas with low natural vegetation cover may be related to the decreasing availability of large continuous candidate forests for clearing or the increasing arrival of small-holders to the easily accessible forest fringe.

Figure 21 depicts the comparison of large- and small-scale deforestation inside and outside permanent preservation areas (APP) in high and low enforcement areas. Areas within and close to APPs experience no significant difference in high versus low enforcement areas. This is inconsistent with the hypothesis expecting a relatively stronger decrease in deforestation within APPs of the high enforcement area. The only remarkable difference between forest cover change in high and low enforcement areas occurs outside APPs. However, the status of APPs could also be generally accepted (i.e. by rural producers) which motivates compliance regardless of FEMA enforcement.

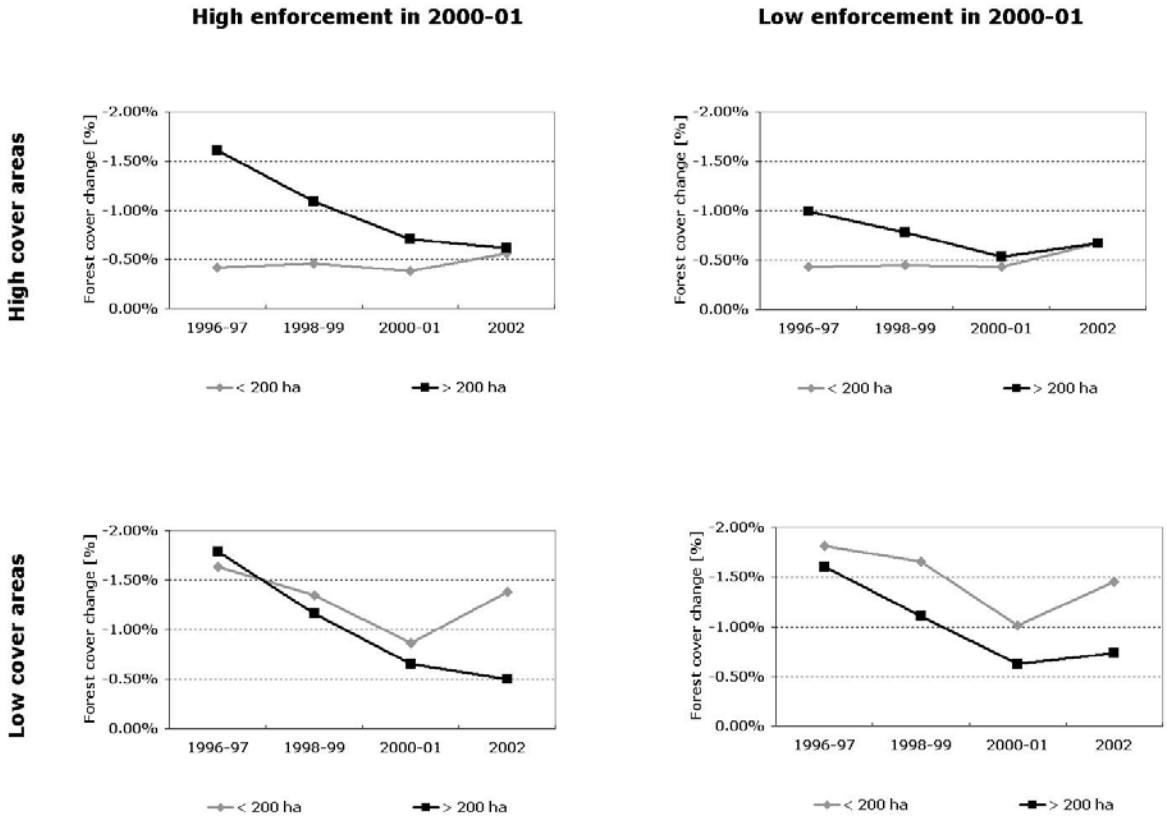


Figure 20: Forest cover change 1996-2002 in high/low cover areas by high/low enforcement (FEMA 2003b)

In sum, the tests reveal some behavioral response to increased enforcement. This is especially the case for large-scale deforestation (clearings greater 200 ha) in areas where FEMA targeted initial efforts in 2000-01 (high enforcement areas), and in areas near roads. Further evidence for program effectiveness is suggested by the relatively greater decline in post-program large-scale deforestation in Mato Grosso compared to Para. However, a behavioral response of large-scale deforestation is less unambiguous in areas with low natural vegetation cover and within permanent preservation areas.

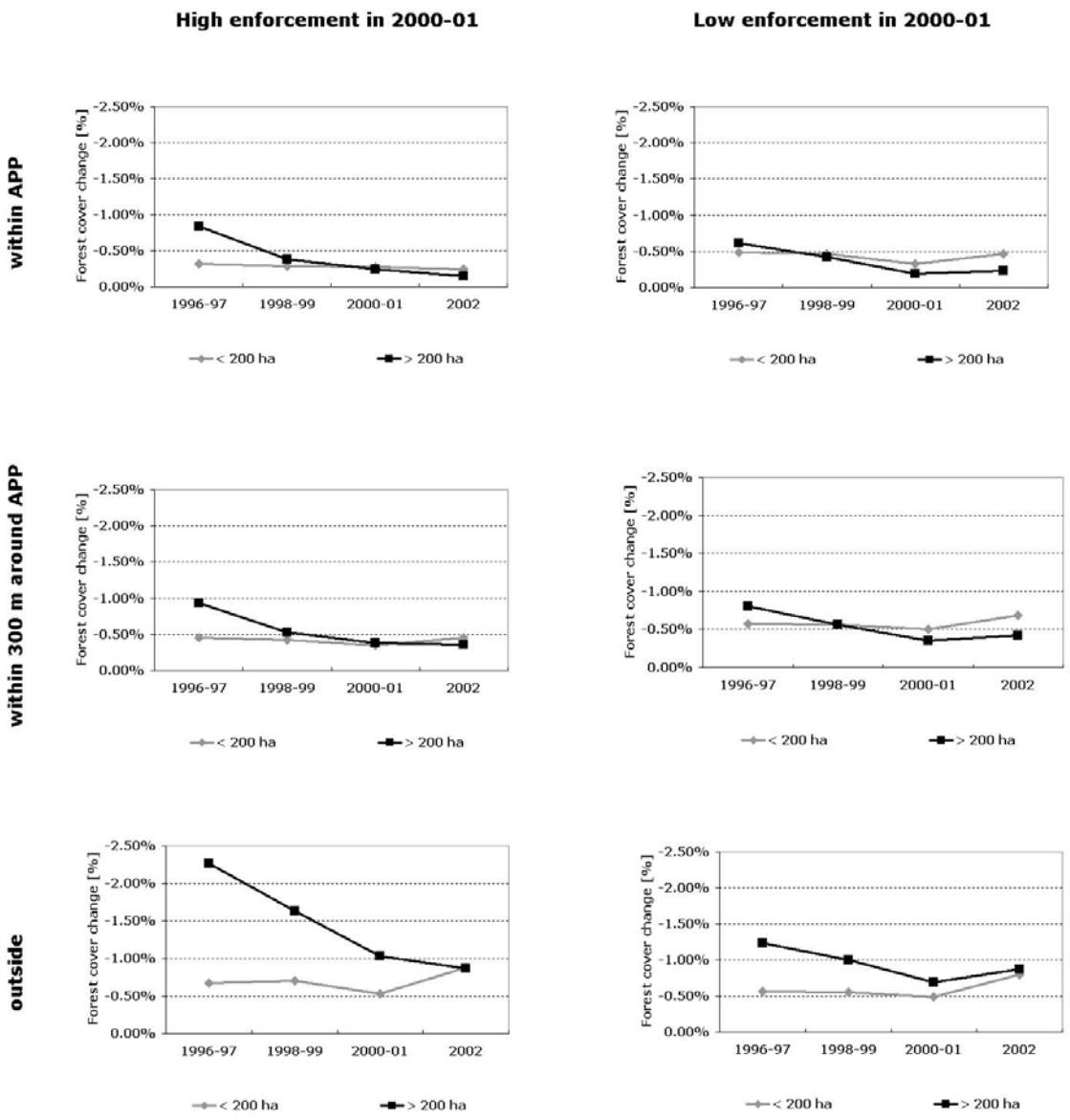


Figure 21: Forest cover change 1996-2002 inside/outside APP in high/low enforcement areas (FEMA 2003b)

3.4 Econometric analysis of program effectiveness in Mato Grosso

To overcome the possibility of some shifts in patterns from year to year (due to crop prices or rainfall pattern) resulting in spurious correlations at aggregate level, the probability of deforestation at each point was estimated as a function of high/low natural vegetation cover, APP status, enforcement status, road distance, slope and agricultural suitability. The hypothesis is that prior enforcement, a landholder will seek to maximize his utility by deforesting in road proximity and in areas of high agricultural suitability. With increased

enforcement, however, a landholder will also comply with environmental regulation, i.e. with the legal reserve and the APP requirement.

The probability of deforestation is estimated using the following probit specification:

$$P [y_{dt}=1] = \Phi (\beta' X_t)$$

where y_{dt} is an indicator value taking on the value of one for deforestation, and zero for no deforestation during period t, point d; Φ (.) denotes the normal distribution function; X_t denotes a vector of determinants of deforestation; and β is a vector of parameters to be estimated. The sample consists only of points having forest cover at the beginning of the observation period t. To reduce spatial autocorrelation, the sample consists of a spatially regular grid of selected set of points (every ninth point) from the original 1 km distant point data set of non-protected areas in Mato Grosso (Chapter 3.2) To examine policy effects on land use over time, four sub-samples, one for each period (1996-97, 1998-99, 2000-01, 2002) with spatially differently selected points (different ninth-point combination) were created and merged into a single dataset spanning the entire period. Two sets of probit regressions were analyzed. The first consists of a simple estimation of total deforestation within the extent of the SEPLAN natural vegetation 1995. The second is based on the same model specification but applied to estimate deforestation greater 200 ha (i.e. the dependent variable is the event that the point is part of a new, greater 200 ha deforestation patch). The motivation for the latter refers to FEMA's objective to target large-scale deforestation (FEMA 2001b).

Table 8 contains the summary statistics of the regressors and Table 9 depicts the outcome of the first set, i.e. the estimation of total deforestation within the SEPLAN natural vegetation cover. Table 10 depicts the magnitude of the effects in terms of the change in predicted deforestation rates, and is easier to interpret. The mean predicted, within-period deforestation rate, at sample means of the independent variables is .0169. In other words, a forested point with typical characteristics had a mean 1.69% probability of being deforested during one of

the time periods (three of which are two year periods, one a single year period). For convenience, effects, evaluated at means of the independent variables, are expressed in terms of absolute measures of deforestation rates (e.g., a 0.5% reduction would mean that the deforestation rate decreases from 1.69% to 1.19%). As depicted in Table 10, the estimation finds:

(i) compared to the two year period 1996-97: a statistically significant 0.24% reduction in deforestation in 1998-99, an insignificant 0.08% reduction in 2000-01, and a highly significant reduction of 0.62% for the single year period 2002 implying an increase in the average annual rate for that year;

(ii) compared to 1996-97, deforestation in low-cover areas is not significantly different in 1998-99, but is significantly lower by 0.66% and 0.53% in 2000-01 and 2002. This is consistent with a post-program response to a perceived increase in enforcement of the legal reserve requirement;

(iii) a very strong and highly statistically significant reduction in deforestation as distance to road increases; points that are 2 to 5 km from roads had deforestation rates 1.27% lower than close-in points in 1996-97 (see below for changes in this relation over time);

(iv) compared to 1996-97, deforestation in areas close to roads is not significantly different in 1998-99, but has significantly decreased by 0.78% and 0.92% in 2000-01 and 2002. This is consistent with a post-program response to a perceived increase in enforcement near roads;

(v) compared to 1996-97, deforestation rates in high-enforcement areas are significantly lower by 0.33% and 0.38% in 1998-99 and 2000-01, yet the magnitude of effects increases in 2002 yielding a highly significant decrease in deforestation rates of 0.73% compared to 1996-98. This is consistent with a program response to increased enforcement in 2000-01;

(vi) no statistically significant decrease in the deforestation rates within permanent preservation areas (APP) from 1996-2002. Yet deforestation rates within APP are significantly lower by 0.7% compared to deforestation rates outside permanent preservation areas. This suggests no effects of the SLAPR in deterring deforestation within APPs;

(vii) a very strong and highly statistically significant relationship between deforestation and soil quality; areas with soil quality rated 'no agricultural value' or 'possible for planted pasture' had deforestation rates of about 1.5% lower than areas rated 'good for annuals and perennials';

(viii) a significant relationship between deforestation and very steep slopes. Areas with slopes above 10 degrees have a 0.76% lower deforestation rate than flat areas.

Table 11 depicts the outcome of the second estimation, i.e. the probability of a greater 200 ha deforestation event. Table 12 depicts the magnitude of the effects depicting that a forested point with typical characteristics had a mean 0.91% probability of being part of a greater 200 ha deforestation event during one of the time periods. Furthermore, the estimation finds (Table 12):

(i) compared to 1996-97, there is a highly significant reduction in large-scale deforestation (clearings above 200 ha) by 0.19% in 1998-99, 0.24% in 2000-01 and 0.54% in 2002. The magnitude of effects increase significantly over time. This is consistent with a large-holder response to the FEMA program;

(ii) compared to 1996-97, deforestation in low-cover areas is neither significantly different in 1998-99, 2000-01 or 2002. Yet the significance increases since 2000-01. This is not consistent with a program response to a perceived increase in enforcement of the legal reserve requirement;

(iii) compared to 1996-97, large-patch deforestation in areas near to roads (0-2 km) is not significantly different in 1998-99, but has significantly decreased by 0.046% and

0.057% in 2000-01 and 2002. This is consistent with a post-program response to a perceived increase in enforcement close to roads.

(iv) no statistically significant decrease in the post-program deforestation rates within permanent preservation areas (APP) from 1996-2002. Yet, deforestation rates within APP are significantly lower by 0.4% than outside permanent preservation areas. This suggests no effects of the SLAPR in deterring deforestation within APPs;

(v) compared to 1996-97, deforestation rates in high-enforcement areas are significantly lower by 0.23% and 0.3% in 1998-99 and 2000-01. The magnitude of effects increases in 2002 yielding a highly significant decrease in deforestation rates by 0.49% compared to 1996-98. This is consistent with a response to targeted enforcement in 2000-01;

(vi) deforestation is strongly and significantly related to road proximity, agricultural suitability and slope.

The goodness of fit for the estimation of deforestation greater 200 ha is higher than for the estimation of total deforestation, yet the magnitude of both values is small. According to the McFadden pseudo-R^2 values the goodness of fit for estimating total deforestation is 7.04%, and 8.15% for estimating deforestation above 200 ha (Table 9 and 11).

3.5 Results

Aggregate deforestation rates for Mato Grosso 1996-2002 suggest ambiguity regarding any effectiveness of the SLAPR in deterring deforestation in Mato Grosso. However, aggregate deforestation rates can vary strongly across space and time due to climatic, economic and other factors. Simple before versus after assessments of aggregate deforestations rates are therefore not suitable to provide insights into program effectiveness. Seeking improved evidence for any program effectiveness, this study applied a variant of the *difference in difference* approach to geographic data. Notably, the rates of deforestation in areas where

deforestation was likely to be authorizable/authorized versus areas where deforestation was likely to be non-authorizable (first difference) were compared before versus after program implementation (second difference). The general hypothesis was that the program, if effective, should depress non-authorizable deforestation relative to authorizable/authorized deforestation. Lacking data on rural property boundaries present a major challenge to an accurate assessment of the SLAPR effectiveness. To overcome this difficulty, a proxy for *high/low natural vegetation cover* was constructed seeking to capture the likelihood of compliance with the legal-reserve requirement. The results suggest indeed some behavioral responses to the program, although aggregate deforestation rates remain high. Specifically, the results reveal:

- **Program effects on the permanent preservation area-requirement (Hypothesis 1):** According to the isolated tests and the econometric analysis, there is no clear indication of any effects from enforcing the APP requirement, i.e. there is no significant post-program deforestation decrease within APPs. There is, however, statistically significant evidence for a greater deterrence of deforestation within APP relative to non-APPs. Since the latter is not necessarily connected to increased FEMA enforcement, the hypothesis is not validated.
- **Program effects on the legal-reserve requirement (Hypothesis 2):** Using a proxy to assess compliance with the legal reserve requirement, the analysis revealed some evidence for a program response related to the legal-reserve requirement, especially in the Amazon biome and for large-scale deforestation. The econometric analysis confirmed the statistically significance of low cover areas in deterring deforestation after program implementation only for *total deforestation* as dependent variable, not for *large-scale deforestation (greater than 200 ha)*. This means the hypothesis is only partly validated.

- **Program effects near roads (Hypothesis 3):** There is strong and statistically very significant evidence for a reduction in post-program deforestation, especially large-scale deforestation, near roads. This is consistent with a program response to increased enforcement near roads and validates the hypothesis.
- **Program effects on large-scale deforestation (Hypothesis 4):** There is evidence for a greater post-program response in large-scale deforestation compared to small-scale deforestation. This is also supported by a relatively greater decline of post-program large-scale deforestation in Mato Grosso compared to Para. The hypothesis is validated, although large-scale clearings could have been substituted by medium-size clearings.
- **Program effects in targeted municipalities (Hypothesis 5):** There is strong and statistically significant evidence for greater post-program effects on deforestation, especially large-scale deforestation, in municipalities with high enforcement activity compared to areas with low enforcement activity in 2000-01. The hypothesis is validated.

Despite some indications of behavioral program effects, the results raise the question why aggregate deforestation rates have increased again in 2002. These questions are addressed within the next chapter which adopts a political economic approach to assess the SLAPR of Mato Grosso.

4 Power and interests in environmental policy-making: A political economic analysis of the SLAPR in Mato Grosso

Although aggregate FEMA deforestation rates decrease until 2000-01, they rebound in 2002 and increased even more in 2003. Figure 22 indicates that the trend of increasing deforestation rates since 2002 severed in 2003, especially the proportion of illegal deforestation jumped up drastically in 2003 relative to 2002. At the regional level of the Legal Amazon, aggregate total deforestation in 2003 reached its highest value since 1995 – of which 43% in Mato Grosso (INPE 2004).

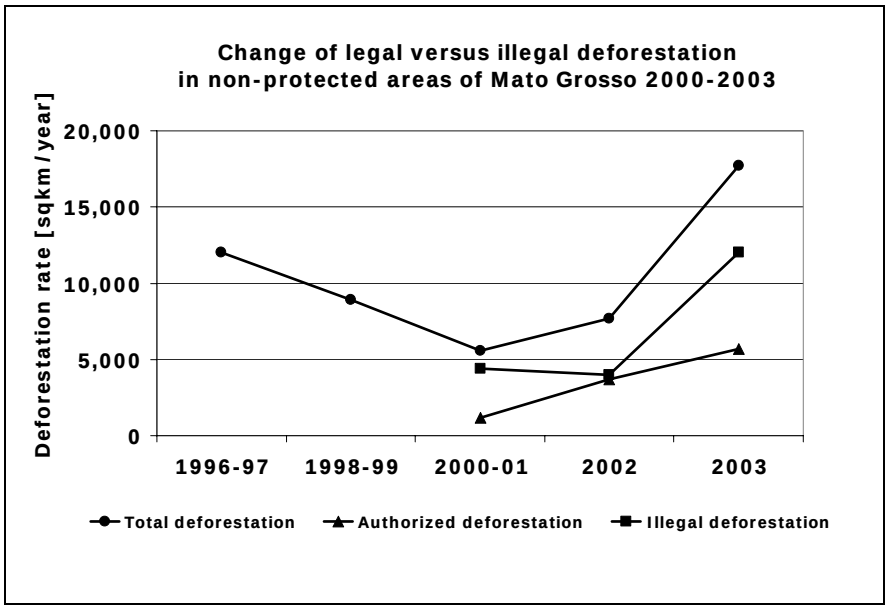


Figure 22: Authorized versus illegal deforestation in non-protected areas of Mato Grosso from 2000 to 2003 (FEMA 2004c) [31]

According to the *New Political Economy of the Environment*, the design and implementation of environmental policy measures is shaped by the political process between actor groups and their political-economic context. In Mato Grosso, the political economic context changed upon the elections in 2002 with a new state government since 2003. By adopting a political economic perspective, this chapter addresses thus the political actors of the SLAPR

[31] "Authorized" deforestation refers to the aggregated share of deforestation that was authorized by FEMA. But, authorization does not necessarily imply "effective" deforestation. The difference between total deforestation and authorized deforestation is the minimum proportion of necessarily "illegal" deforestation.

to complement its quantitative impact analysis in Chapter 3 with qualitative insights on the political economic determinants of the observed deforestation pattern in Mato Grosso between 1996 and 2003. The chapter starts with an introduction into the theoretical context of the political economy of the environment, and continues with a description of the methodology and the analysis of the political actors of the SLAPR.

4.1 Theoretical context

The basic premise of the new political economic theory, or public choice theory, consist of the assumption that all agents within the political sphere act out of a narrow self-interest, maximizing their own individual welfare through rational choice (Johnston et. al 2000). Unlike traditional economic policy analysis, the new political economy adopts a positive approach to analyze the behavior of and between political decision-makers and the political process itself (Dixit 1998; Clapham 1989).[32] Instead of a benevolent dictator, the state is viewed as elected government composed of individuals with own interests who, as politicians, also pursuit to get reelected. The application of the political economic theory to environmental problems is a relatively young field. The type of application consists of interest analysis in the area of environmental policy-making, and formal models that seek to capture political interactions via a reduction to essential variables.[33] Due to limitations in the formal analyses of the interplay of political actors, many authors adopt a verbal approach to political economic analysis of the environment (Graichen 2003).[34] Such verbal analyses base on an *"extended version" of the political-support approach* (Endres and Finus 1996). The

[32] Traditional economic policy analysis bases on the assumption that policy was made by an omnipotent, omniscient and benevolent dictator. Even with the recognition that other constraints impede policy-makers to opt for the "first-best" solution (to be *omnipotent*) and that existing information asymmetries impede policy-makers to be *omniscient*, economic policy analysis remains normative as it typically assumes a social-welfare maximizing principal (benevolent dictator) and neglects the role of the political process itself (Dixit 1998, 8).

[33] For a review of different models and approaches to the new political economy of the environment, see Graichen (2003) or Endres and Finus (1996).

[34] The critique refers to the partial analysis approach of these models often limited to two actors (politicians - voters, interest groups - politicians) while neglecting the interplay of all actors (Endres and Finus 1996).

objective is to analyze all relevant actors and their interests, processes and structures, to explain why political decision-makers find it rational to accept the observed type and degree of pollution – defined generally to capture harm from any environmental externality –, and to favor the observed environmental conservation measures (Schaltegger 1998). Important in the definition of relevant actors is the underlying institutional context which has to be the same for all groups (Schaltegger 1998). Typically, relevant actors include citizens, consumers, interest groups, politicians and the bureaucracy. The following outline of the political actors, their interests and political weight in environmental policy-making bases on Endres and Finus (1996).

a. **Politicians:** Politicians seek to gain enough political support to ensure their re-election (and other utility-improving advantages, e.g. high income, privileges, recognition). Therefore, they consider the interests of individual groups depending on their political weight in the political process. Generally, politicians will prefer policy-measures with quick and visible results so that any policy effectiveness is clearly attributable to the politicians in office.
b. **Bureaucracy:** Bureaucrats tend to have a weak position in the formulation of the policy objective, but a strong position in the choice of the policy instrument as administrative support is crucial in environmental policy implementation.
c. **Interest group 1: Management and employees of the polluting industry** will oppose stricter environmental conservation measures as they imply a cost-increase and, via the change in the relative prices, decreasing returns, profits and number of employees.
d. **Interest group 2: Management and employees of the clean industry**[35] advocate environmental conservation measures as it induces the demand for their products which increases returns, profits, and job and payment security for their employees.

[35] The term "clean" refers to environmentally friendly production of goods (e.g. low emission).

e. **Interest group 3: Environmental conservation groups** advocate strict environmental conservation measures. Yet, environmental conservationists will have a relatively weak political weight since they are more difficult to organize because of their size, their interest in a public good (e.g. less pollution) which entails the free-rider problem, and costs of political activity.[36]

f. **Consumers:** Except for victims of environmental damages, consumers will only have little interest in increased environmental conservation measures as it generally translates in higher prices for their consumption goods. Moreover, consumers will only have relatively weak political weight due to the same reasons as environmental conservation groups (costs of political activity, free-rider problem).

g. **Voters:** Except for victims of environmental damage, general demand for more environmental conservation is related to income, since increasing income levels imply decreasing marginal utility of consumption goods while increasing for services and immaterial goods. Voters will generally possess only little political weight for the same reasons as environmental conservation groups and consumers.

The specification and implementation of an environmental policy is largely the result of political processes between different actor groups. However, the outcome of the political process is not only defined by the interests whose fulfillment ensures re-election (political restriction), but also by the available budget (economic restriction) and the available administrative support in the implementation of the chosen policy measure (administrative restriction) (Schaltegger 1998). Further exogenous factors in the environmental policy-making process are macro-economic development (environmental concerns have lower priority in recession periods), ideology of the ruling party (left-wing parties are generally

[36] Still, the influence of environmental groups on environmental protection policy should not be underestimated, as their activities force politicians to justify their projects and generally raise public awareness of environmental problem – although the environmental movement in developing countries is very heterogeneous (Shams 1994).

assumed to be more concerned with environmental issues), and environmental consciousness of the population (the greater the degree of environmental concern, the easier their mobilization for environmental policies). Taking these factors into account, the *extended version of the political support approach* captures more facets and aspects of the political decision process as existing formal models (Endres and Finus 1996). This refers also to the number of interest groups, and to the integration of all relevant actors in *one* theoretic framework. The strength of the extended version of the political-support model could be increased if it additionally takes into consideration its constraints which are:

- Overlaps among actor groups, especially related to "voters" (Endres and Finus 1996).
- Behavior of politicians is limited to the maximization of existing political support while pro-active behavior, as political entrepreneurs, is not yet considered (Graichen 2003).
- Equity aspects are often neglected. The general assumption is that environmental policy functions regressive, i.e. it implies a relatively greater cost burden on lower than higher income groups, without any greater utility compensation (Endres and Finus 1996).

An important outcome from the new political economy of the environment is that environmental policy measures evolve endogenously from the interplay of individual actors in their political economic context (Weck-Hannemann 1994). A political-economic approach to environmental-policy concerns appears therefore especially suitable when seeking insights why concrete environmental policy outcomes differ from the economic optimum (Endres and Finus 1996).

4.2 Methodology

The analysis in this chapter adopts a qualitative research approach. The idea is to complement the outcome from the previous quantitative analysis (Chapter 3) with further qualitative insights. The motivation bases on the different orientation of the two concepts, i.e. while quantitative research seeks to *explain* a social phenomenon based on axioms and

theories (deductive approach), qualitative research seeks to *understand* a social phenomena based on a individual orientation (inductive approach) (Mayring 2003). Qualitative analysis is characterized by a case study orientation and the aim to view social phenomena holistically (Creswell 2003). A major criticism against qualitative research refers to its interpretative methods and lacking generalization potentials of its outcomes (Mayring 2003). The criticisms are considered by seeking to remain theory-driven and consistent in the analysis.

To examine, from a political economic perspective, the influence of the SLAPR program on deforestation in Mato Grosso, potential stakeholders were identified and theory-driven interrogated. Stakeholder identification was guided by the actor categories of the *extended version of the political support concept* as suggested by Endres and Finus (1996).

As suggested for qualitative research, not hypotheses, but research questions were defined (Cresswell 2003). The research questions of this chapter base on the *extended version of the political support model* and adopted to meet the context in Mato Grosso, i.e. to assess the political weight of the SLAPR stakeholders before and after the elections in 2002:

(i) Who are the relevant stakeholders of the SLAPR?

(ii) What are the individual stakeholder interests and inter-relationships?

- What are the *expressed* interests and *underlying* motives regarding the SLAPR?
- How did the interests and relationships change after the elections in 2002?
- What are the framing factors that shape the behavior of SLAPR stakeholders?

The interviews were conducted during a field work phase in Mato Grosso from February to April 2004. In total, 50 interviews with 20 institutions were realized. The interviews were conducted face-to-face with the interviewee, based on semi-structured, non-standardized questionnaires (Atteslander 1995) and, if permitted by the interviewee a tape-recorder was used during the interview. As suggested by Atteslander (1995), memory protocols were written after each interview. If the interview was taped, relevant additional statements were

summarized and added to the respective memory protocol. Based on the interviews, further interview partners were identified and complementary explanatory information obtained. Table 5 depicts the persons, institutions and businesses that were interviewed or consulted by the author. The interview questions are listed in Annex 3. As the aim to grasp the political economic context before and after 2002 was challenged by the short duration of the conducted fieldwork and the political sensitivity of the topic, further independent experts (e.g. university researchers, extra-local experts) were consulted, and newspaper articles were collected to increase the analysis basis.[37] The interviews were analyzed using qualitative content analysis techniques (Mayring 2003).[38]

In addition to the fieldwork duration and selected interview partners, qualitative research results are influenced by the researcher's background knowledge (Cresswell 2003). Familiarity with the political economic background of the colonization process of the study area was gained during the first visit to Mato Grosso in September 2002 and by a literature review which was conducted early 2003 (Chapter 2). The quantitative analysis (Chapter 3), conducted prior to the fieldwork in Brazil, provided additional background knowledge to the author on the spatial and temporal land use and deforestation pattern of Mato Grosso.

[37] Still, qualitative research remains fundamentally interpretative (Cresswell 2003). While the analysis bases on the premises of the new political economy of the environment, and addresses the above outlined research questions, it leads to partly very pessimistic conclusions. The author is, however, aware of existing intrinsic motivation of individuals involved in the SLAPR to achieve environmental conservation in Mato Grosso.

[38] Following the three principles of qualitative content analysis as described by Mayring (2003), memory protocols served to "summarize and reduce" interview statements (first principle), and complementary information were assembled to "explicate" interview statements (second principle). While the first two steps of content analysis were conducted during the fieldwork phase, the "structuring" of the interview statements (third principle) was realized afterwards.

Interviewed persons, institutions and businesses

Mato Grosso State Foundation of the Environment (FEMA)	
Decision makers	* Mato Grosso Secretary of the Environment (i.e. Director of FEMA) since 2003 * Ex-Mato Grosso Secretary of the Environment (i.e. Director of FEMA) 1995-2002 * Director of the Forest Resource Division since 2003 * Ex-Director of the Forest Resource Division 1995-2002
Technical staff	* Coordinator of the Geo-processing Unit of the Forest Resource Division * Coordinator of the Licensing Unit of the Forest Resource Division * Coordinator of the Enforcement Unit at the Forest Resource Division * Ex-Coordinator of the Protected Areas Unit until 2002
Brazilian Institute for the Environment and Renewable Renewable Resources (IBAMA)	
Decision makers	* Director of IBAMA office in Mato Grosso since 2003
Technical staff	* Coordinator of the Technical Division of the IBAMA office in Mato Grosso since 2003 * Coordinator of the Fire Prevention Program (PREVFOGO) at the IBAMA office in Mato Grosso * Coordinator of the Licensing Division at the IBAMA head quarter in Brasilia
Ministerio Publico of Mato Grosso	
	* State Attorney ot the Mato Grosso * Ex-Attorney at the Ministerio Publico in Mato Grosso 2001-2003
Large-holder interest groups	
Experts	* President of the Mato Grosso Association of Agriculture and Livestock (FAMATO) * Lawyer at FAMATO * 4 members of FAMATO (visitors at the National Agro-Pecuarian Congress in Cuiaba - ENIPEC)
	* Research Coordinator at the Mato Grosso Institute for Agronomy (IMEA) * IMEA Consultant to rural producers of Mato Grosso
Non-governmental organizations of Mato Grosso	
Experts	* Coordinator of the NGO "Association to defend the Rio Coxipo" (ADERCO) * Director of the NGO "Instituto Centro da Vida" (ICV) in Cuiaba * Coordinator of ICV activities in Northern Mato Grosso
Brazilian Institute for Colonization and Agrarian Reform (INCRA)	
Technical staff	* Coordinator for rural settlement projects * Specialist for land valuation for expropriation
State Institute Territorial Management (INTERMAT)	
Technical staff	* 2 members of the technical staff
Agency for Rural Assistance and Extension in Mato Grosso (EMPAER)	
Technical staff	* Specialist for smallholder technical assistance in Cuiaba, Mato Grosso * Ex-Coordinator of the EMPAER office in Sorriso, Mato Grosso
Association of forestry engineers in Mato Grosso (AMEF)	
Experts	* President of the Association * Technical staff in 2 consultancy firms in Sorriso, Mato Grosso
Federal University of Mato Grosso (UFMT)	
Experts	* 2 Professors for Agronomy (Specialization on smallholder land use, agrarian reform) * 1 Professor for Rural Sociology (Specialization on agrarian reform)
University of Brasilia (UnB)	
Experts	* 2 Researchers at the Center for Sustainable Development
Ministry of the Environment (MMA)	
Decision makers	* Coordinator of the Evaluation of the G7-Pilot Program
Technical staff	* Coordinator of the SLAPR replication to other Amazon states * Coordinator of the socio-economic ecological land use zoning projects in Brazil
International donors	
Experts	* Coordinator of the UNDP-GEF project in NW-Mato Grosso * Ex-UNDP Consultant for the land use zoning (ZSEE) project in Mato Grosso * Coordinator of the PPG7 activities in Mato Grosso since 2003 * Ex-Coordinator of the PPG7 activities in Mato Grosso until 2002 * Task Manager at the World Bank Office in Brasilia
Public Banks	
Experts	* Commercial Manager of the Banco do Brazil (BB) Regional Headquarter for Mato Grosso and Rondônia * Representative of the Banco do Brasil (BB) Office in Sorriso, Mato Grosso * Operations Coordinator at Banco da Amazônia (BASA) Cuiaba

Table 5: Interviewed persons, institutions and businesses (own survey)

4.3 Identification of relevant stakeholders

The identification and classification was a process that started during the fieldwork phase and ended when interview statements were analyzed after the fieldwork phase. There are three modifications to the "extended version" of the political-support concept by Endres and Finus (1996). The first modification refers to the interest group of the "clean industry". As it basically captures the winners of an environmental policy measure, it was renamed to "interest group of the benefiting companies" to more adequately capture the interest group that "gains" from the SLAPR. The second modification refers to the introduction of an additional interest group for "international donors" which provided substantial financial means for the SLAPR and had thus certain voice in the implementation of the SLAPR. The third was motivated by the internal heterogeneity of actor groups due to distinguished utility function and their spatial activity scales (i.e. local, national and international) which was identified from the interviews. Identified relevant stakeholders of the SLAPR in Mato Grosso were:

- **Politicians:** Relevant politicians concerning the SLAPR belong to the *Mato Grosso State Government* (i.e. the State Governor and his cabinet), which enjoys significant independency from the federal government, and power over state politics and state agencies. It has the role of the "political facilitator" of the SLAPR in Mato Grosso.
- **Bureaucracy:** There are several bureaucratic bodies that have a stake in the SLAPR.[39]
  - *Federal ministry of the environment (MMA)* decides over the federal environmental strategy. It functions as direct financial facilitator in the SLAPR by allocating resources from international loans and funds for its implementation to Mato Grosso.

[39] Until 2004, public institutions coordinating public territory and agrarian reform projects (INCRA, INTERMAT) had not an active stake in the SLAPR. Except for one initiative, involvement with the SLAPR occurred in cases of property disputes over public or expropriated lands. As agrarian reform projects require different licensing and enforcement procedures than currently practiced in the SLAPR, and as agrarian reform projects in Mato Grosso cover only about 3.5% of the total state area (SEPLAN 2004b), they were excluded from the analysis. Yet the role of small-holder deforestation cannot be neglected especially as the share of small scale deforestation (below 20 ha) in Mato Grosso has increased since 1996 (Chapter 3).

  - *Mato Grosso State Environmental Agency (FEMA)* is in charge of executing the state environmental agenda and enforcing state environmental laws. To do so, FEMA receives a budget from the state government. As FEMA elaborated and implemented the SLAPR, it has the role as "SLAPR initiator".
  - *Mato Grosso State Attorney's Office (Ministerio Publico)* functions as "watch-dog" over the enforcement of federal and state laws. It is the state representative of the federal attorney's office and represents the society not the government. Still, spatial proximity allows for lobbying and so for some political influence.
  - *Federal environmental agency (IBAMA)* is in charge of enforcing federal environmental laws and policies for which it receives a budget from the federal government. IBAMA's stake in the SLAPR is related to unclearly defined responsibilities between federal and state environmental agencies.

- **Interest group 1 – Polluting industry:** The SLAPR seeks to regulate large-holder deforestation.[40] The *Association of Agriculture and Livestock of Mato Grosso (FAMATO)* represents the interests of rural large-holders, i.e. rural producers[41], in Mato Grosso, and as the SLAPR was designed to control large-holder deforestation, also with respect to the SLAPR.
- **Interest group 2 – Benefiting companies:** The *Association of forestry engineers of Mato Grosso (AMEF)*[42] represents the interests of forestry engineers who also offer consultancy services to land use projects such as required by the SLAPR. Although AMEF is not an active SLAPR stakeholder, the SLAPR induced a new demand (market) for the services of FEMA trained forestry engineers.

[40] In the context of the SLAPR, "pollution" refers to deforestation.

[41] Here, the term "large-holders" is used to distinguish against smallholders and also includes medium-size landholders. It is further applied interchangeably with "rural entrepreneur" and "rural producer".

[42] Agricultural engineers also provide LAU-related consultancy services to large-holders. It was not possible to interview representatives of their association, yet their interests in the SLAPR are assumed to be similar to those of forestry engineers. All information of this interest group bases on the interview with AMEF.

- **Interest group 3 – Environmental conservation groups:** Local environmental conservation groups of Mato Grosso did not have a stake in the SLAPR, at least not until April 2004. Local NGOs welcomed the SLAPR as important contribution to environmental conservation, and regretted their missing involvement which was explained by lacking information transparency on spatial and temporal deforestation dynamics. Information transparency was viewed as necessary condition to enable civil society participation.
- **Interest group 4 – International donors:** Two parties have a stake in the SLAPR as they provided financial support for its implementation.
  - PPG7-donors provided substantial financial resources to the conservation of Brazil's rainforests, and 18.1% of the SLAPR was financed by PPG7 (FEMA 2002a). PPG7 donors present thus indirect financial facilitators of the SLAPR.[43]
  - The *World Bank* loans Prodeagro and Proarco supported the implementation of the SLAPR, i.e. 20.6% originated from Prodeagro, 17.5% from Proarco (FEMA 2002a). In turn, the World Bank presents an indirect financial facilitator of the SLAPR.
- **Consumers & Voters:** If not member of an interest group, citizens of Mato Grosso did not appear as major actor group in the SLAPR (e.g. to denunciate environmental crimes to FEMA or the State Attorney's Office). There was neither any sign that consumers of large-holder production (e.g. agro-industries) had an active role in the SLAPR.

Table 6 depicts the identified stakeholders classified by spatial activity level and according to the actor categories from the political-support model. The upcoming analysis is limited to the actors that were identified as relevant. They are marked by a bold font in Table 6.

[43] The term "indirect" is used as international funding is provided to the federal government, not to projects.

Actors	State level	Federal level	International level
Politicians	** State Government of Mato Grosso*		
Interest Group 1: Polluting industry	** Association of Agriculture and Livestock of Mato Grosso (FAMATO)*		
Interest Group 2: Benefiting companies	* Association of forestry engineers of Mato Grosso (AMEF)		
Interest Group 3: Environmental conservation groups	* Instituto Centro da Vida (ICV); * ADERCO		
Interest Group 4: International donor groups			** G7-Countries; European Union, Netherlands, * World Bank*
Bureaucracy	** State Environmental Agency (FEMA); * State Attorney's Office;* * State Agency for Public Territory & Agrarian Reform (INTERMAT)	** Ministry of the Environment (MMA); * Federal Environmental Agency (IBAMA);* * Federal Agency for Colonization and Agrarian Reform (INCRA)	
Consumers & Voters			

Table 6: Classification of the SLAPR-stakeholders (own survey)

4.4 Analysis of the stakeholder perspectives and behavior

Based on the premises of the political-economy of the environment and based on the previously outlined research questions, this paragraph analyzes the identified relevant stakeholders of the SLAPR in Mato Grosso.

4.4.1 Politicians: State Government of Mato Grosso

Since its implementation in 1999, the SLAPR has experienced two state governments with distinct political agendas. Governor Dante de Oliveira (Brazilian Social Democratic Party - PSDP) ruled the state between 1995 and 2002. Governor Blairo Maggi (Brazilian Popular Socialist Party - PPS) took over in 2003.[44]

Expressed and underlying interests

Although there was only little indication for environmental concern in past land use policy-making in Mato Grosso, it changed at the latest when Governor Dante de Oliveira addressed deforestation as environmental concern and supported the implementation of the SLAPR in

[44] According to the interviews, policy-making in Mato Grosso is defined by the individual politicians in power rather than by the political orientation of their party as suggested by the party name.

Mato Grosso (Fearnside 2002). Substantial state-level political support was provided to FEMA and the SLAPR, whose implementation was defended against strong opposition of the state-deputies who were mostly rural producers (FEMA 2002a; Müller 12.07.2002). From a political economic viewpoint, politicians seek to ensure their re-elections and have a defined period of time to do so (in Mato Grosso, a state government term consists of four years). As additionally, Mato Grosso was a highly indebted state in the beginning of the 1990s (Klein 1998), international spending in Mato Grosso that allowed responding to voters' demands, such as investments in services and infrastructure projects, was of vital importance to the state administration.[45] Although the PPG7 did not allow for infrastructure investments, it appears rational for the state government to view the PPG7-funding as means to access other international resources to invest in projects that are more visible and of faster utility to the citizens and voters of Mato Grosso. In addition, interviewees emphasized that friendship and trust between the State Governor and the State Secretary of the Environment, as well as their common professional civil engineering background implying environmental sensitivity and an appreciation of the SLAPR, present supplementary factors for the great state-level political support granted to FEMA. Moreover, the state administration under Dante de Oliveira demonstrated lower opposition than previous state governments against interference in their regional policies (Klein 1998) which also facilitated the dialogue with international donors and the implementation of the SLAPR.

Change upon the elections in 2002

After the state elections in fall 2002, a new state administration under Governor Blairo Maggi took office in 2003.[46] In the political discourse of his election campaign, candidate

[45] With the World Bank loan Prodeagro (US$ 177 million), Mato Grosso had a budget of US$ 258.4 million during 1994-1998 (5 years) of which 16% were spent on management, protection and monitoring of natural resources and 25% on water supply, rural electrification and road improvement (World Bank 2003, 34).

[46] The election success of Blairo Maggi is attributed to his professional origins (i.e. a rural producer, not politician as usually), and his sudden and late campaign (entering the election campaign only in the summer 2002) which had a positive "novelty effect" to voters.

Blairo Maggi illustrated the SLAPR as obstacle to agro-economic growth in Mato Grosso (Maggi 11.07.2002). As successful rural producer, expressed by his achievement to be one of the world-wide largest individual soybean producers, and as Director of the Mato Grosso Foundation, an agriculture and livestock research center, Blairo Maggi appeared as a credible candidate. In turn, he gained sufficient political support to get elected. After the election, it was rational for the new government to comply with the election promises and to be receptive to concerns of its political supporters, the rural producers. According to the interviews, the newly appointed Secretary of the Environment has little background in environmental management and appeared assigned to ensure the coexistence between FEMA's official agenda and the interests of rural producers. This suggests that the combination of the rural producers' dismissive attitude towards the SLAPR (as emphasized by the interviewees) and the perception of deforestation as "necessary bad" for agro-economic development (Rother 17.09.03) contributed to the weak state-level political support for the SLAPR at least during the first year of the new state government's term.

The official discourse of the State Governor became more moderate after the election. Notably environmental law compliance of rural producers became emphasized in official discourses (e.g. 24 Horas News 30.05.2003) as well as the political will to accommodate economic and environmental objectives in land use management (e.g. Gazeta de Cuiabá 21.08.2004). One underlying motivation for the latter could be related to the individual utility function of the State Governor whose family owns the agro-business Grupo Amaggi. The latter is one of the leading soybean operators in Mato Grosso which sought to obtain the renewal of a private investment loan of an amount of US$ 30 million from the International Finance Corporation (IFC), a member of the World Bank Group (IFC 2004).[47] Still,

[47] The loan was approved in September 2004 (IFC 2004) after a one year delay due to national and international civil society objections on the firm's compliance with environmental criteria, including environmental laws (Stickler et al. 2004). The loan approval is, however, contested and an audience with civil society groups is determined by the President of the World Bank (amazonia.org.br, 3.11.2004).

economic objectives remain relevant as expressed by statements such as "we have an environmental responsibility, but we also have an economic responsibility to the people" (Dow Jones 14.7.2004). The seriousness of environmental conservation objectives can also be questioned in the context of dwindling conservation units as observed by interview partners. In a newspaper article, a FEMA director explains "the reduction of national parks was the solution identified by the government to manage national parks without creating conflicts with landholders" (Alves 21.11.2004). However, although there remain reasons to suspect a divergence between political discourse and factual policy-making, also expressed by the little support for the SLAPR, the change in discourse suggests some political awareness of environmental issues, at least officially.

4.4.2 Bureaucracy I: Federal ministry of the environment (MMA)

The Ministry of the Environment (MMA) is part of the federal bureaucracy and the national partner for executing environmental projects with international environmental spending in Brazil. It has thus, via the PPG7, also a stake in the SLAPR of Mato Grosso.

Expressed and underlying interests

The objective of the MMA is to define and coordinate the Brazilian environmental policy, i.e. to frame environmental conservation measures in Brazil (Magalhães 2002). From the political economic perspective, public administrations seek to ensure their budgets and activities. Due to the international public demand and internationally provided financial means for environmental conservation of the Brazilian Amazon (e.g. PPG7), it is rational for the MMA to meet the funding requirements as international funds implied a utility increase for the institutions in terms of budget increase and national and international recognition for their activities. Improvement of public image is of interest to the federal government due to (i) public accusations of federal government policies to have contributed to Amazon deforestation during the 1970s and 1980s, and (ii) their objective to realize further

infrastructure investments in the Amazon (e.g. *Avança Brasil*) which received strong international criticism for its expected environmental impacts (Chapter 2). To meet the expectations of its supporters (financial facilitators), it is politically rational for the MMA to support projects with fast and visible results – given the defined period of available time (i.e. the four year government terms). In its function as executing agency of international environmental spending, the MMA allocated substantial PPG7 resources to FEMA to (among other activities) implement the SLAPR in Mato Grosso. The PPG7 resource allocation to FEMA was facilitated by the political accordance between the federal government and the state government of Mato Grosso as both belonged to the same political party.[48] Upon the decrease of state-level deforestation in Mato Grosso after two years (1998/99-2000/01), the Mato Grosso model became a celebrated solution for effective deforestation control in the Legal Amazon (FEMA 2002a; Fearnside 2002; World Bank 2002). In turn, the MMA decided to allocate the renewed PPG7-funding from mid-2001 to mid-2003 to the replication of the SLAPR in other states of the Legal Amazon (MMA 9.10.2003) and in Mato Grosso, for refinements of the SLAPR (FEMA 2003a).

Change upon the elections in 2002

A new federal government, under President Luiz Inácio Lula da Silva, took office in 2003. As expressed by the interviewees, government changes in Brazil are usually accompanied with radical staff turnovers in the public administration resulting in slow allocation and release of federal budgets and thus in an incapacity of public institutions to execute their tasks, at least during the first months of a new government. In addition to own institutional inertia in 2003 including the insecurity over a continuation of PPG7 (which depended on the negotiation between international donors and Brazil), the MMA denoted a change in the SLAPR functioning after the new state government took office in Mato Grosso in 2003. The

[48] The Brazilian President between 1995 and 2002, Fernando Henrique Cardoso, was member of the PSDB.

change was partly explained by the ending PPG7-funds in mid-2003 and the insecurity over renewal, but also – rather hidden – attributed to the new political priorities of the state administration in Mato Grosso. This suggests that both, initial inertia in the federal public administration (MMA, IBAMA) combined with new political priorities in Mato Grosso contributed to a weakened the relationship between the MMA and Mato Grosso in 2003.

4.4.3 Bureaucracy II: State environmental agency of Mato Grosso (FEMA)

FEMA is a state agency and thus under strong influence of the State Governor. The FEMA model SLAPR received financial means from the MMA, and was implemented upon the "federative pact" between the MMA, IBAMA and FEMA in 1999 (Chapter 2).

Expressed and underlying interests

The objective of FEMA is the promotion of environmental conservation measures and the enforcement of the state environmental legislation. As one approach to meet its objectives, FEMA developed the SLAPR as mechanism to achieve effective deforestation control.

One important underlying motive for FEMA was related to the strong federal and state-level political commitment of the state government to respond to the international interest in deforestation control in Mato Grosso. It was thus rational for FEMA to respond to these interests and to implement the SLAPR. The provided political and financial support translated in significant control over budget and activities for FEMA, especially since the federative pact between the federal and the state agencies implied greater competencies for FEMA, as well as further privileges (e.g. new cars, computers, office space), and national and international recognition for their activities. According to the political economic rationale, these factors increase individual utility of public servants. In addition to the political economic factors, the implementation of the SLAPR was supported by the environmental sensitivity of the directors at FEMA during that period, and their possibility to hire new, young and motivated staff from their increased FEMA budget.

From a political economic perspective, preferred environmental conservation measures are those that are highly visible and allow quick results (Weck-Hannemann 1994). FEMA's approach to realize effective deforestation control consisted in facilitating land use licensing procedures (i.e. by introducing the unified environmental license) and in focusing on rural large-holders. The rationale for the latter was that the majority of deforestation in Mato Grosso occurred on large-holdings, at least until 1999 (Chapter 3) and that it was more feasible to control large rural properties in terms of identification (property owners are usually registered), monitoring (properties appear on satellite image) and accountability (property owners can be hold liable). Hence, the decision to focus on large-holders, as "easy targets" is rational to achieve quick and visible results and thus, to ensure any funding renewal.[49] As emphasized by the interviewees, high-level political support facilitated the implementation of the SLAPR despite the large-holders' discontent and opposition (FEMA 2002a; Müller 12.07.2002).[50]

FEMA viewed the decreasing rates from 1998/99-2000/01 as confirmation for their strategy. The deforestation increase in 2002 (Figure 1) was explained by (i) the temporal coincidence of the fire ban (July-September) and the election contest in 2002, especially the sudden candidature and election campaign of the rural entrepreneur Blairo Maggi, and (ii) missing funds for deforestation prevention campaigns (April to June) as PPG7-funds for 2002 were only released in late July after the burning season had already started (FEMA 2003a).

[49] The number of licensed properties (mostly over 10,000 hectares size) increased from 2000 to 2002. While 26 properties were licensed in 2000, the number rose to 76 in 2001 and 1443 in 2002 (FEMA 2004b).

[50] After the election in 2002, former FEMA officials reflected on the possibility that they might have underestimated the need for discussion and training during the SLAPR implementation (public awareness campaigns started only 5-6 months after the introduction of SLAPR) and the omission of their consultation could have provoked additional resistance against the system. Yet, FEMA also observed a low share of large-holders attendance during public audiences, especially compared to NGO-representatives.

Change upon the elections in 2002

FEMA's stake in the SLAPR changed when the new state government took office in 2003, and new senior staff was appointed at FEMA. At the beginning of 2003, negative publicity about the effectiveness and the potentials of the SLAPR were raised (Oliveira 21.05.2003). Moreover, the degree of political support for the SLARP altered. As expressed by the new FEMA staff, the objective of FEMA now is to focus "on result-oriented activities rather than punishing landholders for past activities" (i.e. ex-post, for deforestation of legal reserves or permanent preservation areas).[51] Due to the new political priorities of the state government, the strong influence of the state government on state agencies and due to the nomination of FEMA leaders with lower environmental sensitivity, the public opinion attributes only little potential to FEMA to pursue effective environmental law enforcement in the new political context (Sávios 14.04.2004).

Slow budget release in 2003 and substantially lower funds since 2004, present a challenge for FEMA to fulfill its licensing, monitoring and enforcement tasks. The general opinion amongst the interviewees is that FEMA appears to be less influential on large-holder behavior (through the SLAPR) than during previous years.[52] Missing financial resources were mentioned as primary cause for slower enforcement efforts. Yet according to the interviewees, political priorities of the state government did neither facilitate consequent enforcement of the SLAPR. The perception arises from the situation that FEMA is under great influence of the state government. From a political economic perspective, it therefore appears rational for FEMA officials to consider the state government's political agenda and possibly become more lenient in their enforcement tasks to maintain certain control over budget and activities, and a conflict-free life.

[51] Any literally translated quotations from the interviews are printed in a lower font size.

[52] A quantification of these statements requires information on the number of licensed properties, enforcement activities, etc. conducted between 1999 and 2004. However, this information was not available to the author.

Consequent environmental law enforcement was also affected by the reduced demonstrated and expressed willingness to collaborate with the State Attorney's Office, at least until the end of the author's fieldwork in April 2004. FEMA explained the reduced willingness for collaboration by the heavy bureaucracy of legal prosecution, expressed by the great number of the 1700 cases which were submitted to the State Attorney's Office by the former FEMA personal (in 2002) and returned to FEMA because of missing documentation. In turn, FEMA opted for an omission of bureaucratic obstacles and to resolve incidences of environmental law offence directly between FEMA and the concerned large-holder.

4.4.4 Bureaucracy III: State Attorney's Office (Ministerio Publico)

To ensure law enforcement, FEMA sought an official partnership with the State Attorney's Office, which functions as independent "watch-dog" over law compliance.

Expressed and underlying interests

The objective of the State Attorney's Office in the SLAPR is to ensure law compliance. Environmental sensitivity of the state attorneys in office was mentioned as further motive for the interest in the SLAPR. The idea of the partnership with FEMA was to ensure the sanction mechanism of the SLAPR. On the other hand, the State Attorney's Office required enforcement not only to occur at the new frontier in northern part of the state, but to also include areas at the consolidated frontier in the south-east part where many permanent preservation areas and legal reserves were already extinct and landholders in factual non-compliance with environmental laws (FEMA 2003a). Although the partnership between FEMA and the State Attorney's Office is documented since 2001 (FEMA 2001b, 2002, 2003), the interviews indicated that it had not yet officially been realized.

As also suggested by various interviewees, the underlying motive of the State Attorney's Office to collaborate with FEMA could refer to efforts to include significant amount of financial resources in the proposal renewal for PPG7 funding in 2001. As the latter would

translate in a budget increase for the agency, it was rational for the State Attorney's Office to participate. Hence, at least until 2002, the State Attorney's Office had a stake in the enforcement activities of the SLAPR and had thus an impact on large-holders' land use decision making.

Change upon the elections in 2002

In 2003, the state attorney's office denoted FEMA's lower willingness to collaborate. According to the State Attorney's Office, the new FEMA staff was very passive in sending over cases of law offences to the State Attorney's Office. This was the case at least until the end of the author's fieldwork phase (April 2004). Nonetheless, the State Attorney's Office omitted to request any justification from FEMA until 2003 with the reasoning that government changes usually imply a period of adaptation in public agencies which was also attributed to FEMA. From a political economic perspective, it is indeed rational to neglect any intervention to ensure a "conflict-free life". Although the State Attorney's Office is independent from the state government, it is still under certain influence of state politics. As the interviews suggest, reduced intervention by the State Attorney's Office is also related to the perceived lower environmental awareness of the new state attorneys in charge since 2003, compared to the former attorneys.

The stake of the State Attorney's Office in the SLAPR appears influenced by the utility function of individual state attorneys in terms of control over budget and activities, conflict-free life and environmental concern.[53] The objective for conflict-free life could explain why any detailed quantitative information on the number of submitted and prosecuted cases of environmental law offense since 2000 were unavailable to the author. Although this is public information, the only information on this subject refers to 1700 cases submitted to the State

[53] As indicated by the interviews, the degree of environmental awareness among state attorneys influences their working priorities. This has an even greater impact on SLAPR enforcement as state attorneys have to be pro-active (i.e. take own initiative and prosecute non-compliers) due to low civil society participation in the SLAPR (e.g. denunciation), i.e. only 10% of the law suits originate from denunciations.

Attorney's Office by the former FEMA personal at the end of 2002. As FEMA stopped handing over cases of law offense, the influence of the State Attorney's Office on landholder behavior reduced. This raises the question whether FEMA's interest in a reduced collaboration with the Ministerio Publico linked to "controllability" of trial outcomes. A FEMA proposal of 2004, however, re-emphasizes the partnership between FEMA and the State Attorney's Office (FEMA 2004b), still the question remains to which degree it is actually implemented.

4.4.5 Bureaucracy IV: Federal environmental agency (IBAMA)

The SLAPR bases on a "federative pact" between the MMA, IBAMA and FEMA to hand over responsibilities from the federal level (IBAMA) to the state (FEMA). In the context of remaining unclearly defined responsibilities between IBAMA and FEMA, IBAMA questions FEMA's competencies to enforce federal environmental laws as done in the SLAPR.

Expressed and underlying interests

After the "federative pact" between IBAMA and FEMA was signed in 1999, a phase of great inter-institutional rivalry between IBAMA and FEMA was observed. Disputes between FEMA and IBAMA affected not only SLAPR enforcement (e.g. what regulations to apply), but also SLAPR compliance by landholders (e.g. what regulations to follow). The latter implied additional transaction costs for landholders to identify the "correct" land use procedures and occasionally, landholders felt induced to comply or arrange themselves with the regulation or regulator that suit most for their purposes. From a political economic perspective, IBAMA feared reduced control over budget and activities, and to eventually become obsolete as result of increasing decentralization of federal competencies (as intended by the Brazilian Constitution of 1988). This in turn, could have contributed to the rivalry over competences with FEMA.

Change upon the elections in 2002

When the new federal government tool office in 2003, IBAMA experienced a turnover in their staff composition. A frequent statement was that IBAMA and FEMA staff stopped conducting inter-institutional disagreements in public and sought to achieve better inter-institutional cooperation (e.g. Werle 3.03.2003). Still, there remain contested regulations between IBAMA and FEMA (e.g. legal reserve use, legal reserve definition for Transition forests). From a political economic reasoning, IBAMA realized that it is more beneficial to collaborate with the state agency to ensure budget and activities while avoiding to become obsolete.

4.4.6 Interest group: Rural producers (FAMATO)

FAMATO represents the interests of the rural producers in Mato Grosso. Their stake in the SLAPR originates from FEMA's objective to focus on large-holder land use (Chapter 2).

Expressed and underlying interests

FAMATO opposes the SLAPR especially for its objective to enforce the legal reserve requirement. While large-holders expressed their willingness to contribute to environmental conservation, they insist on the scientific justification of conservation measures. This is why FAMATO tends to agree with the permanent preservation areas (APP) requirement (although in the past, large-holders hardly complied with that regulation either), rather than with the legal reserve requirement. Large-holders express incomprehension against the reproach that they destroy the environment since they feel literally dependant from it and claim that they learned from the past experience in southern Brazil.[54] Large-holders explain their opposition against legal reserve enforcement by the lenient-to-lacking environmental law enforcement in the past (1960s-1980s) when public policies induced agricultural

[54] As described in Chapter 2, many rural entrepreneurs are originally from southern Brazil from where they migrated to Mato Grosso induced by federal government policies in the 1960s and 1970s.

colonization and modernization (rather than forest conservation) of the Legal Amazon (Chapter 2). In consequence, large-holders also strongly oppose the increased legal reserve proportion in 1996 (Presidential Provisional Measure 1996), which is viewed as arbitrary defined, with neither a scientific basis nor a participation of the affected population (rural landholders) in the decision-making, but upon strong and internationally supported environmentalists' movement. Large-holders view the legal reserve as an old-fashioned institution, originally created for paternalistic reasons to ensure private fire wood supply, not environmental conservation. Consequently, rural entrepreneurs who invested into agrarian projects in the Amazon feel misguided since they bought their lands – induced by government incentives – with the expectation to at least use 50% (according to the Forest Code 1965). In this context, rural entrepreneurs, persuaded by their significant contribution to regional economic development, feel utilized and claim for (international) compensation for the "expropriated" land proportion.

From an economic viewpoint, the enforced legal reserve requirement presents a loss of agricultural use area resulting in a profit loss for its owners. According to FAMATO, the introduction of the FEMA system in 2000 came very surprisingly without previous notification or training. Due to severe sanctions in cases of law offence and due to requirement of a FEMA license (LAU) for agrarian credits from public banks[55], rural entrepreneurs (even without FEMA notification) started to get licensed despite their resistance towards the enforced legal reserve proportion and discontent about the time[56] and costs[57] involved.[58] Costs refer not only to monetary costs, but include transaction costs to

[55] The Banco do Brasil, as greatest public provider of agrarian credits in Mato Grosso, started to require the FEMA license since 2002. The environmental credit requirement influences large-holders' land use decision-making and made public banks unintentionally to supporters of the SLAPR.

[56] According to large-holders, considerable time, up to one year, was needed to get licensed, to compensate for missing legal reserve proportions or to resolve court processes.

[57] The total costs for registering a property at FEMA usually consist of licensing fees, consultancy fees, and compensation costs. The licensing fees depend on the property size and have to be paid to FEMA. The elaboration of the SLAPR required land use plan is usually done by a forestry engineer who is hired for this

resolve unclearly defined regulations and responsibilities, especially between FEMA and IBAMA (e.g. Freitas 7.12.1999). Hence, rural large-holders opposed the SLAPR for historic and financial reasons, but were induced to comply with the FEMA regulation as public banks started to demand the FEMA license as requirement for agrarian credits and any non-compliance was sanctioned by the State Attorney's Office.

FAMATO attributes the increase in deforestation rates since 2002 to the increase in agrarian prices which induced numerous rural producers to expand their agricultural production. Another explanation refers to the combination of (i) the anticipated election of the presidential candidate Luiz Inácio Lula da Silva and his expected pro-environmentalist attitude entailing more severe environmental regulations, and (ii) the anticipated election of candidate Blairo Maggi as state governor. While the first might have induced deforestation as precaution to stricter environmental regulation in Brazil, the latter might have induced deforestation in expectation of more lenient forest policy enforcement in Mato Grosso.

Change upon the elections in 2002

According to the interviewees, the candidature of Blairo Maggi in the election 2002 was widely supported by rural producers as he was perceived as credible leader to represent their interests. Rural producers benefited from the election in 2002 as they gained direct and strong links to state-level policy-making. In response to time-consuming licensing procedures, especially after the staff turnover at FEMA in 2003, rural producers started to take up production even without a license and, if necessary, with credits from private lenders (e.g. private banks, agro-businesses) which do not demand a LAU, although generally

purpose. The compensation costs refer to the costs associated to the repair of degraded permanent preservation areas (reforestation) and to the compensation of deforested legal reserve proportions (purchase of land in conservation units). Both compensations are costly. Reforestation projects are costly since bank credits for reforestation projects embrace high credit interests (compared to production projects) due to the long time horizon of the project. Legal reserve compensations can be costly, especially for the time-intensive requirements (location and vegetation type) of a compensation area.

[58] A further incentive to comply with the legal reserve requirement consists in the legal decree of 2000 that each private landholder has to register their legal reserves at the land registration office (*cartório*) (Leite 2002).

impose higher interest rates. In cases where the licensing proposal was complete and legal land use was solely hindered by slow emission of a license or deforestation permit, FAMATO actually motivated to enter "illegality" (i.e. land use without legal authority). The latter could present another explanation of the sudden increase of the proportion of illegal deforestation in 2003 (Figure 22). From a political economic viewpoint, this behavior is further rational if it occurs under powerful "protection" such as by like-minded persons in the government. Despite weakened SLAPR enforcement by FEMA and the State Attorney's Office, rural producers were induced to register at FEMA when seeking an agrarian credit from public banks, or when seeking to avoid the cost-intensive environmental licensing EIA/RIMA at IBAMA for properties above 1000 ha through property fragmentation. [59]

4.4.7 Interest group: International donors

In the 1990s, international donors provided substantial financial support to Brazil to invest in projects to conserve the Brazilian rain forests, including the SLAPR in Mato Grosso.

Expressed and underlying interests

The objective of PPG7 was to promote the conservation and sustainable use of natural resources in the Amazon and Atlantic forests through projects such as the SLAPR in Mato Grosso. From a political economic perspective, the underlying motivation of PPG7 (i.e. of its donors and managers) is related to the increasing national and international concern regarding the persistent high deforestation rates in the Amazon for which national and international public spending (e.g. SUDAM subsidies) was seen jointly responsible (Chapter 2). In consequence, the support for PPG7 can be interpreted as a mean to improve or restore the public image of national and international stakeholders. Following the political economic argumentation that politicians seek to ensure their reelection, politicians from involved

[59] It was, however, also mentioned that better-off large-holders could find ways and means to pay-off the regulators and obtain necessary documents without strict compliance.

countries benefit from investments into PPG7. The argumentation is that politicians respond to their voters' demand for more environmental quality while improving their public image and avoiding interest conflicts that would complicate re-election objectives if addressing environmental conservation issues in their home countries. Hence, if domestic budgets allow, it can be politically more efficient for politicians to conduct public environmental conservation spending as demanded by voters on an ecosystem that is geographically far away, valued for its function as the "lungs of the world" and thus a popular media topic.

Furthermore, the SLAPR was supported by the World Bank loans *Prodeagro* and *Proarco.* The objective of the first consists of sustainable natural resource management, the latter seeks to prevent and control forest fires in the Amazon (Chapter 2). The underlying political economic motivation for the World Bank to support PPG7 and environmental conservation loans *Prodeagro* and *Proarco* could be related to the interest to "restore the public image" and to gain a "conflict-free life" for the institution. These interests are linked to the strong public criticism of the institution as World Bank loans to Brazil are considered jointly responsible for Amazon deforestation in the 1970s and 1980s (World Bank 2003).

Hence, from a political economic viewpoint, the underlying interest of international donors and the World Bank to support the SLAPR in Mato Grosso refers to efforts to improve or restore their public image which in turn facilities further political interests (e.g. re-election, conflict-free life). This could also explain why the deforestation decrease between 1998-99 and 2000-01 was promoted as evidence for enforcement effectiveness (e.g. FEMA 2002a; World Bank 2002); although the decreasing trend in deforestation rates started already in 1996-97 (Chapter 3), while the increase since 2002 remained hardly commented.

Change upon the elections in 2002

Federal government elections impact the dialogue between international donors and country representatives. This is due to the common practice that the election of a new administration

imply a turnover of the managing directors in Brazilian public agencies and thus also of the contact partners for international donors. The establishment of a new dialogue and collaboration between international donors and country representatives requires time and can entail a phase of insecurity regarding the continuation of projects that started during the former government, e.g. in 2003, the PPG7-phase 2001-2003 ended (FEMA 2003a) and, according to the interviewees, left insecurity over any renewal.

4.5 Results

By adopting the *extended version of the political-support approach* to the political context of the SLAPR in Mato Grosso, the following relevant stakeholders were identified as response to the first research question in Chapter 4.2: (i) international donors, (ii) the Federal Ministry of the Environment (MMA), (iii) the State Administration of Mato Grosso, (iv) the Mato Grosso State Environmental Agency (FEMA), (v) the State Attorney's Office, (vi) the Federal Environmental Agency (IBAMA) and (vii) rural producers (FAMATO). The adoption of the political support approach to the political context of the SLAPR in Mato Grosso entailed the following changes:

- **Stakeholder identification:** Unlike in the extended version of the political-support approach by Endres and Finus (1996), not all political actors were considered in the political economic analysis of the SLAPR for the following reasons: While forestry engineers benefited from the SLAPR as it opened a new market for their services, the analysis suggests that they did not have a relevant stake in the SLAPR, at least not until April 2004. Similarly, although the initial SLAPR proposal intended active civil society participation (FEMA 2001b), environmental conservation groups did not have an active stake in the SLAPR, at least not until April 2004. Consumers or voters did neither have a stake in the SLAPR.

- **International heterogeneity of the bureaucracy:** A subdivision of the public administration into the individual public agencies involved in the SLAPR appeared meaningful to capture their individual stakes and power relations in the SLAPR.
- **Spatial heterogeneity of the bureaucracy:** The consideration of the spatial activity scale appeared meaningful to capture the respective institutional context that was valid for each public agency and resulting inter-agency rivalries.

The political economic analysis of the interests of the identified relevant SLAPR stakeholders suggests a change in the power relations between the two political moments, i.e. under Governor Dante de Oliveira until 2002 and under Governor Blairo Maggi since 2003. The analysis of the stakeholder interests responds to the second research question in Chapter 4.2. Table 7 summarizes for each relevant stakeholders, its actor category according to the extended political support model and its function in the SLAPR. Moreover, it depicts the expressed stakeholder interests during the two political moments as suggested by the interview content, and their underlying political economic interests as interpreted by the author based on a political economic rationale. The change in political weight after the elections in 2002 is depicted in the last column of Table 7. An alternative view of the change in individual power relations in the SLAPR is provided in Figure 23. The figure depicts the identified relevant stakeholders in their national or local institutional context and their power relations in the two political moments. The major difference in stakeholder relations can be summarized as follows:

- **Until 2002**: Land use policy-making in Mato Grosso was shaped by the interests of international donors and the MMA as it entailed the allocation of substantial financial resources for environmental conservation in Mato Grosso. In turn, substantial political support was provided to FEMA for the implementation of the SLAPR in Mato Grosso.

Actor category	SLAPR stakeholder	Function in SLAPR	Political period in Mato Grosso	Official interests	Underlying political-economic interest	Change in political weight regarding SLAPR after 2002
politicians	State administration	allocation of political support to SLAPR	Dante de Oliveira (until 2002)	sustainable development with strong SLAPR	(i) reelection, (ii) environmental sensitivity,	*indifferently strong*
			Blairo Maggi (since 2003)	economic development with lenient SLAPR	(i) reelection, (ii) profits	
public administration	Federal Ministry of the Environment (MMA)	allocation of financial support to SLAPR	Dante de Oliveira (until 2002)	Amazon deforestation control, e.g. through SLAPR	(i) control over budget & activities, (ii) public image, (iii) support Mato Grosso	*decreased*
			Blairo Maggi (since 2003)	SLAPR replication in other Amazon states	(i) control over budget & activities, (ii) public image, (iii) conflict-free life	
	State environmental agency (FEMA)	implementation & enforcement of SLAPR	Dante de Oliveira (until 2002)	effective deforestation control via SLAPR	(i) competencies, budget & activities, (ii) environmental commitment	*decreased*
			Blairo Maggi (since 2003)	environmental conservation without accountability for past law-offenses (lenient SLAPR)	(i) control over budget & activities, (ii) conflict-free life	
	State Attorney's Office	prosecution of environmental law offense	Dante de Oliveira (until 2002)	collaboration with FEMA to ensure SLAPR enforcement	(i) control over budget & activities, (ii) environmental concern	*decreased*
			Blairo Maggi (since 2003)	s.a.	(i) conflict-free life, (ii) less environmental concern	
	Federal environmental agency (IBAMA)	check-and-balance of FEMA competencies	Dante de Oliveira (until 2002)	decentralization of competencies which enabled SLAPR	(i) rivalry over competences, (ii) control over budget & activities	*indifferently low*
			Blairo Maggi (since 2003)	collaboration with FEMA	s.a.	
interest group	International donors	indirect allocation of financial support to SLAPR	Dante de Oliveira (until 2002)	sustainable natural resource use	public image	*decreased*
			Blairo Maggi (since 2003)	s.a.	s.a.	
	Rural producer representative (FAMATO)	target population in SLAPR	Dante de Oliveira (until 2002)	oppose SLAPR	profits	*increased*
			Blairo Maggi (since 2003)	s.a.	s.a.	

Table 7: Stakeholders, their function and political economic interests in the SLAPR (own survey)

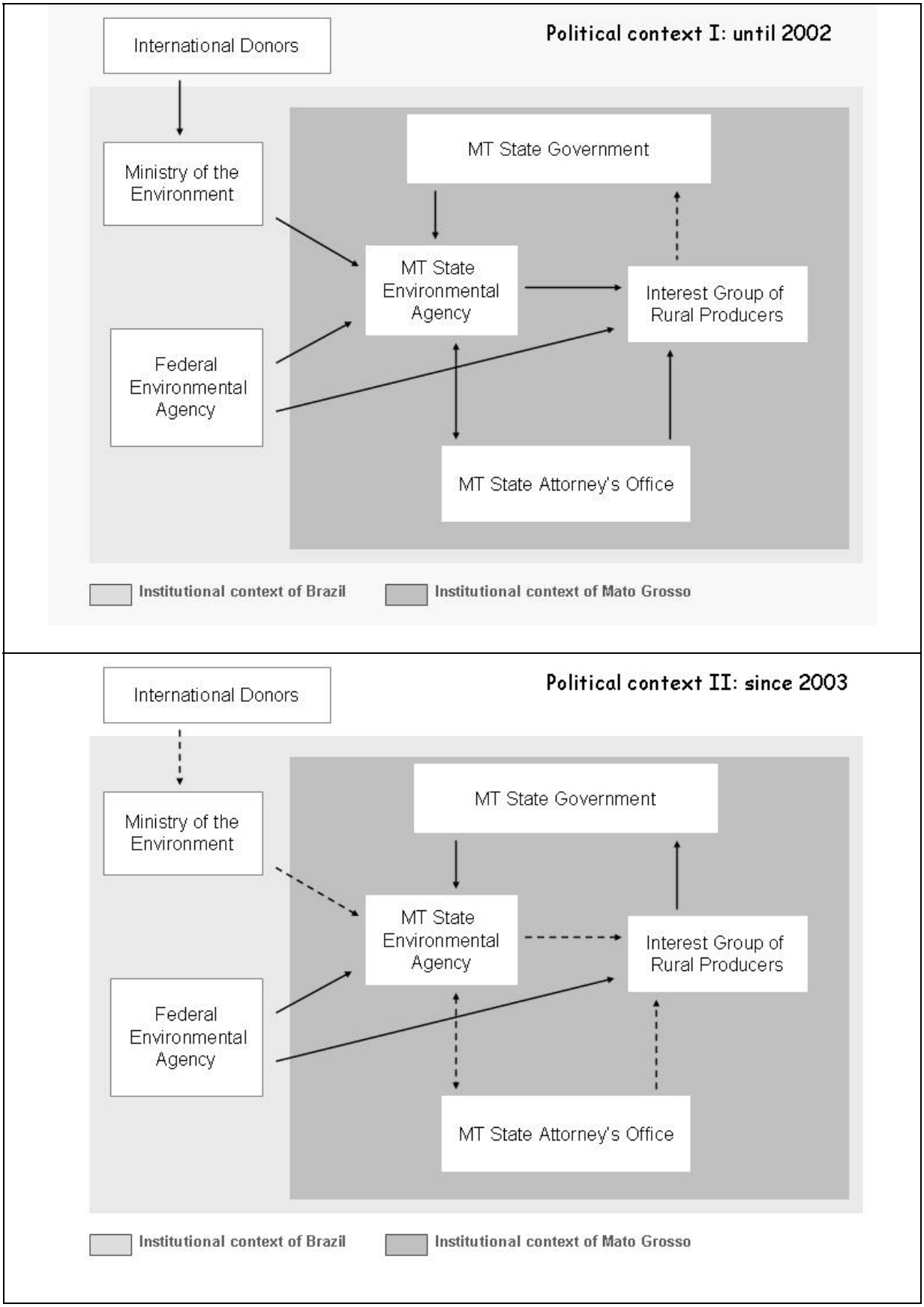


Figure 23: Stakeholder map for the two political situations. Continuous (discontinuous) arrows refer to "influential in the decision-making" ("little-influential in the decision-making") of the stakeholder to whom the arrow points, from the stakeholder from whom the arrow starts (own survey)

- **Since 2003:** Land use policy-making by the new state administration was largely shaped by diminishing international funding in Mato Grosso, and increasing political weight of rural producers interest group. This altered the degree of political support for the SLAPR.

The results suggest that the state administration considered the interests of the stakeholders that offered the greatest reelection potentials, in addition to other components of the respective Governor's individual utility function. While the first reactive behavior of Mato Grosso politicians is in line with the statements of the *New Political Economy of the Environment*, the latter indicates, for the case of Mato Grosso, that the utility function of the Mato Grosso politicians is not limited to reelection objectives.

Moreover, the analysis suggests institutional rivalry across different spatial level of activity, i.e. at state and federal level Brazil is federative political system and each state government owns great independency from the federal government. Still, federal public agencies have their representatives in each state which leads to a co-existence of federal and state agencies acting in the same domain. Remaining gaps in the partition of institutional competencies and increasing decentralization efforts entail situations of counter-productive inter-institutional rivalry, and hence weak authority systems, such as in the case of the SLAPR.

Furthermore, the analysis suggests that the deforestation behavior in Mato Grosso was influenced by the political priorities of the state administration, but also by international market conditions (soybean and beef prices) and the institutional context (forest policy, arrangements enabling participation in land use policy-making, environmental conditionality of rural credits from public banks). While the institutional context remained constant over the two political moments, political priorities shifted from a sustainable development oriented agenda to a growth-oriented agenda. The shift in political priorities entailed reduced political support for FEMA to execute their tasks (i.e. SLAPR enforcement). In addition,

producer prices for agriculture and livestock commodities increased after 2002 which induced an enhanced expansion of agricultural use area despite missing legal status.

Finally, the analysis suggests that the combination of a growth-oriented political agenda and increased agricultural commodity prices induced the strong increase of (illegal) deforestation in 2003 (Figure 22). Based on the qualitative evidence, it is however not possible to quantify the proportion of increased deforestation (or weaker forest policy enforcement) due to the change in the political power constellation relative to other external factors, such as agrarian price developments. Still, the influence of international environmental spending, rural credit requirements, and agrarian price developments as incentive for SLAPR compliance or otherwise, raises the question how economic incentives could be applied to ensure greater law compliance. A detailed cost-benefit analysis of the SLAPR and an analysis of the current incentive structures of land use actors could inform in this respect, and also allow a more in-depth analysis of the factual "winners" and "losers" of the SLAPR. Presumably, an important actor group in local land use policy-making present multi-national agro-businesses. Although not directly involved in the SLAPR, they influence local land use decisions indirectly, e.g. by providing credit alternatives to rural producers. Moreover, possibilities to increase economic returns from law compliance could be explored. However, in addition to potential further lines of research, both preceding analyses reveal important political economic and institutional factors shaping the SLAPR outcome. The subsequent chapter seeks to discuss them with respect to evidence and insights from other studies on the subject.

5 The SLAPR of Mato Grosso: Discussion of results

The qualitative and quantitative analysis of Chapter 3 and 4 point to various factors that shaped the outcome of the SLAPR in Mato Grosso. This chapter discusses revealed political economic and institutional determinants of the SLAPR in view of evidence from other studies on the subject. It ends with a reflection of the SLAPR as potential deforestation control model for the Brazilian Amazon.

5.1 Political economic determinants of the SLAPR

This paragraph discusses the political economic determinants of the SLAPR outcome as revealed by the preceding analyses. They consist of the political power constellation, the political objective function, political leadership and profitability of agriculture.

Political power constellation

The outcome of the SLAPR appears largely influenced by the political power constellation of interest groups which changed upon the elections in 2002 (Chapter 4). The results from the stakeholder analysis (Chapter 4) indicate that the implementation of the SLAPR in 1999 was largely induced and supported by international donors, basically due to their financial power. In a context where growth objectives continue to predominate, such as in many developing countries, external demand for improvements in the quality of global environmental goods (rain forests, biodiversity, global climate) has indeed been a much stronger factor than internal demand in persuading local political bodies to take action on the environmental front (Shams 1994). The simultaneity of ending international funds for environmental projects in Mato Grosso and the election of a more agro-economic growth-oriented new Governor in 2002, contributed to weaker political and financial support for the SLAPR after 2002 (Chapter 4). This suggests that the implementation of the SLAPR was supported as long as it appeared beneficial to the state politicians which is consistent with a

political-support model. Moreover, according to the political economic theory, interest-groups are usually very well organized to express and promote their interests. In this sense, the post 2002 development could also be interpreted as a result of democracy, where missing rural producer participation in territorial management could be translated into a refusal of votes. If the new state government's support for rural producers' interest is considered as result of FAMATO's lobbying and respective political support during the state government elections, the example of Mato Grosso suggests support for the political economic model and the power of interest-groups. Lastly, the SLAPR is under control of the state environmental agency FEMA. As a state agency, FEMA is under great control of the state administration (Chapter 4). Political power is thus further relevant in a context where bureaucratic functioning is highly dependent on the government in office, as in Mato Grosso. This confirms the general intuition, that a consideration of the interests and power positions of involved stakeholders is relevant to understand policy outcomes (e.g. from the SLAPR), which could also inform the design of forest policy enforcement measures (e.g. SLAPR).

Political objective function

The question arises whether the objective function of politicians is indeed limited to maximization of existing political support as assumed by the "political support" approach that was applied to the case of Mato Grosso. The SLAPR support by Governor Dante de Oliveira can be interpreted as politically rational in the expectation of further international funding to invest into "vote-friendly" infrastructure and service projects. Yet given the time-horizon for the future returns to take effect and the SLAPR support against strong opposition of influential voter groups suggest that the political objective function of Governor Dante de Oliveira was not solely limited to the maximization of political support. On the other hand, the political agenda of Governor Maggi appears to suggest explanatory value for the "political support"-model as he responds to the interests of his political supports, the rural

producers. The peculiarity here, however, consists of his individual utility function which includes political objectives (as State Governor) and economic objectives (as rural entrepreneur). Therefore, his strategy to adopt a pro-agro-entrepreneurial policy serves both, the political and economic elements of his objective function. The pursuit of personal objectives as rural entrepreneur is also expressed by his changing attitude towards environmental conservation which occurred almost simultaneously as it became a crucial factor in the IFC loan approval for his family business (Chapter 4). Hence, unlike assumed by the "political support"- model of environmental policy-making, the behavior of both ruling politicians in Mato Grosso suggests that it was not solely limited to the maximization of existing political support. This supports also one of the criticisms of the model (Chapter 4.1). Hence, while the political-support model focuses on the interests and power relations of the political actors at stake, it leaves the politicians in a passive re-active position which appears not necessarily the case in reality. Therefore, an explicit consideration of the politicians, their interests and relationships, appears relevant to understand policy outcomes and to inform policy design.

Political leadership

Although it is not clear to which extent the SLAPR was linked to the election defeat of the Dante de Oliveira administration in 2002, it is clear that the SLAPR implementation was greatly supported by that state administration. From a political economic viewpoint, it was rational for the state administration under Governor Dante de Oliveira (1995-2002) to facilitate internationally supported natural resource conservation measures (i.e. the SLAPR) as a mean to access further financial means to invest in other services and transportation infrastructure projects to please its voters (Chapter 4). On the other hand, the expectation of future economic and political returns can be questioned due to a limited time-horizon (i.e. the Governor's term in office) in which the chances for effective returns were minimal, as

proven by reality. However, the introduction of the SLAPR in 1999 was largely facilitated by "environmentally concerned" leaders in office (i.e. directors at FEMA and the State Governor), as well as friendship and trust between them (Chapter 4). Leadership plays indeed an important role in reform situations but continues to be largely exogenous to theory and not well explained in political economic theory, although evidence suggests that reform leaders in developing countries often act against the wishes of their political parties and support reforms that impose costs on their traditional support bases (Grindle 2000). Surely, the Governor's support for the SLAPR occurred despite the opposition of the influential rural producers lobby group (FAMATO) and many state deputies (Chapter 4). In this context, Grindle (2000) suggests that it might therefore be useful to explore the role of leaders, i.e. how leaders emerge, on what bases they claim to exert leadership, what particular tasks they must perform, and what strategies they select to promote reform in particular contexts. Such an analysis for the case of Mato Grosso could inform on the role of leadership in the SLAPR implementation and thus also for SLAPR replication plans.

Profitability of agriculture

Enforcement of forest regulation on private properties in Mato Grosso is challenged by the great profitability of agriculture, which also shaped the outcome of the SLAPR. Agricultural prices developments present an important determinant in land use decision-making of rural producers in Mato Grosso (Chapter 4, Stickler et al. 2004).[60] Indeed, surveys suggest that agricultural prices belong to the key factors for agricultural expansion and tropical deforestation (Barbier 2001). Furthermore, there is evidence that deforestation in the Brazilian Amazon has been driven by domestic market developments in the 1990s and by international market developments since 2000 (Alencar et al. 2004). In this context, the export products beef and soybeans play a crucial role in Amazon deforestation. Especially

[60] Soybean and beef prices increased in 2002 (e.g. soybean: 22 R$/sack in 01/2002 to 43 R$/sack in 12/ 2002) and remained high in 2003 (e.g. soybean: 30-40R$/sack) (IMEA 2004).

cattle-ranching is seen as a major driver for recent Amazon deforestation (Kaimowitz et al. 2004; Margulis 2003).[61] Still, soybean cultivation appears as a further important indirect driver. Evidence suggests that agriculture does not compete with cattle ranching in forest areas due to geo-ecological barriers (Chomitz and Thomas 2001). Nonetheless, soybean-cultivation expands typically on cleared land in the Cerrado or on former pasture areas in the Amazon pushing ranchers and slash-and-burn farmers ever deeper into the forest frontier (Laurence et al. 2004). The increasing international demand for agricultural products from the Brazilian Amazon is explained by the devaluation of the Brazilian currency *(real)*, improvements in transportation infrastructure, existence of vast areas of agricultural value and local agro-climatic conditions (Alencar et al. 2004). These location factors are concentrated in Mato Grosso, which makes agriculture highly profitable, which therefore competes with forest conservation objectives. This suggests that efforts to increased forest policy enforcement require an explicit consideration of the private and social costs and benefits of deforestation and its alternatives in order to be effective– especially in agrarian growth regions such as Mato Grosso.

5.2 Institutional determinants of the SLAPR

This section discusses the identified institutional determinants of the SLAPR, notably the weak authority system, the adequacy of the legal reserve requirement as enforced by the SLAPR, the ecological conditionality of public bank credits, enforcement instruments, stakeholder participation, and the path dependency of forest policy enforcement.

Weak authority system

The political economic analysis revealed the crucial role of the State Attorney's Office (Ministerio Publico) in the enforcement part of the SLAPR (Chapter 4). The analysis,

[61] The Brazilian inter-ministry working group for the reduction of Amazon deforestation attributes 80% of total Amazon deforestation to cattle-ranching (Presidência da República 2004).

however, also revealed difficulties which do not appear limited to the Ministerio Publico of Mato Grosso. At least in the Legal Amazon, Ministerio Publicos suffer from missing financial, technical and scientific means to allow for greater specialization of their attorneys to respond to environmental crimes in the Amazon, and also from insufficient collaboration with environmental agencies as they do not forward environmental malpractice to the Ministerio Publicos, but just assign monetary penalties (Valente 1993). While the first challenges the prosecution of environmental crimes (but does not necessarily impede it), the latter allows for fraud and "as if compliance", and thus impunity of law offenders. Still, the SLAPR experience in Mato Grosso, at least until 2002, indicates the potentials and benefits of improved collaboration between the environmental agencies and the Ministerio Publico. Hence, with its peculiar position of being government-independent and its objective to represent societal interests (Valente 1993), the Ministerio Publico is in the position to contribute to increased environmental law enforcement. As also suggested by the interviewees in Mato Grosso, environmental law enforcement could be improved by strengthening the capacity of the Ministerio Publicos to prosecute environmental crimes (e.g. collaboration with environmental agencies, environmental education of attorneys).

Furthermore, rivalry over competencies between federal and state environmental agencies affected the SLAPR authority system and thus the SLAPR outcome (Chapter 4). Indeed, institutional rivalry is common between state and federal agencies in Brazil (e.g. Campari 2002). Concerning the SLAPR, conflicts arose from unclearly defined regulation and enforcement competencies, e.g. with respect to legal reserve compensation or the required legal reserve portion in the Transition biome (Chapter 4). A further source of rivalry is related to increased efforts to decentralize federal competencies to state and municipal governments and the fear of federal institutions to become obsolete. Since the Brazilian Constitution of 1988, legislative competencies are distributed between the federal, state and municipal level, which is viewed as one of the most promising trends in frontier governance

(Nepstad et al. 2002). In turn, Brazilian state governments became very independent in their state politics, and influential on their state agencies. State power also shaped the SLAPR outcome under both state administrations (Chapter 4). Decentralization of SLAPR licensing and enforcement tasks could reduce inter-institutional rivalry and balance (monopolistic) state control. For example, a decentralization of tasks to municipal governments could also ensure enforcement in areas, where enforcement is usually low due to remoteness and bad roads. The realization of the latter is, in fact, planned for 2005 (Alves 10.12.2004). Moreover, a stake of federal institutions in state policy enforcement mechanisms (e.g. SLAPR) appears crucial to balance the influence of the state government on law and policy enforcement (Alecnar et al. 2004).

Finally, the authority system is undermined by fraud and corruption among enforcing agents. The fraud and corruption potential is nourished by low public salaries and time-intensive licensing procedures which generates amongst rural producers (due to defined agricultural time plans) a willingness to pay off the regulators to speed up the licensing process. Greater repartition of tasks could, if clearly defined, also result in greater mutual performance control by the involved institutions.

Adequacy of the legal reserve requirement as enforced in the SLAPR

The SLAPR seeks to enforce the legal reserve requirement. Yet the way it the legal reserve requirement is enforced entails tricky economic, ecological and social implications as discussed in turn.

From economic viewpoint, the enforcement of the legal reserve requirement is challenged due to the high opportunity costs of compliance. Despite high penalties for non-compliance with the legal-reserve requirement (circa 300-400 Euros per hectare using the exchange rate

of 2004)[62], and presumably consequent enforcement between 2000 and 2002, there is only little evidence for effective compliance with the legal reserve requirement in this time period (Chapter 4). The efficiency problem could be linked to the landholders' perspective that compliance with the legal reserves requirement implies high opportunity costs if

- legal reserves are located in prosperous agricultural regions (lower production costs);
- legal reserves are located in proximity to other intensive use areas (economies of scale),
- legal reserves have no economic returns, e.g. from compensation payments,
- new lands for agriculture and ranching are remote (additional transport costs).

Areas with favorable location factors for agriculture are primarily located in the Cerrado and Transition biome. Thus conserving private forests (i.e. legal reserves) in the Cerrado or Transition biome can imply higher private opportunity costs than for example in the Amazon biome. High opportunity costs of legal reserve preservation will therefore contribute to the landholders' reduced propensity to comply with the environmental regulation in Mato Grosso. A system of tradable development rights, such as explored in Paraná, could reduce the opportunity costs of legal reserve conservation while compensating landholders in less prosperous agricultural regions who have their forests protected (Chomitz et al. 2004).[63] In fact, the SLAPR in Mato Grosso allows also for the compensation of missing legal reserve portions, but only by the time of licensing. The inflexibility was criticized by rural producers who prefer to keep the option of further intensification for a later point in time (Chapter 4).

From an environmental perspective, the legal reserve requirement can be tricky due to potential ecological impacts of rigorous enforcement. For example, an 80% legal reserve requirement can contribute to an accelerated expansion of the agricultural frontier (Alencar et al. 2004). The latter can occur since the legal reserve requirement impedes agricultural

[62] The environmental crimes bill of 1998 empowers environmental agencies to levy fines and to impose jails sentences for illegal deforestation, burning and logging activities (Nepstad et al. 2002).

[63] However, the ultimate ecological value of tradable development rights will depend on the definition of forest substitutes (e.g. whether the compensation area has to be of the same vegetation type) or on complementary measures such as land use zoning plans.

expansion in areas with a low proportion natural vegetation cover and stimulates expansion to areas with a high proportion of natural vegetation cover (Chapter 3). Stimulation of agricultural expansion in areas with high proportion of natural vegetation, i.e. primarily in areas at the remote and hardly tapped Amazon frontier, require complementary road construction to facilitate accessibility. However, inaccessibility has provided passive protection to Amazon forests (Nepstad et al. 2002), and there is substantial concern regarding road construction in still undeveloped areas of the Amazon since typically, deforestation and land speculation close to roads is difficult to control (Kaimowitz et al. 2004; Carvalho et al. 2001). The legal reserve requirement, as currently enforced by the SLAPR, appears therefore in the long run counter-productive if consequently enforced. This corresponds to the general observation of "over-regulated" policies in Brazil which can imply economic losses (Campari 2002). Although demanded by rural producers, the interviews in Mato Grosso revealed that a loosening of the legal reserve requirement is not expected, primarily due to strong pressure from environmental conservation groups. However, one advantage of tradable development rights (see above) is precisely that it removes the incentive to expand the frontier, enabling greater intensification of land use near markets and on good soils.

From a social perspective, a vigorously enforced legal reserve requirement can entail difficulties because of

- the perception of rural entrepreneurs that their lands get – without any compensation – "misappropriated" for environmental purposes although by the time of land purchase (mostly around 1960s-70s) the lands were designed for economic purposes for which landholders received substantial government support (Chapter 2.3),
- missing scientific justification for the legal reserve requirement as currently defined which reduces the willingness among rural entrepreneurs to comply, especially as the

current legal reserve definition is viewed as result of vehement pressure from the (presumed internationally supported) environmental movement,

- the possible consequence of land ownership concentration. This is especially the case in the Amazon biome where consequent enforcement of the legal reserve requirement of 80% requires the preservation of four fifth of the property under native vegetation cover. In consequence, a rural producer who, for example, wants to put 200 ha into agricultural use would have to purchase 1000 ha in order to comply with the Amazon legal reserve requirement. Yet such endeavors require the necessary financial means to do so. Thus in addition to resulting land ownership concentration with the potential consequences of social exclusion (lower opportunities for smallholders to purchase and cultivate lands) and further deforestation (expansion of agricultural use lands, migration of expulsed smallholders to the frontier), also amongst rural producers only the wealthier will have the means to respond to the new demands (i.e. purchase of large land tracts in remote areas of the Amazon which implies transport costs). Conversely, consequent enforcement of the legal reserve requirement can also lead to a decrease in land values as only one fifth of a property can be exploited for agricultural uses.[64] Decreasing land values facilitate land purchase (at least for capitalized agents) and so land ownership concentration.

Hence, rigorous enforcement of the legal reserve requirement as currently defined and implemented in Mato Grosso, can lead to resistance by one of the most important stakeholders (rural landholders), and entail undesired social effects such as land ownership concentration and social exclusion. In a context of already very unequal land ownership distribution as in the Brazilian Amazon (Chapter 2.1) and limited land access for small-

[64] On the other hand, lands in watershed areas where land price can increase in response to increasing demand for land to compensate missing legal reserve portions. However, compensating missing legal reserve portions in watershed areas is only allowed by FEMA, but contested by IBAMA raising another aspect of unclearly defined competencies between FEMA and IBAMA.

holders (Neuburger 2001), incentives to further concentration of land (as well as profits and power) as can result from a vigorously enforced legal reserve requirement, appear counter-productive. Integration of land use stakeholders in territorial management (e.g. land use zoning) could be a bottom-up approach to land use management which can contribute to a greater consideration and accommodation of the various concerns and thus increase the potential to achieve more sustainable land use (see below). However, past experiences demonstrate the difficulties in implementing such approaches (Chapter 2).

Ecological conditionality of public bank credits

The results of Chapter 4 suggest that one of the relevant formal legal institutions in the SLAPR were rural credit requirements which are defined by federal legislation and bank policy. By federal law, banks are required to ensure environmental law compliance of their borrowers, at least since 1981.[65] Additionally in 1995, five government controlled banks of Brazil[66] signed a *Letter of Sustainable Development Principles (Green Protocol*) committing themselves to incorporate the environmental dimension in their project analysis and evaluation systems, and prioritize sustainable development actions (MMA 2002). Thus at least since 1995, environmental licensing is one condition for agrarian credits from public banks. The legal reserve requirement however, only became official credit requirement with the introduction of the unified environmental license (LAU) from FEMA.[67] With the obligation to comply with their regulations (federal law and official bank agreements), public banks became additional enforcers of the SLAPR obligations. Over time, the environmental license requirement for bank credits became an important driving force for

[65] Joint liability of financial agents for any environmental damage of their borrowers exists since the National Environmental Policy 1981 and was reinforced by the Presidential Decree in 1990 (Decree 99.274/90, Art. 23). Liability of financial institutions was further specified in the Environmental Crimes Law in 1998 which holds liable those who "in any form contribute" to environmental crimes.

[66] I.e. the Social, Economic National Development Bank (BNDES), the Brazilian Bank (BB), the Federal Economic Fund (CEF), the Northeast Bank of Brasil (BNB) and the Amazon Bank (BASA).

[67] Prior to the LAU, only BASA requested legal reserve compliance as credit requirement. Yet in Mato Grosso, the BASA volume of agrarian credits to landholders is small compared to the Banco do Brasil.

landholders to register and license their properties at FEMA. However, banks only require the environmental license, but do not monitor effective environmental law compliance after credit approval. While continuous law compliance by registered properties is could be improved, the ecological conditionality of public bank credits functions as an incentive for rural property owner to – at least – register their properties in the SLAPR.

Enforcement instruments

The SLAPR outcome is also determined by the applied enforcement instrument. To enforce forest policy on private landholdings, FEMA applies a command-and-control instrument. However, these instruments imply monitoring and control costs, and leave room for individual judgments and arrangements by the enforcing agents. Complementary market-based instruments to private forest policy enforcement could be tradable development rights (see above) or certificates. Under vigorous property rights enforcement, certificates for law-complying properties could not only signal law concordance, but could also entail a higher market valuation of certified properties (or their agrarian products) than non-certified properties (or their products).

Stakeholder participation

The SLAPR stakeholders criticized the lack of opportunities to be involved in territorial management, including in the SLAPR implementation (Chapter 4). Indeed, territorial management in the Legal Amazon appears to remain primarily shaped by top-down decision-making (Alencar et al. 2004), which therefore entail little societal acceptance. Stakeholder participation in territorial management can improve policy-making and enforcement (Chapter 4, Redwood 2002). Hence, in line with Margulis (2004), forest policy enforcement could be improved if enforcing agencies work with the relevant stakeholders, not against them. Furthermore, civil society involvement in forest policy enforcement appears valuable to increase societal environmental awareness and to complement public

enforcement efforts, e.g. via denunciation of environmental crimes. One step to enable participation in the SLAPR is to provide critical information, e.g. deforestation maps, to the public, e.g. via the Internet, such as it was planned originally (FEMA 2001b).

Path dependency of forest policy enforcement

The SLAPR outcome was also influenced by past practices and priorities in land use policy. According to the new institutional economics, success or otherwise of environmental policies is shaped by historical conditions, i.e. former institutional arrangements, and public ideological and emotional preferences (Chapter 4.1). With the objective to increase forest policy enforcement on private rural properties, the SLAPR entailed certain institutional change. Indeed, an obstacle to environmental law compliance consists of the general opinion that public authority intervention in private property rights to ensure environmental law compliance is not justified, and private landholder should be allowed to use their property as they feel appropriate (Santos 1993). This perception was also pronounced by the rural producers in Mato Grosso, and presumably nourished by missing forest policy enforcement during large-scale Amazon colonization in the 1960s and 1970s (Chapter 2.2). Hence, past public policies influence the view of to date's Amazon colonization model which also affected the implementation of the SLAPR. Still, despite the political economy forces that arrayed against increased forest policy enforcement (Chapter 4), there is evidence for some behavioral impacts of the SLAPR on private land use (Chapter 3). Moreover, the SLAPR raised the awareness and the discussion on the adequacy of environmental legislation, as well as on alternative environmental management solutions.

5.3 The SLAPR as deforestation control model in the Brazilian Amazon

The SLAPR in Mato Grosso presents a new model to enforce forest regulation on private landholdings as means to control illegal deforestation. While there is evidence for some

behavioral impacts of the SLAPR on private land use, this thesis also reveals some challenges to efficient forest policy enforcement in Mato Grosso. Specifically, these are

- strong dependence on the political objectives of the state government,
- current strategy to enforce the legal reserve requirement,
- weak enforcement mechanism due to a weak Ministerio Publico, institutional rivalry, and preferential treatments for powerful land use agents,
- low opportunities for stakeholder and civil society participation,
- path dependency of environmental policy enforcement (past public policies)

Still, the SLAPR presents a first step into the direction of effective law enforcement, which is especially relevant in a context of wide-spread non-compliance with private forest policy as common in the Legal Amazon (Chapter 1). To which degree the SLAPR presents a suitable model for increased forest policy enforcement in other state of the Legal Amazon will depend to which extent the identified obstacles can be overcome. The experience in Mato Grosso suggests that technological advances are supportive, but not sufficient to ensure factual law enforcement. Especially economic, social and institutional factors play an important role. Therefore, a replication of the SLAPR to other states should consider the realization of a context-specific feasibility study including a (i) political economic analysis of the stakeholders (including politicians) to capture the underlying interests and power positions, and (ii), a micro-level cost-benefit analysis of forest policy enforcement to capture its individual and societal gains and losses.

So far, the SLAPR controls medium- and large-holder deforestation as they are perceived as primary deforestation actors in Mato Grosso, and as it appeared fair to enforce accountability for their actions. Still, the SLAPR licensing requirements entail comparably higher cost burden for medium-size landholders compared to large landholders. This refers especially to the power potential to pay off the regulators (Chapter 4). After all, smallholder deforestation

requires licensing and accountability measures that are adopted for their social and economic situation. Smallholder deforestation predominates in other Amazon states (e.g. Rondônia, Acre), and also in Mato Grosso, the proportion of small and medium size landholder deforestation increased between 1996 and 2002 (Chapter 3.3). Hence, while addressing equity aspects of the SLAPR requirements for medium-size landholders appears advisable, adequately designed deforestation control measures for smallholders appear inevitable, especially where smallholder deforestation dominates.

Hence, despite the strong political economic forces that arrayed against the SLAPR (Chapter 4), there is evidence for behavioral effects of the SLAPR on deforestation (Chapter 3). While there remains need for further improvements, the SLAPR in Mato Grosso presents a valuable experience for illegal deforestation control on private properties in the Brazilian Amazon. As any innovation, it suffers initial implementation problems. Still, it can serve as first step to enhance forest policy enforcement and to improve deforestation control. Yet limited financial resources, weak bureaucratic structures, political priorities, and other social problems (land inequality, poverty) will continue to challenge effective enforcement and natural resource management at the Amazon frontier.

6 Summary and conclusion

Although private forest use has been restricted since 1965, tabulations from the Brazilian agricultural census indicate that many private lands of the Legal Amazon are out of compliance with the Brazilian Forest Code. Large-scale agricultural colonization of the Legal Amazon started with the regional development and economic growth strategies of the military government after 1964. The phases of the regional colonization process are:

(i) Mid-1960s: Opening up of the Amazon frontier with road construction and fiscal and credit incentives for agrarian investment projects in the Amazon;

(ii) Early 1970s: State-directed agrarian colonization accompanied with infrastructure investments (Transamazonian highway, Cuiabá-Santarém highway);

(iii) Mid-1970s: Modernization with development poles (*POLAMAZÔNIA, POLOCENTRO)* and extended public incentives for private investments projects;

(iv) Early 1980s: Basic-needs program for integrated rural development (*POLONOROESTE)*;

(v) Mid-1980s: Modernization with big projects (Grande Carajás) and export-oriented agriculture (soybean cultivation in Cerrado savanna and Mato Grosso);

(vi) 1990s: Globalization and sustainable development programs (*PPG7*).

While the 1980s-90s were marked by substantial reforms in the Brazilian environmental policy, actual environmental law enforcement remained lenient. This contributed to the massive conversion of tropical forests to agricultural land, especially in Pará, Rondônia and Mato Grosso. In 2003, cumulative deforestation in the Legal Amazon totaled to about 653,000 km^2 since 1974, of which about 40% occurred in Mato Grosso (INPE 2004).

In 1999, a step into a new direction was undertaken by the State Foundation of the Environment (FEMA) in Mato Grosso by introducing a new environmental licensing system of rural properties (SLAPR). The idea was to control illegal deforestation on private rural

properties through the enforcement of the *duty* of private rural properties to comply with private forest use regulations. Specifically, compliance was required with the *permanent preservation area* and the *legal reserve requirement* of the Brazilian Forest Code 1965. According to the property rights theory, the absence of well-defined and consequently enforced property rights is seen as an important cause of deforestation. FEMA's approach to control deforestation via the promotion of land titling and the enforcement of the legal duties of private lands to comply with private land use regulations addresses an important cause of deforestation and presents thus an innovative approach to environmental management in the context of the Brazilian Amazon. Although initially FEMA targeted large-holdings, properties of any size can meanwhile be registered at FEMA. In 2001, decreasing deforestation rates since program implementation in 1999 suggested evidence for program success resulting in wide-spread national and international recognition with replication plans of the Mato Grosso SLAPR to other states of the Legal Amazon. In addition to its role in Brazilian environmental policy-making, the SLAPR of Mato Grosso presents a relevant research subject, notably for (i) its approach to control deforestation by addressing an important cause of deforestation as stated by the property rights theory, (ii) apparent effectiveness in deterring aggregate deforestation between 1999-2001, and (iii) its implementation in an agrarian growth region with significant land use and deforestation dynamics in the last 40 years that are only starting in other Amazon states.

Enforcing property rights to control deforestation: the case of the Mato Grosso SLAPR

Motivated by the innovative and presumably successful approach of the SLAPR in deterring illegal deforestation via the enforcement of property duties, the first objective of this thesis was to seek for improved evidence of program effectiveness. A further motivation consisted in the ambiguous effect in the pattern of aggregate deforestation rates as aggregate deforestation rates decrease already prior to program implementation 1996/97-1998/99,

continue afterwards in 2000/01, yet rebound in 2002, especially in the Amazon biome. Therefore, FEMA data on the spatial extent and location of deforestation (1996-2002) was assessed. Specifically, a variant of the *difference-in-difference* approach was applied to assess the difference in FEMA deforestation rates in areas where deforestation was likely to be authorized/authorizable versus areas where deforestation was likely to be non-authorizable (first difference) before versus after program implementation (second difference). The overall hypothesis was that the program, if effective, should depress non-authorizable deforestation relative to authorized/authorizable deforestation. As data to assess the change in the deforestation types was unavailable, five hypotheses stating potential evidence of program effectiveness were defined. Using geographic information system (GIS) techniques, sample points at 1-km intervals of the non-protected areas of Mato Grosso were selected for the statistical analysis. In a first step, exploratory analysis was conducted to compare the approximated authorized/authorizable versus non-authorizable deforestation rates before and after program implementation, i.e. 1996/97 and 1998/99 versus 2000/01 and 2002. In a second step, explanatory analysis was conducted by analyzing FEMA deforestation data (1996/97, 1998/99, 2000/01, and 2002) within a probit regression model. Specifically, the probability of deforestation was estimated by the proportion of natural vegetation cover (as proxy for the legal reserve requirement), permanent preservation area status, enforcement status, biome type, distance to roads, slope, and agricultural suitability. Two sets of probit regressions were assessed. The first consisted of a simple estimation of total deforestation, while the second was based on the same model specification but applied to estimate large-scale deforestation – defined as deforestation greater than 200 ha. The motivation for the latter based on FEMA's objective to target large-holder deforestation. The results suggest some behavioral responses to the program, although aggregate deforestation rates remain high. Specifically, the results are:

- There is no clear indication of any effect from enforcing the *permanent preservation areas*-requirement, i.e. there is no significant post-program decrease in deforestation rates within permanent preservation areas.
- Using a proxy to assess compliance with the *legal reserve*-requirement, the analysis revealed some evidence for decreasing rates of deforestation of legal reserves, especially in the Amazon biome and for large-scale deforestation.
- There is strong and statistically very significant evidence for a post-program reduction in deforestation rates, notably large-scale deforestation, near roads. This suggests a program response.
- There is evidence of a greater post-program response in large-scale deforestation compared to small-scale deforestation. This is also supported by a relatively greater decline of post-program large-scale deforestation in Mato Grosso compared to its neighboring state Pará, notably within a 10 km buffer along the state border.
- There is strong and statistically significant evidence for greater post-program effects on deforestation, especially large-scale deforestation, in municipalities with high enforcement activity compared to areas with low enforcement activity in 2000/01.

Despite some indications of program effectiveness, the results raise the question why aggregate deforestation has increased in 2002. However, the analysis results could be substantially improved if spatial data on the SLAPR registered properties was available, as well as a longer time-series of deforestation data after 2002. This could allow a more accurate analysis on landholder behavior upon FEMA licensing.

Power and interests in environmental policy-making: the case of the Mato Grosso SLAPR

FEMA deforestation rates of 2003 indicate a continuation of the rebounding trend of 2002. Especially the share of illegal deforestation jumped up in 2003 relative to 2002. The changing trends in deforestation rates raises questions about its driving forces. According the

new political economy of the environment, the design and implementation of environmental policy measures are shaped by the political process of various actor groups and their framing political-economic context. In Mato Grosso, the political economic context changed upon the elections in 2002 with a new state government since 2003. By adopting a new political economic perspective, the second research objective of this thesis was thus to analyze the political actors of the SLAPR. The idea was to complement the preceding quantitative analysis with a qualitative analysis of the political-economy of the SLAPR. Therefore, 50 semi-structured non-standardized interviews with representatives of 20 institutions were conducted in Brazil between February and March 2004. The interview statements were subsequently assessed using qualitative content-analysis techniques to examine relevant SLAPR stakeholders as means to gain a greater understanding of the SLAPR functioning and of the drastic deforestation increase in 2003. The analysis was guided by the *extended version of the political-support approach* which was adopted to the SLAPR context in Mato Grosso. Specifically, the following relevant SLAPR stakeholders were identified and interviewed: (i) international donors, (ii) the Federal Ministry of the Environment (MMA), (iii) the State Administration of Mato Grosso, (iv) the Mato Grosso State Environmental Agency (FEMA), (v) the State Attorney's Office, (vi) the Federal Environmental Agency (IBAMA) and (vii) large-holders (FAMATO).

The results of the political economic analysis of the SLAPR, suggest a shift in the political power relations among stakeholders between the two political moments, i.e. under Governor Dante de Oliveira until 2002 and under Governor Blairo Maggi since 2003. Specifically, the identified changes between the two political moments were:

- Until 2002: Land use policy-making in Mato Grosso was shaped by the interests of international donors and the MMA to realize deforestation control in Mato Grosso. As politicians expected benefits from responding to the international and federal interests, substantial political support was provided to the SLAPR implementation.

- Since 2003: Land use policy-making by the new state administration was largely shaped by diminishing international funding in Mato Grosso, and increasing political weight of the rural producers interest group. This contributed to an altered degree of political support for the SLAPR.

The results suggest that the state administration considered the interests of those who offered the greatest reelection potentials in addition to other elements of its individual utility function. This corresponds to the statements of the new political economy of the environment. The analysis suggests further that the combination of a growth-oriented political agenda and increased agricultural commodity prices induced the strong increase of primarily illegal deforestation in 2003. On the other hand, the analysis also revealed that the licensing requirement of public bank credits presented an important licensing incentive for landholders. Hence, the results emphasize the relevance of political economic and institutional factors in the understanding of the deforestation pattern in Mato Grosso.

Discussion of results

Findings from both preceding analyses, notably political economic and institutional factors that resulted influential in the SLAPR outcome were discussed in consideration of other empirical evidence concerning the subject. Specifically, the following political economic determinants of the SLAPR outcome were discussed:

- Political power constellation, i.e. the political weight of SLAPR stakeholders: In line with the political economic statement, an analysis of the interests and power positions of all involved political actors to "understand" policy outcomes was found relevant.
- Political objective function: Unlike assumed by the political-support approach of new political economy, the political objective function is not always limited to reelection.
- Political leadership: The role of leaders in reform situations (e.g. as present during the SLAPR introduction) receives low attention in political economic analysis.

- Profitability of agriculture: International market conditions play an important role in land use decision-making in Mato Grosso and other states of the Legal Amazon.

The following institutional determinants of the SLAPR outcome were discussed:

- Weak authority system (weak institutions): As emphasized by the new institutional economy, weak authority systems contribute to lenient SLAPR enforcement.
- Legal reserve requirement as enforced in the SLAPR: This can – if consequently enforced – entail undesired economic, social and environmental effects.
- Ecological conditionality of rural credits from public Brazilian banks: This was found as an important complementary enforcement element of the SLAPR.
- Enforcement instrument: While the SLAPR is based on command-and-control, it could be complemented with market-based instruments to increase efficiency of enforcement.
- Stakeholder participation: Missing opportunities to participate in land use policy-making shapes responsibility and willingness in forest policy compliance.
- Path dependency in environmental policy: As stressed by the new institutional economy, past practices in public policies shape current forest policy enforcement in Mato Grosso.

Lastly, this thesis reflected on of the SLAPR as model for deforestation control in the Legal Amazon and identifies several issues which, context-specific, need to be addressed to enhance SLAPR effectiveness, especially when considering a replication the system.

Conclusions

This thesis concludes that despite political economic forces that arrayed against increased forest policy enforcement in Mato Grosso (strong and well-organized large-holder lobby, high profitability of agriculture), there is indeed evidence for some behavioral impacts of the SLAPR on private land use. The SLAPR of Mato Grosso can thus be viewed as an important step into the direction of enhanced forest policy enforcement in the Brazilian Amazon,

although its implementation and effectiveness is shaped by various political-economic and institutional factors. Specific conclusions from the two empirical analyses are:

- The econometric analysis of the SLAPR effectiveness suggests some behavioral program response – although aggregate deforestation rates remained high. The results could be improved with data on the spatial outline and licensing status of private rural properties in Mato Grosso. A larger time-series of deforestation data as well as more recent land use/land cover data could further inform the SLAPR effectiveness.
- The political economic analysis of the SLAPR focused on the perspective of SLAPR stakeholders and revealed an evident shift in political power relations between the two state governments before and after 2002. In fact, both, political power and agricultural commodity prices appeared influential in the SLAPR outcome and the increase in 2003 deforestation rates. The results could be improved with a micro economic analysis of the costs and benefits of the SLAPR.

From a methodological viewpoint, the innovative application of the difference in difference approach to geographic data provides a further possibility to assess the effectiveness of policies with spatial reference. Moreover, the combination of both, rigorous quantitative and positive qualitative empirical analysis methods were complementary and allowed different perspectives on the same subject. The use of spatially-explicit data in econometric analysis allowed for a more context-specific approach where the scope of analysis was defined by a more adequate analysis scope (e.g. natural vegetation cover) instead of administrative units as usually applied in econometric analysis. The positive and qualitative approach to a political economic analysis of the SLAPR was challenged by potential subjectivity, yet allowed a greater understanding for the complexity of real-world phenomenon. Hence, while the mix of quantitative and qualitative research methods is demanding, it can lead to a more holistic picture on the analysis subject than a single-method approach. This supports the idea of interdisciplinary research.

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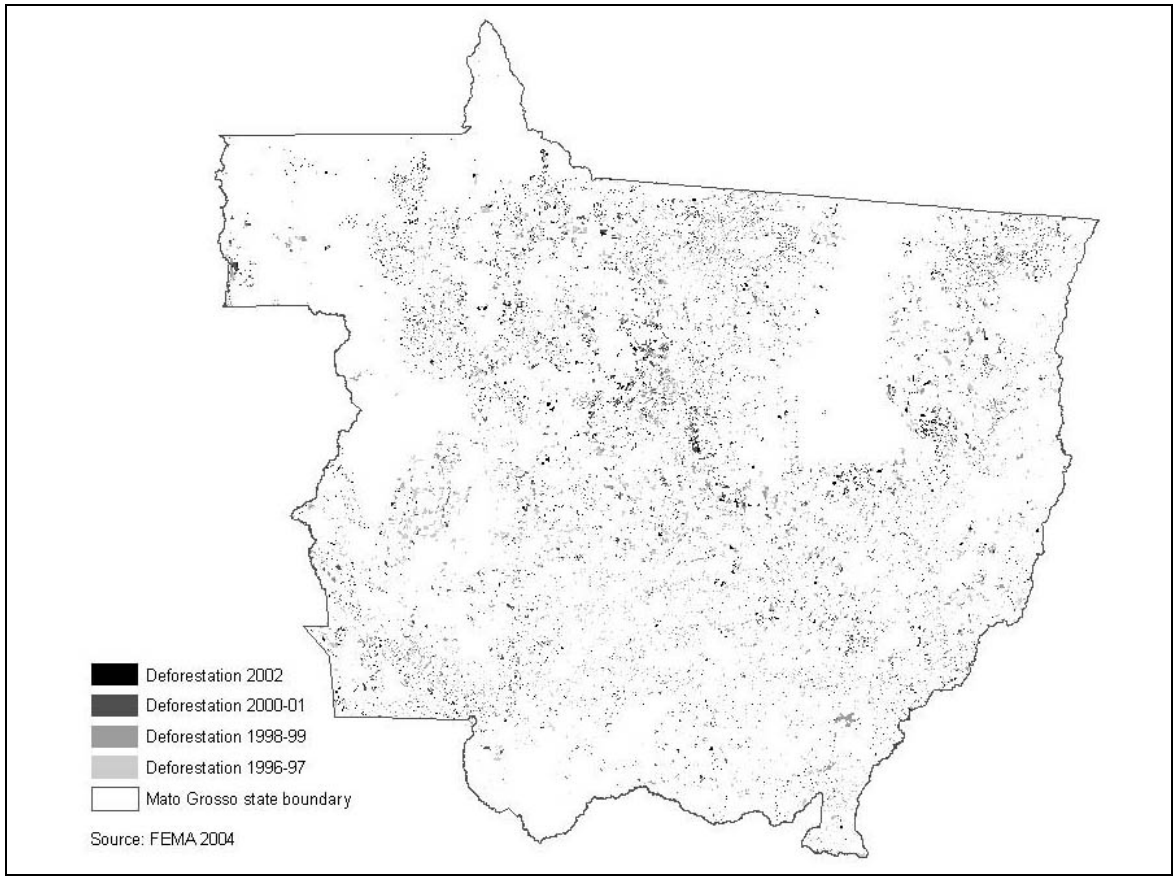
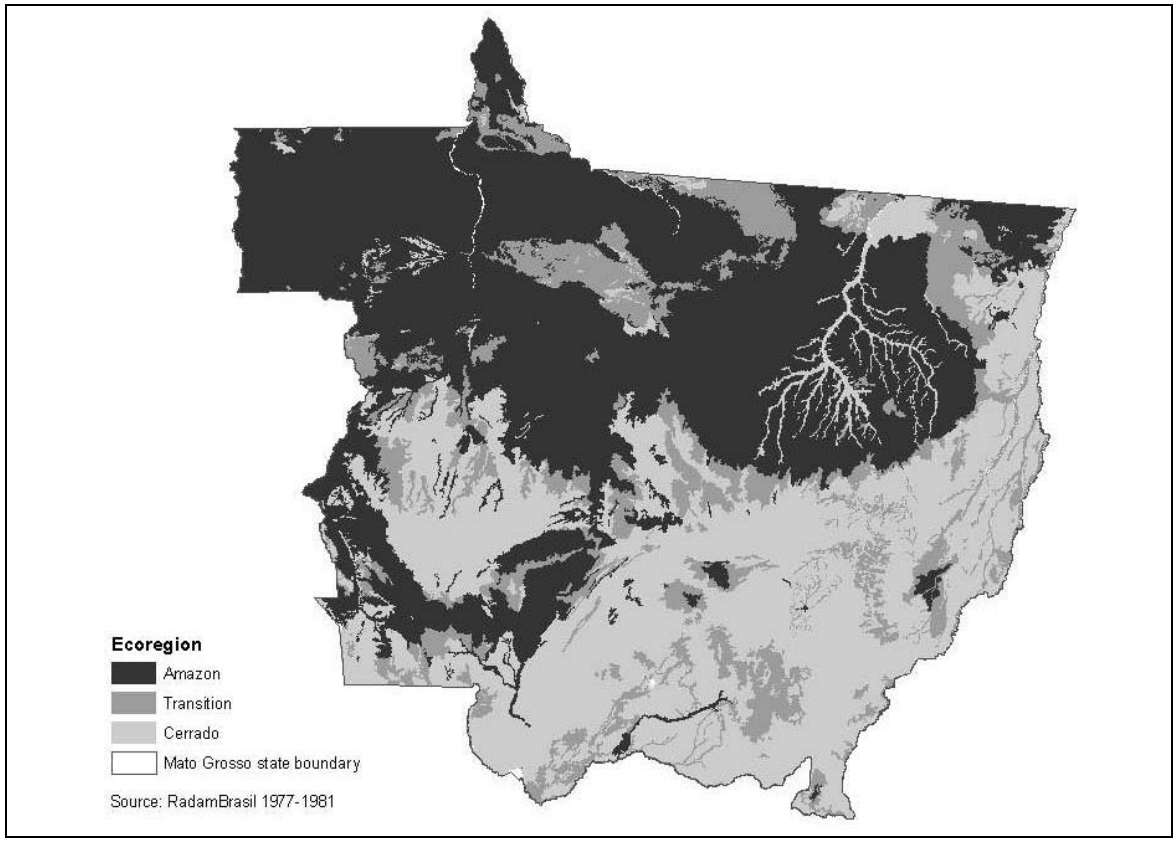
Mato Grosso Environmental Code 1995

ANNEX I

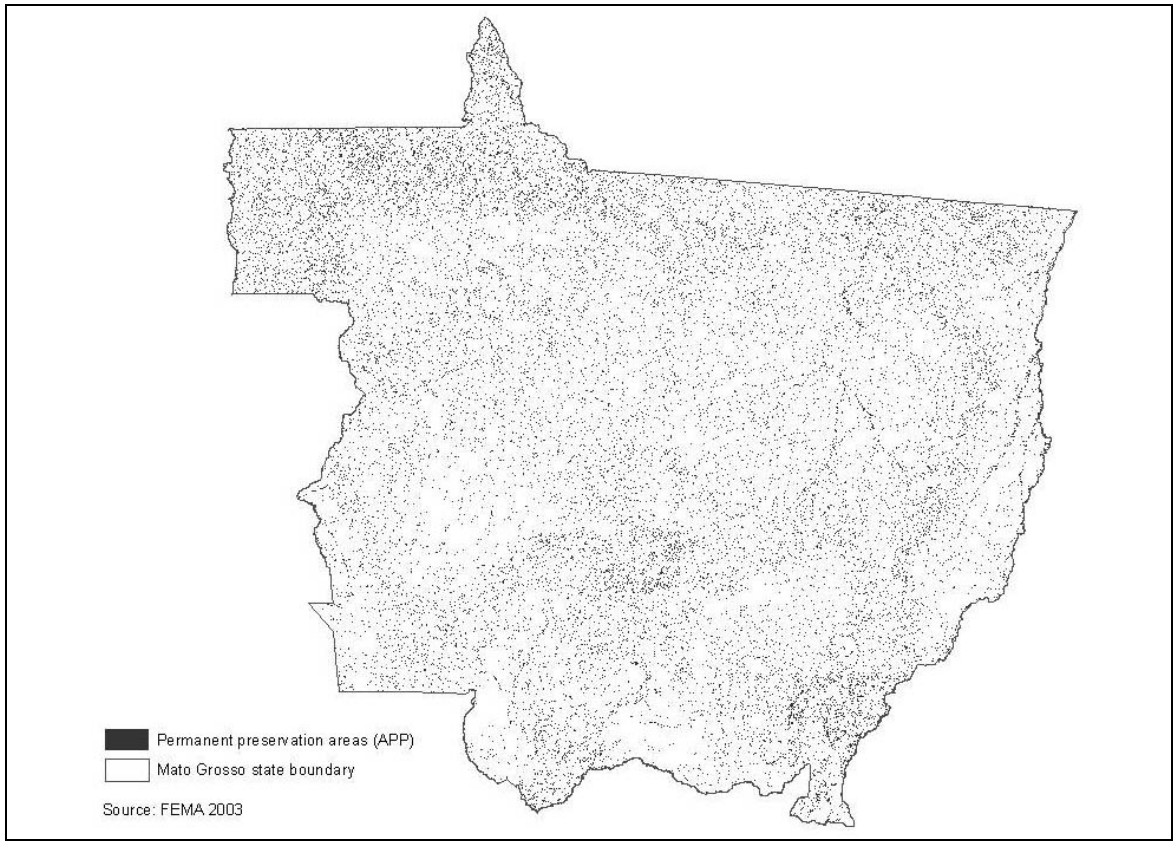
Map 8: Deforestation in Mato Grosso from 1996 to 2002



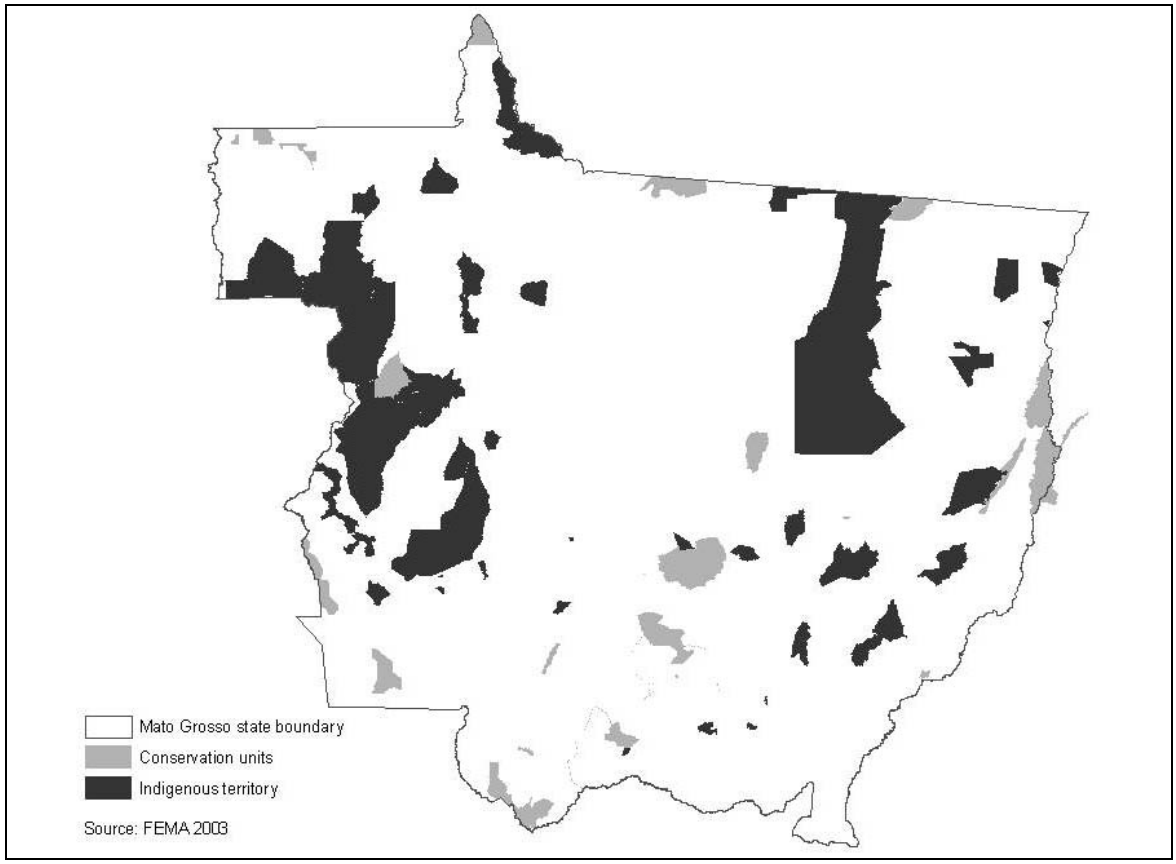
Map 9: Ecoregions of Mato Grosso



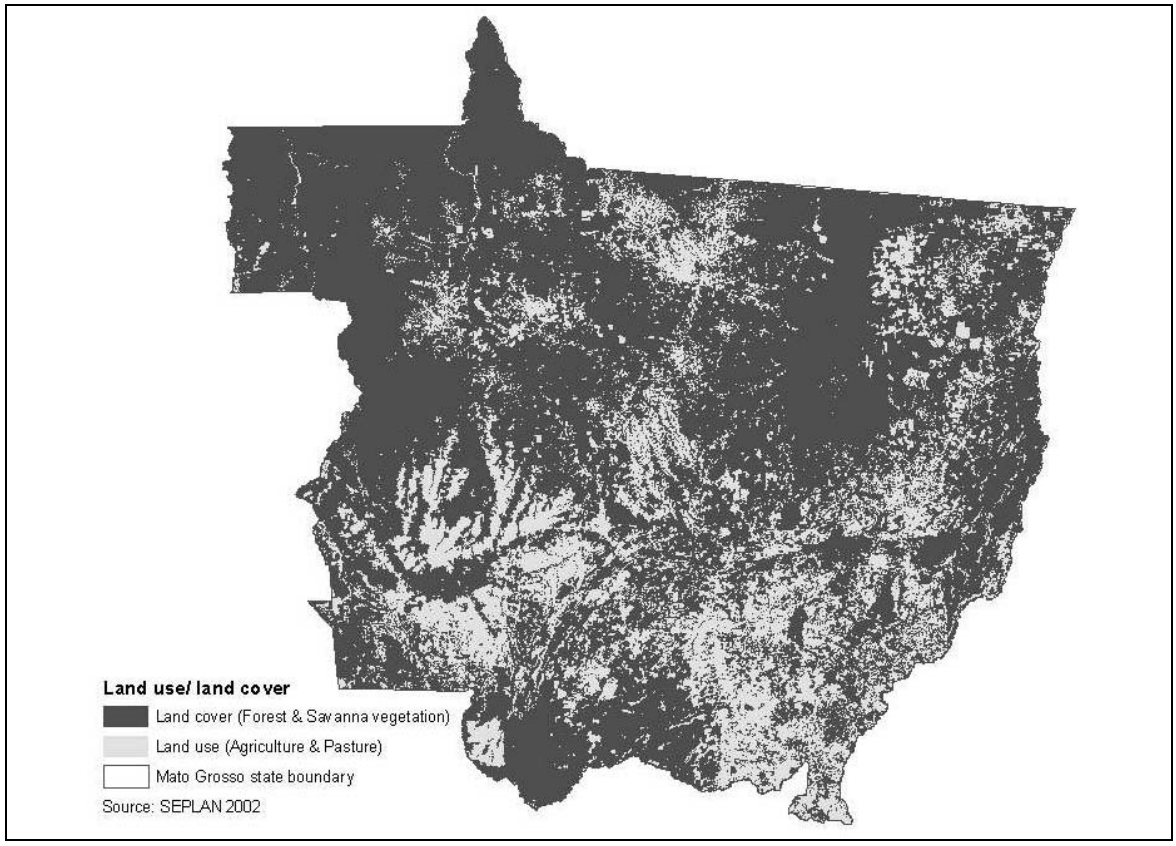
Map 10: Permanent preservation areas of Mato Grosso



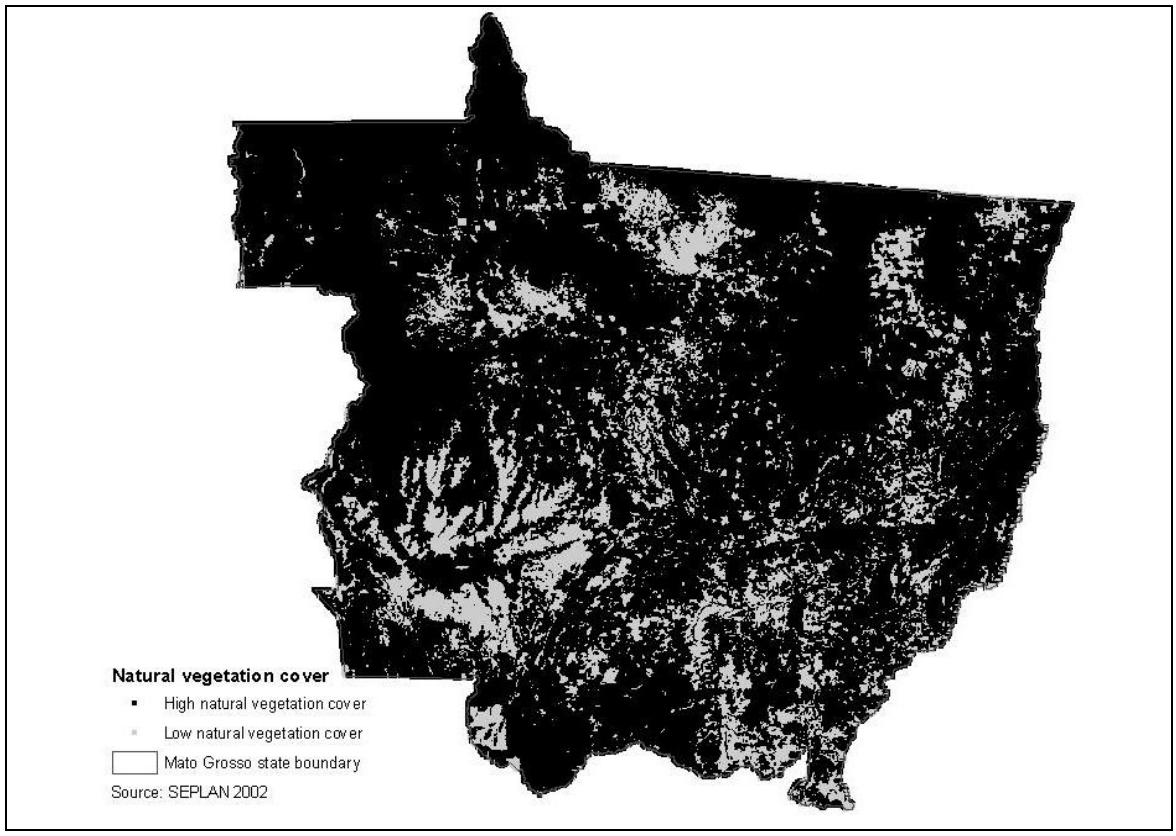
Map 11: Protected areas of Mato Grosso



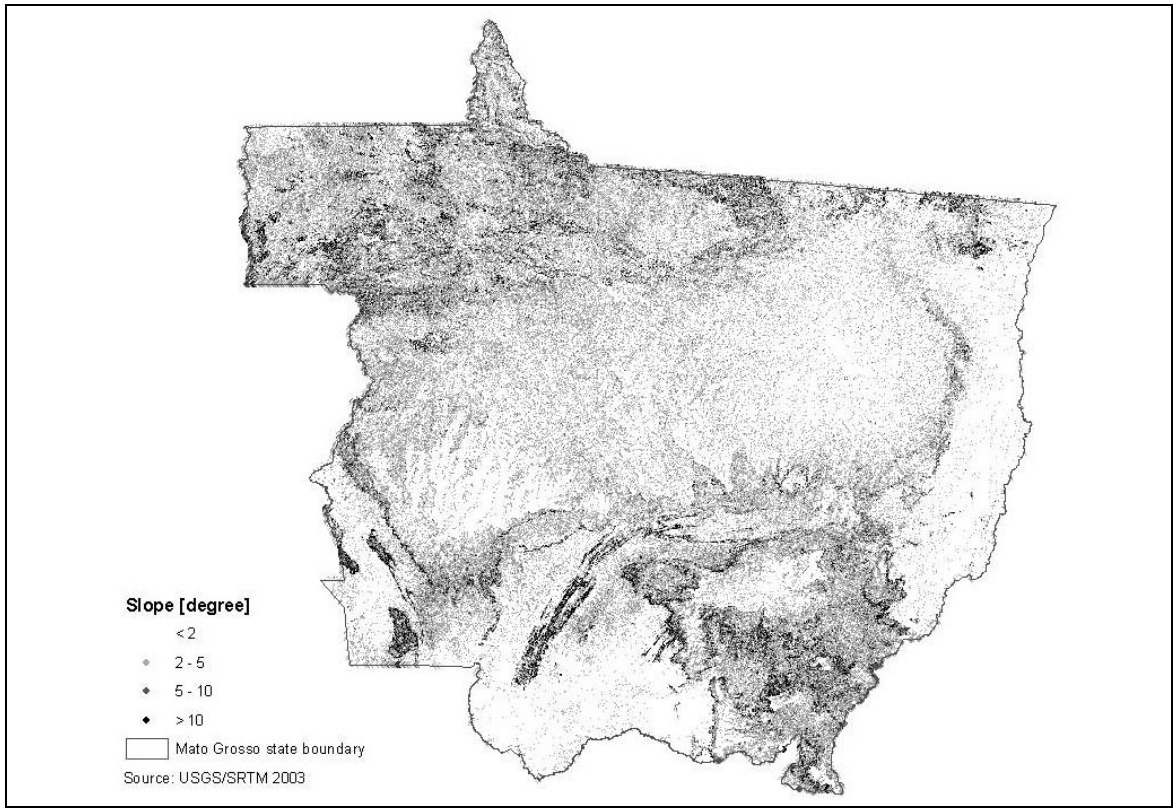
Map 12: Land use / land cover map



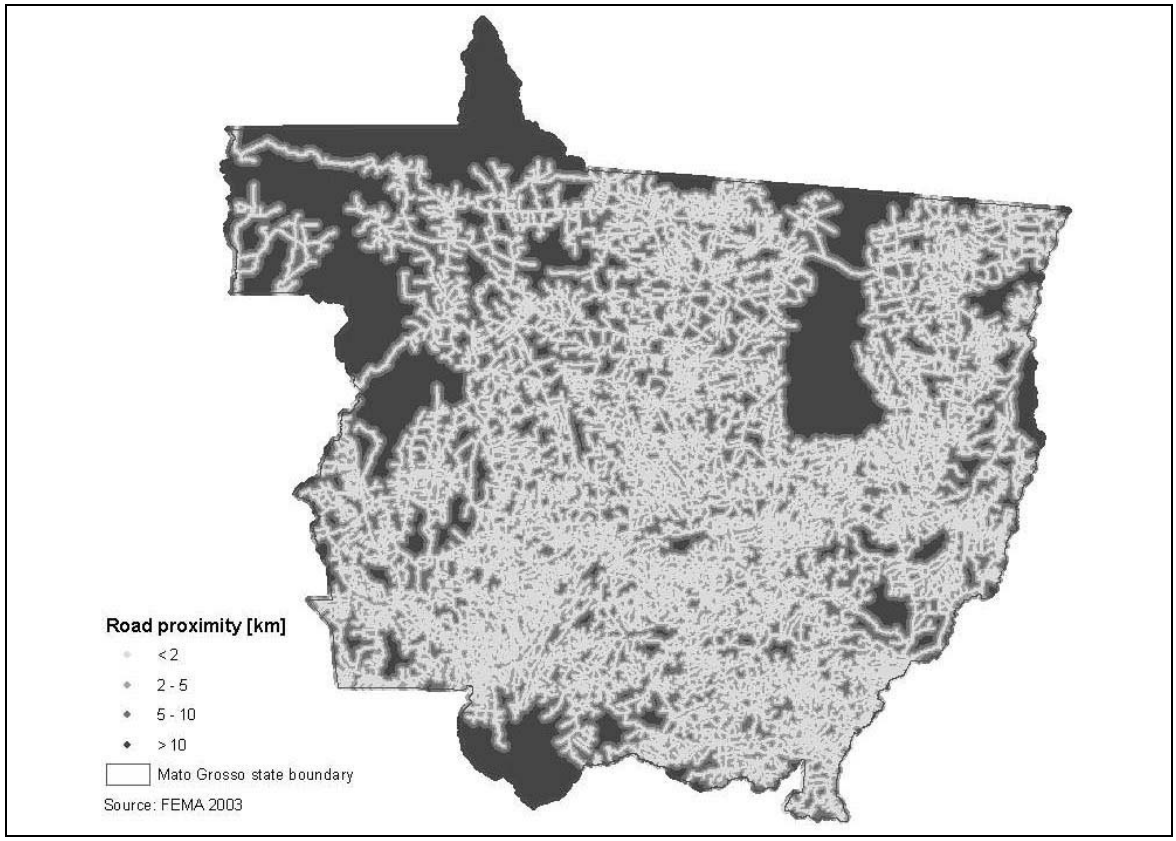
Map 13: High/low natural vegetation cover



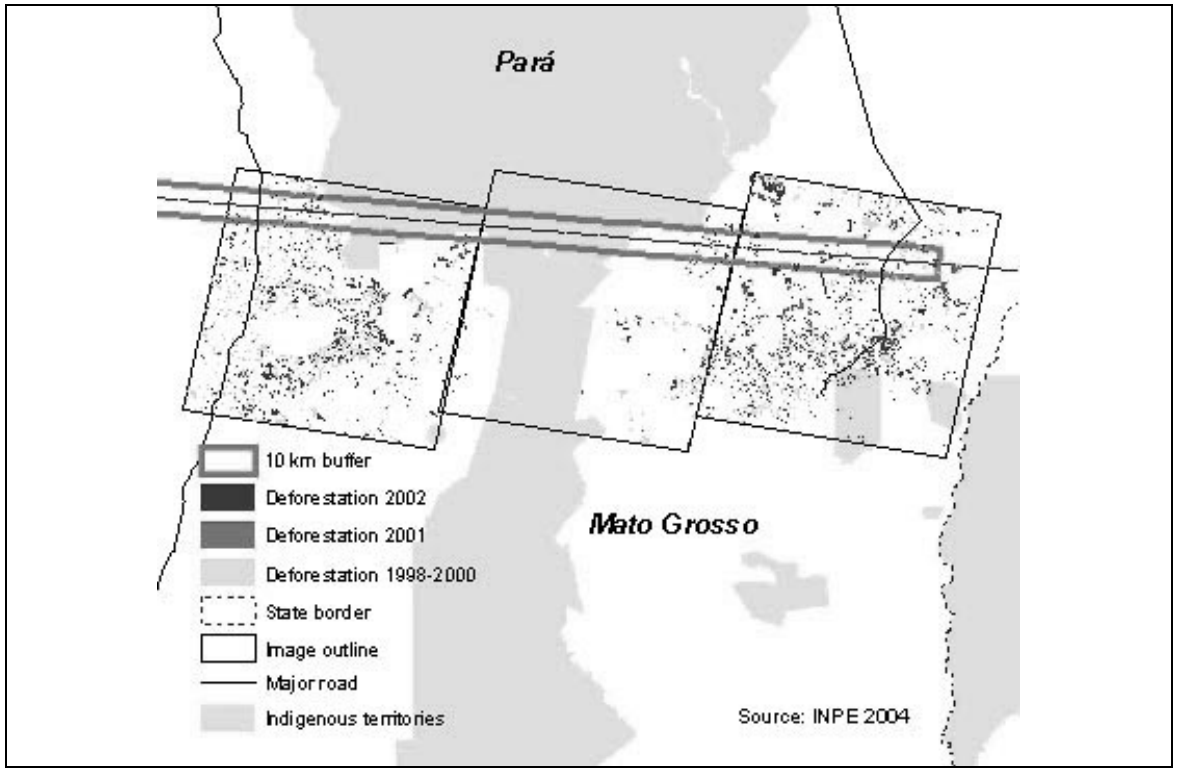
Map 14: Slope



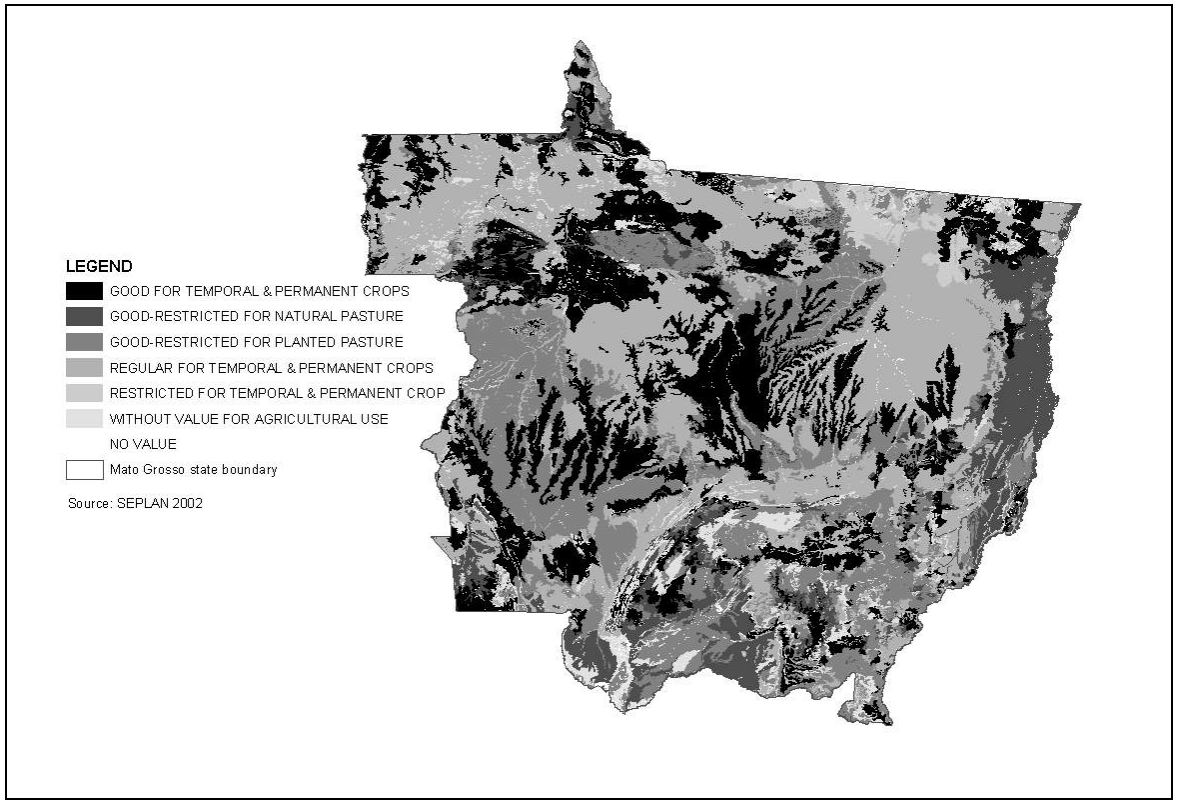
Map 15: Road proximity in Mato Grosso



Map 16: 10 km buffer from Mato Grosso – Pará state border



Map 17: Agricultural suitability



ANNEX II

Table 8: Summary statistics for probit regression on deforestation

Variable	Observation	Mean	Standard deviation	Min	Max
Deforestation					
Total deforestation	225210	0.024200	0.153669	0	1
Deforestation greater 200 hectares	225210	0.014684	0.120285	0	1
High/low natural vegetation cover (omitted "low")					
low cover	225210	0.092492	0.289719	0	1
high cover	225183	0.907498	0.289735	0	1
Inside/outside permanent preservation areas (omitted "outside")					
within permanent preservation areas (APP)	225210	0.073296	0.260622	0	1
within 300 m buffer around APP	225210	0.347729	0.476250	0	1
Ecoregions (omitted "Amazon")					
Transition	225183	0.165181	0.371345	0	1
Cerrado	225183	0.318696	0.465972	0	1
Road distance classes (omitted "0-2 km distance from roads")					
2-5 km distance from roads	225210	0.324160	0.468061	0	1
5-10 km distance from roads	225210	0.164389	0.370629	0	1
> 10 km distance from roads	225210	0.126065	0.331923	0	1
Slope categories (omitted "0-2 degree slope")					
2-5 degrees	225210	0.304312	0.460116	0	1
5-10 degrees	225210	0.069184	0.253768	0	1
> 10 degrees	225210	0.029524	0.169269	0	1
Agricultural suitability class (omitted "good, annual & perennial")					
Regular, annual & perennial	225066	0.351390	0.477406	0	1
Resticted, annual & perennial	225066	0.021087	0.143675	0	1
Possible for planted pasture	225066	0.226249	0.418403	0	1
Possible for natural pasture	225066	0.129780	0.336062	0	1
No agricultural value	225066	0.062164	0.241454	0	1
Year-dummies (omitted "year 1996-97")					
Year 1998-99	225210	0.252715	0.434570	0	1
Year 2000-01	225210	0.245562	0.430421	0	1
Year 2002	225210	0.240029	0.427102	0	1
Interaction variable permanent preservation areas (APP) & year-dummies (omitted "APP" & year 1996-97					
APP & year 1998-99	225210	0.018534	0.134872	0	1
APP & year 2000-01	225210	0.018174	0.133581	0	1
APP & year 2002	225210	0.017557	0.131335	0	1
Interaction variable road distance 0-2 km & year-dummies (omitted "0-2 km distance & year 1996-97")					
Road distance 0-2 km & year 1998-99	225210	0.098033	0.297360	0	1
Road distance 0-2 km & year 2000-01	225210	0.093388	0.290977	0	1
Road distance 0-2 km & year 2002	225210	0.090129	0.286367	0	1
Interaction variable low cover & year-dummies (omitted "low cover & year 1996-97")					
Low cover & year 1998-99	225210	0.023787	0.152384	0	1
Low cover & year 2000-01	225210	0.022099	0.147007	0	1
Low cover & year 2002	225210	0.021043	0.143527	0	1
Interaction variable low cover & road distance 0-2 km					
Low cover & road distance 0-2 km	225210	0.057355	0.232521	0	1
Enforcement dummy (high enforcement in 2000-01)					
High enforcement in 2000-01	225210	0.146299	0.353407	0	1
Interaction variable enforceement & year-dummies (omitted "enforcement & year 1996-97")					
Enforcement & year 1998-99	225210	0.036979	0.188710	0	1
Enforcement & year 2000-01	225210	0.035740	0.185642	0	1
Enforcement & year 2002	225210	0.035096	0.184023	0	1

Table 9: Results from probit regression on total deforestation

Probit regression for total deforestation within SEPLAN natural vegetation cover
(including APP interaction variable & enforcement dummies)

Number of observation:	225041
Pseudo R-squared:	0.0704
Likelihood Ratio Chi-squared:	3613.86

Variable	Parameter	Standard error	z	P|z|	[95% confidence intervall]	
High/low natural vegetation cover (omitted "low")						
high cover	-0.350923	0.036913	-9.51	0.0000	-0.423271	-0.278576
Inside/outside permanent preservation areas (omitted "outside")						
within permanent preservation areas (APP)	-0.206696	0.045904	-4.5	0.0000	-0.296667	-0.116725
within 300 m buffer around APP	-0.146679	0.013566	-10.81	0.0000	-0.173269	-0.120089
Ecoregions (omitted "Amazon")						
Transition	0.020845	0.017650	1.18	0.2380	-0.013749	0.055439
Cerrado	-0.040962	0.015665	-2.61	0.0090	-0.071666	-0.010259
Road distance classes (omitted "0-2 km distance from roads")						
2-5 km distance from roads	-0.338743	0.022718	-14.91	0.0000	-0.383270	-0.294216
5-10 km distance from roads	-0.538846	0.027045	-19.92	0.0000	-0.591854	-0.485838
> 10 km distance from roads	-1.094768	0.044025	-24.87	0.0000	-1.181055	-1.008482
Slope categories (omitted "0-2 degree slope")						
2-5 degrees	0.022816	0.013449	1.7	0.0900	-0.003544	0.049176
5-10 degrees	-0.026659	0.027088	-0.98	0.3250	-0.079751	0.026433
> 10 degrees	-0.225880	0.055048	-4.1	0.0000	-0.333772	-0.117988
Agricultural suitability class (omitted "good, annual & perennial")						
Regular, annual & perennial	-0.110407	0.014720	-7.5	0.0000	-0.139258	-0.081556
Resticted, annual & perennial	-0.097376	0.040440	-2.41	0.0160	-0.176636	-0.018116
Possible for planted pasture	-0.282881	0.018094	-15.63	0.0000	-0.318344	-0.247417
Possible for natural pasture	-0.424715	0.025597	-16.59	0.0000	-0.474883	-0.374547
No agricultural value	-0.587180	0.043637	-13.46	0.0000	-0.672707	-0.501653
Year-dummies (omitted "year 1996-97")						
Year 1998-99	-0.059638	0.025758	-2.32	0.0210	-0.110124	-0.009153
Year 2000-01	-0.021291	0.025765	-0.83	0.4090	-0.071790	0.029208
Year 2002	-0.160522	0.028037	-5.73	0.0000	-0.215473	-0.105571
Interaction variable permanent preservation areas (APP) & year-dummies (omitted "APP" & year 1996-97")						
APP & year 1998-99	-0.073980	0.069372	-1.07	0.2860	-0.209947	0.061987
APP & year 2000-01	-0.078882	0.074185	-1.06	0.2880	-0.224282	0.066518
APP & year 2002	-0.138083	0.087767	-1.57	0.1160	-0.310103	0.033936
Interaction variable road distance 0-2 km & year-dummies (omitted "0-2 km distance & year 1996-97")						
Road distance 0-2 km & year 1998-99	0.016587	0.031297	0.53	0.5960	-0.044754	0.077928
Road distance 0-2 km & year 2000-01	-0.224242	0.032836	-6.83	0.0000	-0.288600	-0.159885
Road distance 0-2 km & year 2002	-0.278775	0.036565	-7.62	0.0000	-0.350441	-0.207109
Interaction variable low cover & year-dummies (omitted "low cover & year 1996-97")						
Low cover & year 1998-99	-0.052178	0.041955	-1.24	0.2140	-0.134407	0.030052
Low cover & year 2000-01	-0.189497	0.047453	-3.99	0.0000	-0.282503	-0.096492
Low cover & year 2002	-0.146455	0.052794	-2.77	0.0060	-0.249929	-0.042980
Interaction variable low cover & road distance 0-2 km						
Low cover & road distance 0-2 km	-0.212143	0.035389	-5.99	0.0000	-0.281503	-0.142783
Enforcement dummy						
High enforcement in 2000-01	0.165540	0.027061	6.12	0.0000	0.112501	0.218579
Interaction variable enforceement & year-dummies (omitted "enforcement & year 1996-97")						
Enforcement & year 1998-99	-0.085847	0.040634	-2.11	0.0350	-0.165488	-0.006205
Enforcement & year 2000-01	-0.100181	0.043354	-2.31	0.0210	-0.185154	-0.015208
Enforcement & year 2002	-0.212650	0.050785	-4.19	0.0000	-0.312187	-0.113114
Constant	-1.074200	0.038666	-27.78	0.0000	-1.149984	-0.998417

Table 10: Magnitude of effects from probit regression on total deforestation

Magnitude of effects for probit regression on total deforestation within SEPLAN natural vegetation cover
(including interaction variable APP_year, enforcement dummies)

Number of observation:	225041
Pseudo R-squared:	0.0704
Likelihood Ratio Chi-squared:	3613.86

Variable: deforest	dF/dx	Standard error	z	P|z|	x-bar	95% confidence intervall	
High/low natural vegetation cover (omitted "low")							
high cover	-0.0200558	0.0027647	-9.51	0.0000	0.907466	-0.025474	-0.014637
Inside/outside permanent preservation areas (omitted "outside")							
within permanent preservation areas (APP)	-0.0072208	0.0013164	-4.5	0.0000	0.073084	-0.009801	-0.004641
within 300 m buffer around APP	-0.005893	0.0005238	-10.81	0.0000	0.347683	-0.006920	-0.004866
Ecoregions (omitted "Amazon")							
Transition	0.0008886	0.0007638	1.18	0.2380	0.165134	-0.000608	0.002386
Cerrado	-0.0016939	0.0006377	-2.61	0.0090	0.318480	-0.002944	-0.000444
Road distance classes (omitted "0-2 km distance from roads")							
2-5 km distance from roads	-0.0127416	0.0007905	-14.91	0.0000	0.324212	-0.014291	-0.011192
5-10 km distance from roads	-0.0159598	0.0005884	-19.92	0.0000	0.164428	-0.017113	-0.014807
> 10 km distance from roads	-0.0225896	0.0004382	-24.87	0.0000	0.125924	-0.023448	-0.021731
Slope categories (omitted "0-2 degree slope")							
2-5 degrees	0.0009675	0.0005756	1.7	0.0900	0.304465	-0.000161	0.002096
5-10 degrees	-0.0010928	0.0010836	-0.98	0.3250	0.069214	-0.003217	0.001031
> 10 degrees	-0.007593	0.0014431	-4.1	0.0000	0.029541	-0.010421	-0.004765
Agricultural suitability class (omitted "good, annual & perennial")							
Regular, annual & perennial	-0.0044862	0.0005810	-7.5	0.0000	0.351425	-0.005625	-0.003347
Resticted, annual & perennial	-0.0037061	0.0013887	-2.41	0.0160	0.021085	-0.006428	-0.000984
Possible for planted pasture	-0.0101795	0.0005660	-15.63	0.0000	0.226239	-0.011289	-0.009070
Possible for natural pasture	-0.0130188	0.0005693	-16.59	0.0000	0.129776	-0.014135	-0.011903
No agricultural value	-0.0147543	0.0005925	-13.46	0.0000	0.062122	-0.015916	-0.013593
Year-dummies (omitted "year 1996-97")							
Year 1998-99	-0.0024288	0.0010166	-2.32	0.0210	0.252701	-0.004421	-0.000436
Year 2000-01	-0.0008841	0.0010576	-0.83	0.4090	0.245600	-0.002957	0.001189
Year 2002	-0.0061899	0.0009892	-5.73	0.0000	0.240045	-0.008129	-0.004251
Interaction variable permanent preservation areas (APP) & year-dummies (omitted "APP" & year 1996-97")							
APP & year 1998-99	-0.0028817	0.0024989	-1.07	0.2860	0.018481	-0.007779	0.002016
APP & year 2000-01	-0.0030572	0.0026441	-1.06	0.2880	0.018148	-0.008240	0.002125
APP & year 2002	-0.0050392	0.0027531	-1.57	0.1160	0.017508	-0.010435	0.000357
Interaction variable road distance 0-2 km & year-dummies (omitted "0-2 km distance & year 1996-97")							
Road distance 0-2 km & year 1998-99	0.0007066	0.0013520	0.53	0.5960	0.098035	-0.001943	0.003357
Road distance 0-2 km & year 2000-01	-0.0077929	0.0009371	-6.83	0.0000	0.093427	-0.009630	-0.005956
Road distance 0-2 km & year 2002	-0.0092466	0.0009484	-7.62	0.0000	0.090130	-0.011105	-0.007388
Interaction variable low cover & year-dummies (omitted "low cover & year 1996-97")							
Low cover & year 1998-99	-0.0020792	0.0015845	-1.24	0.2140	0.023796	-0.005185	0.001026
Low cover & year 2000-01	-0.0065791	0.0013412	-3.99	0.0000	0.022116	-0.009208	-0.003950
Low cover & year 2002	-0.0053057	0.0016354	-2.77	0.0060	0.021054	-0.008511	-0.002100
Interaction variable low cover & road distance 0-2 km							
Low cover & road distance 0-2 km	-0.0073219	0.0009874	-5.99	0.0000	0.057376	-0.009257	-0.005387
Enforcement dummy							
High enforcement in 2000-01	0.0078883	0.0014561	6.12	0.0000	0.146400	0.005034	0.010742
Interaction variable enforceement & year-dummies (omitted "enforcement & year 1996-97")							
Enforcement & year 1998-99	-0.0033152	0.0014387	-2.11	0.0350	0.037002	-0.006135	-0.000495
Enforcement & year 2000-01	-0.0038142	0.0014904	-2.31	0.0210	0.035767	-0.006735	-0.000893
Enforcement & year 2002	-0.0072597	0.0013822	-4.19	0.0000	0.035118	-0.009969	-0.004551

obs. P: .0242178
pred.P: .0169256 (at x-bar)

Table 11: Results from probit regression for deforestation > 200 ha

Probit regression for deforestation > 200ha within SEPLAN natural vegetation cover
(including APP interaction variable & enforcement dummies)

Number of observation:	225041
Pseudo R-squared:	0.0815
Likelihood Ratio Chi-squared:	2809.78

Variable	Parameter	Standard error	z	P|z|	[95% confidence intervall]	
High/low natural vegetation cover (omitted "low")						
high cover	-0.1155775	0.0483974	-2.39	0.0170	-0.2104347	-0.0207202
Inside/outside permanent preservation areas (omitted "outside")						
within permanent preservation areas (APP)	-0.224906	0.053928	-4.17	0.0000	-0.3306029	-0.119209
within 300 m buffer around APP	-0.2024815	0.0169569	-11.94	0.0000	-0.2357165	-0.1692465
Ecoregions (omitted "Amazon")						
Transition	-0.0046941	0.0216195	-0.22	0.8280	-0.0470676	0.0376794
Cerrado	-0.017159	0.0185604	-0.92	0.3550	-0.0535367	0.0192188
Road distance classes (omitted "0-2 km distance from roads")						
2-5 km distance from roads	-0.3322056	0.0260834	-12.74	0.0000	-0.3833281	-0.2810832
5-10 km distance from roads	-0.5274178	0.0317489	-16.61	0.0000	-0.5896446	-0.4651911
> 10 km distance from roads	-1.058897	0.0548367	-19.31	0.0000	-1.166375	-0.9514193
Slope categories (omitted "0-2 degree slope")						
2-5 degrees	-0.1010289	0.0168459	-6	0.0000	-0.1340463	-0.0680115
5-10 degrees	-0.2013674	0.0374727	-5.37	0.0000	-0.2748126	-0.1279222
> 10 degrees	-0.2941566	0.0728333	-4.04	0.0000	-0.4369073	-0.1514059
Agricultural suitability class (omitted "good, annual & perennial")						
Regular, annual & perennial	-0.1094015	0.0174425	-6.27	0.0000	-0.1435882	-0.0752148
Resticted, annual & perennial	-0.2183107	0.053933	-4.05	0.0000	-0.3240176	-0.1126039
Possible for planted pasture	-0.3113072	0.0218369	-14.26	0.0000	-0.3541067	-0.2685077
Possible for natural pasture	-0.4782042	0.0314284	-15.22	0.0000	-0.5398028	-0.4166057
No agricultural value	-0.6750996	0.0622712	-10.84	0.0000	-0.797149	-0.5530503
Year-dummies (omitted "year 1996-97")						
Year 1998-99	-0.0800553	0.0302656	-2.65	0.0080	-0.1393747	-0.0207359
Year 2000-01	-0.1052856	0.031252	-3.37	0.0010	-0.1665384	-0.0440327
Year 2002	-0.2554189	0.0348802	-7.32	0.0000	-0.3237828	-0.187055
Interaction variable permanent preservation areas (APP) & year-dummies (omitted "APP" & year 1996-97")						
APP & year 1998-99	-0.1666518	0.0882045	-1.89	0.0590	-0.3395294	0.0062258
APP & year 2000-01	-0.2135669	0.1033177	-2.07	0.0390	-0.4160658	-0.011068
APP & year 2002	-0.007398	0.1050226	-0.07	0.9440	-0.2132385	0.1984425
Interaction variable road distance 0-2 km & year-dummies (omitted "0-2 km distance & year 1996-97")						
Road distance 0-2 km & year 1998-99	-0.0038485	0.0367159	-0.1	0.9170	-0.0758104	0.0681134
Road distance 0-2 km & year 2000-01	-0.2319962	0.0399103	-5.81	0.0000	-0.3102189	-0.1537735
Road distance 0-2 km & year 2002	-0.3063538	0.04607	-6.65	0.0000	-0.3966493	-0.2160583
Interaction variable low cover & year-dummies (omitted "low cover & year 1996-97")						
Low cover & year 1998-99	-0.0343003	0.0541098	-0.63	0.5260	-0.1403536	0.0717529
Low cover & year 2000-01	-0.0987368	0.0633896	-1.56	0.1190	-0.2229781	0.0255044
Low cover & year 2002	-0.1130698	0.0760062	-1.49	0.1370	-0.2620393	0.0358998
Interaction variable low cover & road distance 0-2 km						
Low cover & road distance 0-2 km	-0.1875496	0.0475088	-3.95	0.0000	-0.2806652	-0.0944339
Enforcement dummy						
High enforcement in 2000-01	0.2230833	0.0302184	7.38	0.0000	0.1638562	0.2823104
Interaction variable enforceement & year-dummies (omitted "enforcement & year 1996-97")						
Enforcement & year 1998-99	-0.1041633	0.0465781	-2.24	0.0250	-0.1954547	-0.0128719
Enforcement & year 2000-01	-0.1321294	0.0519795	-2.54	0.0110	-0.2340073	-0.0302514
Enforcement & year 2002	-0.260658	0.0644542	-4.04	0.0000	-0.3869858	-0.1343301
Constant	-1.397906	0.0502882	-27.8	0.0000	-1.496469	-1.299343

Table 12: Magnitude of effects from probit regression on deforestation > 200h

Magnitude of effects for probit regression deforestation > 200 ha within SEPLAN natural vegetation cover (including interaction variable APP_year, enforcement dummies)

Number of observation:	225041
Pseudo R-squared:	0.0815
Likelihood Ratio Chi-squared:	2809.78

Variable: deforest	dF/dx	Standard error	z	P|z|	x-bar	95% confidence intervall	
High/low natural vegetation cover (omitted "low")							
high cover	-0.0031867	0.0014866	-2.39	0.0170	0.907466	-0.0061	-0.000273
Inside/outside permanent preservation areas (omitted "outside")							
within permanent preservation areas (APP)	-0.0044443	0.0008419	-4.17	0.0000	0.073084	-0.006094	-0.002794
within 300 m buffer around APP	-0.0046739	0.0003727	-11.94	0.0000	0.347683	-0.005404	-0.003943
Ecoregions (omitted "Amazon")							
Transition	-0.0001152	0.0005287	-0.22	0.8280	0.165134	-0.001152	0.000921
Cerrado	-0.0004197	0.0004507	-0.92	0.3550	0.31848	-0.001303	0.000464
Road distance classes (omitted "0-2 km distance from roads")							
2-5 km distance from roads	-0.0072782	0.0005378	-12.74	0.0000	0.324212	-0.008332	-0.006224
5-10 km distance from roads	-0.0089582	0.0004075	-16.61	0.0000	0.164428	-0.009757	-0.008159
> 10 km distance from roads	-0.0124805	0.0003282	-19.31	0.0000	0.125924	-0.013124	-0.011837
Slope categories (omitted "0-2 degree slope")							
2-5 degrees	-0.0023801	0.0003817	-6	0.0000	0.304465	-0.003128	-0.001632
5-10 degrees	-0.0040618	0.0006108	-5.37	0.0000	0.069214	-0.005259	-0.002865
> 10 degrees	-0.0052766	0.0009067	-4.04	0.0000	0.029541	-0.007054	-0.003499
Agricultural suitability class (omitted "good, annual & perennial")							
Regular, annual & perennial	-0.0025998	0.0004028	-6.27	0.0000	0.351425	-0.003389	-0.00181
Resticted, annual & perennial	-0.0042221	0.0008	-4.05	0.0000	0.021085	-0.00579	-0.002654
Possible for planted pasture	-0.006376	0.0003866	-14.26	0.0000	0.226239	-0.007134	-0.005618
Possible for natural pasture	-0.008035	0.0003727	-15.22	0.0000	0.129776	-0.008765	-0.007304
No agricultural value	-0.0088456	0.0003847	-10.84	0.0000	0.062122	-0.0096	-0.008092
Year-dummies (omitted "year 1996-97")							
Year 1998-99	-0.0018844	0.0006803	-2.65	0.0080	0.252701	-0.003218	-0.000551
Year 2000-01	-0.0024397	0.0006806	-3.37	0.0010	0.2456	-0.003774	-0.001106
Year 2002	-0.0054401	0.0006405	-7.32	0.0000	0.240045	-0.006695	-0.004185
Interaction variable permanent preservation areas (APP) & year-dummies (omitted "APP" & year 1996-97")							
APP & year 1998-99	-0.0034063	0.0014708	-1.89	0.0590	0.018481	-0.006289	-0.000524
APP & year 2000-01	-0.0041453	0.0015345	-2.07	0.0390	0.018148	-0.007153	-0.001138
APP & year 2002	-0.0001808	0.0025443	-0.07	0.9440	0.017508	-0.005167	0.004806
Interaction variable road distance 0-2 km & year-dummies (omitted "0-2 km distance & year 1996-97")							
Road distance 0-2 km & year 1998-99	-0.0000945	0.0008981	-0.1	0.9170	0.098035	-0.001855	0.001666
Road distance 0-2 km & year 2000-01	-0.0046065	0.0006371	-5.81	0.0000	0.093427	-0.005855	-0.003358
Road distance 0-2 km & year 2002	-0.0056814	0.0006401	-6.65	0.0000	0.09013	-0.006936	-0.004427
Interaction variable low cover & year-dummies (omitted "low cover & year 1996-97")							
Low cover & year 1998-99	-0.0008133	0.0012339	-0.63	0.5260	0.023796	-0.003232	0.001605
Low cover & year 2000-01	-0.0021783	0.0012459	-1.56	0.1190	0.022116	-0.00462	0.000264
Low cover & year 2002	-0.0024544	0.0014435	-1.49	0.1370	0.021054	-0.005284	0.000375
Interaction variable low cover & road distance 0-2 km							
Low cover & road distance 0-2 km	-0.0038135	0.0007868	-3.95	0.0000	0.057376	-0.005356	-0.002271
Enforcement dummy							
High enforcement in 2000-01	0.0066582	0.0010839	7.38	0.0000	0.1464	0.004534	0.008783
Interaction variable enforceement & year-dummies (omitted "enforcement & year 1996-97")							
Enforcement & year 1998-99	-0.0022927	0.0009121	-2.24	0.0250	0.037002	-0.00408	-0.000505
Enforcement & year 2000-01	-0.0028215	0.0009554	-2.54	0.0110	0.035767	-0.004694	-0.000949
Enforcement & year 2002	-0.0048598	0.0008817	-4.04	0.0000	0.035118	-0.006588	-0.003132

obs. P: .0146951
pred.P: .0091409 (at x-bar)

ANNEX III

Table 13: Interview questions to stakeholders of the Mato Grosso SLAPR

Stakeholder	Affiliation/Name	Questions
FEMA	Decision-makers at FEMA until 2002	- What were the major factors allowing the implementation of the SLAPR? - What were the key conflicts during the implementation and why? - Was there any rivalty within FEMA divisions due to the SLAPR-success? - How was the implementation affected by the elections in 2002? - How was the implementation of the SLAPR financed, and how is it financed today? - What were the realized partnerships within the SLAPR and why were they realized? - How was your experience regarding the collaboration with a private company (TecnoMapas)? - Was/is the system effective in controlling deforestation? - How many processes have been sent to the Ministerio Publico? - Why did deforestation in 2003 increase? - In your view, what remains for improvement in the SLAPR?
	Decision-makers at FEMA since 200	- What is the role of the SLAPR in the context of environmental policy making in Mato Grosso? - What are the main difficulties in the execution of the SLAPR? - What are your plans with the SLAPR? - What are the current partnerships w/r to the SLAPR? - What are the experiences with the the Pacto Federativo and how did it change since 2000? - How many processes have been sent to the Ministerio Publico? How many are processed? - How are the plans to execute law enforcement in rural settlements (INCRA, INTERMAT)? - Which type of bank credits require a LAU? - What are the main difficulties in the execution of the SLAPR? - Why did deforestation in 2003 increase?
	Technical staff since 2003	- Is the RadamBrasil vegetation map sufficient to define local legal reserve requirements? - Is deforestation of secondary vegetation also monitored? - How do you monitor compliance with the APP and RL preservation? - How does FEMA react in cases of land ownership disputes? - How was your experience regarding the collaboration with a private company (TecnoMapas)? - How is the budget situation? How many people are working in this division? - How much time and money does it cost to get licensed? Can the LAU expire? - How are the penalities for environmental crimes? - How is the budget situation? How many people are working in this division? - What are the monitoring and control activities in the SLAPR? - In the monitoring and control activities - do you colaborate with IBAMA and Policia Ambiental? - Do you experience any resistance from landholders? - How are the plans to monitor deforestation in rural settlements? - In cases of non-compliance, how does FEMA react? - How many processes have been sent to the Ministerio Publico? How many are processed? - How is the budget situation? How many people are working in this division?
IBAMA	Decision-maker at IBAMA	- What is your opinion regarding the SLAPR? - What were the factors that lead to the implementation of the SLAPR? - Prior to the SLAPR - what land use activities must be licensed with IBAMA? - To your opinion - is the SLAPR effective? - Why did deforestation increase in 2003?
	Technical staff	- What is your opinion regarding the SLAPR? - What are the experiences with the the Pacto Federativo and how did it change since 2000? - How was/is the collaboration with FEMA?
State Attorney's Office	State Attorneys	- What is the role of the Ministerio Publico in the SLAPR? - when does the Ministerio Publico act - only after "denuncias"? - Is there any partnership between the Ministerio Publico and FEMA? - How many processes have been sent to the Ministerio Publico? How many are processed? - What opportunities do you see in the SLAPR? - What problems do you see with respect to the SLAPR? - Is the Ministerio Publico independent from the state administration? - Is last year's fraud accusation resolved? How should it be judged? - Is there any chance to modify the RL-requirement of the Medida Provisoria?

Continuation: Interview questions to stakeholders of the Mato Grosso SLAPR

Large-holders (FAMATO)	Representatives	- What is your opinion regarding the SLAPR? - What was the impact of the SLAPR to your organization? - Were you as largeholder representatives consulted in the decision of the Medida Provisoria? - Were largeholders informed about the objectives of the SLAPR? - Prior to the SLAPR - did largeholders need to license their land use activities? - How much time and money does it cost to get licensed? - Do you plan to use your legal reserve (forest management)? - Are the SLAPR penalities high compared to potential agricultural revenue from opening licensed legal reserves?
Public banks	BASA - Cuiaba Banco do Brasil - MT/RO Banco do Brasil - Sorriso	- What is your opinion regarding the SLAPR? - Since when is the LAU a credit requirement? - Which projects require a LAU? - Did the LAU-requirement present an obstacle for largeholders? - Do you monitor compliance?
INCRA INTERMAT	Technical Staff	- Is there any environmental assessment in the management of rural settlements? - Do you control deforestation in rural settlements? Is yes, how? - Is any of the rural settlement licesed at FEMA? - Do you know how much land is under federal/state responsibility in Mato Grosso?
Forest Engineers	Association of Forest Engineers Delta Consulting - Sorriso Irrigafertil Consulting - Sorriso	- What is your opinion regarding the SLAPR? - What is your role in the SLAPR? - How much time and money does it cost to establish a SLAPR complying project? - Do you monitor licensed properties afterwards? - How much does the clearing of Cerrado-Forest vegetation cost? - How much money can be received from selling timber and fire wood? - Do you suggest sustainable RL-use? - What remains to be improved in the Mato Grosso SLAPR ?
NGO's	Instituto Centro da Vida (ICV) ADERCO	- What is your opinion regarding the SLAPR? - Is the SLAPR effective? - What is your possibility to be the "public voice" - What are the main problems in the SLAPR in Mato Grosso?
International Donors	PPG7/SPRN-Cuiaba World Bank UNDP UNDP	- What is your opinion regarding the SLAPR? - Is the SLAPR effective? - Why did deforestation increase in 2003? - What are the main problems in the SLAPR in Mato Grosso? - What remains to be improved in the Mato Grosso SLAPR ?