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Deforestation Control in Mato Grosso: A New Model For Slowing the Loss of Brazil's Amazon Forest

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INTRODUCTION

Deforestation in Brazilian Amazonia continues to proceed at high rates, as it has since the early 1970s when key highways were built that provide access to the region from other parts of Brazil (1). Since 1988, Brazil's National Institute for Space Research (INPE) has, with only one exception, made annual estimates of deforestation in the region using LANDAT satellite imagery (2). The annual announcement of these results is frequently accompanied by announcements of new "packages" of control measures, especially when the deforestation rate turns upward. In the succeeding years, however, deforestation rate appears to increase or decrease largely independent of these measures. Macro-economic changes affecting investment decisions appear to have much stronger influence on regional deforestation trends than any federal control measures (3). Now, a state-level program to license and control deforestation in Mato Grosso (Fig. 1), which has long been one of the Amazonian states with the highest deforestation rates, provides an indication that this need not continue to be the case.

[Figure 1 here]

The experience in Mato Grosso takes on special importance in the context of Brazil's negotiating positions on the Kyoto Protocol. Brazil's negotiators have consistently opposed awarding credit for avoided deforestation, although they have supported credit for other forest-sector activities such as plantations. The fundamental reason is believed to be the fear among key individuals that accepting credit for avoided deforestation could expose Brazil to international pressures that would threaten the country's sovereignty over the region if Brazil were to take on commitments for emissions reductions that it subsequently was unable to meet (4, 5). The basic problem is a lack of confidence that deforestation can be controlled. From 1997 to 2000 deforestation rates in the Legal Amazon continually crept upward. The events in Mato Grosso suggest that government measures are capable of influencing deforestation, and the process is not inherently uncontrollable. This is a potentially important development for negotiations to begin in 2005 regarding the future of the Protocol after its first commitment period ends in 2012.

THE MATO GROSSO LICENSING AND CONTROL SYSTEM

The Mato Grosso's State Foundation for the Environment (FEMA) has been implementing a program to license and control deforestation since 1999 (6). Mato Grosso is in the process of bringing landowners into compliance with existing legislation, such as Brazil's "Forestry Code." Shortcomings of the Forestry Code for conservation purposes are well known, but efforts to improve it are complicated by intense pressure from farming and ranching lobbies to weaken environmental protection (7, 8). The long traditions of impunity and of government inability to enforce any set of regulations in practice (9) make demonstration of enforcement effectiveness especially important in the process of bringing Amazonian development under the rule of law.

Since 2000, federal requirements specify that the "legal reserve" of native vegetation that must be maintained in each property (or in registered lands elsewhere) equal to 80% of the property in forest and 35% in *cerrado* (central Brazilian savanna) areas. A Mato Grosso state government decision specifies 50% in the "transition" area—the ecotone between the forest and the *cerrado*. The *cerrado* is located in the southern part of the state, the forest in the north, and the transition in the center. Clearing of forest and transition are considered to be "deforestation" by INPE, while clearing of is *cerrado* not. INPE terminology is adopted in the present paper.

Prior to field campaigns, illegal clearings are identified on satellite imagery, after which technicians are sent to inspect specific clearings. LANDSAT-TM imagery in digital form is interpreted manually (the image is magnified on a computer screen, and a cursor traced over the features), allowing detection of clearings as small as 1 ha. Using a global positioning system (GPS), the FEMA technicians are able to locate the clearing and the property headquarters in the field (Fig. 2). Public Internet access to information on registered properties and their owners, including identification of violators, is a new addition to the system. The site (10) lists properties without infractions in blue and violators in red. "Clicking" on a property in the list brings up the personal information on the owner and a map of the property, showing the legal reserve, area of permanent protection (stream banks and steep slopes), and legal and illegal clearings.

[Fig. 2 here]

The responsibility for licensing clearing is divided between FEMA and the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) based on an agreement known as the "federative pact," under which FEMA licenses clearings over 200 ha, while IBAMA licenses smaller clearings. Most clearing in Mato Grosso has been illegal so far. Only 40 000 ha in clearings > 200 ha in area was authorized by FEMA in 2000-2001. The illegal clearing can therefore be calculated by subtracting this area from the > 200 ha total (789 004 ha in the biennium). Illegal clearings > 200 ha in area therefore total approximately 750 000 ha, or 95%.

The sizes of clearings provide an important indication of the relative importance of small *versus* large landholders. Only 36% of the area cleared in the 2000-2001 biennium was in clearings up to 100 ha, while 64% was clearings larger than 100 ha. Most of the clearings under 100 ha in area also represent the work of large landholders, as small farmers using family labor clear an average of only about 3 ha family^{-1} yr^{-1} (11). Clearings 1-6.25 ha in area represented only 2% of the total area of new clearing detected in 2000-2001. The dominant role of large clearings is critical in making it possible to significantly reduce deforestation rates without affecting poor farmers who depend on subsistence agriculture for survival (12).

INDICATIONS OF PROGRAM EFFECTS ON DEFORESTATION

Deforestation (forest and transition clearing) in Mato Grosso can be compared to that in the rest of the Legal Amazon region through 2000, based on INPE estimates (13). The state-level data indicate that Mato Grosso was following or exceeding the general trends in the region through 1999. During the following year (2000), deforestation declined in Mato Grosso while it increased in the rest of the Legal Amazon (Fig. 3), providing an indication that the program was having an effect.

[Fig. 3 here]

According to the FEMA data, the rate of deforestation in Mato Grosso in forest and transition areas declined by 35% in the 2000-2001 biennium relative to the rate in the 1998-1999 biennium (1999 marks the beginning of the licensing program). However, prior to 1999 the rate was either already declining (according to FEMA data, Fig. 4) or beginning to increase less steeply (according to INPE data, Fig.3). The difference between INPE (Fig. 3) and FEMA (Fig. 4) data for the period before 1999 is unexplained: INPE indicates a 13.7% increase in deforestation (forest + transition clearing) from 591×10^3 ha yr^{-1} in the 1996-1997 biennium to 671×10^3 ha yr^{-1} in 1998-1999, whereas FEMA finds a 17.1% decrease from 770×10^3 ha yr^{-1} to 638×10^3 ha yr^{-1} between the same periods. However, the downturn after 1999 is indicated by both agencies. The decline or slackening of deforestation prior to 1999 stems from exhaustion of available land for clearing in some parts of the state, while at least part of the additional decline after 1999 appears to reflect the licensing and control program.

[Fig. 4 here]

The annual rate of loss of original vegetation in Mato Grosso, based on FEMA data, indicates declines varying by vegetation type (Fig. 4). Both the rate of loss of forest and transition (i.e., deforestation) and the rate of *cerrado* clearing declined throughout the period, according to the FEMA data. In the case of *cerrado*, the decline is less steep in the second biennium (i.e., after the licensing system began), possibly because most of the land in *cerrado* areas without agricultural impediments, such as steep slopes, had already been cleared. In the case of forest and transition, the decline is steeper in the second biennium, consistent with an effect from the program.

The sharpest downturn was in the transition zone, where the rate declined by 43.7% for the 2000-2001 biennium as compared to 1998-1999; this corresponds to the zone in the middle of the state that received the most enforcement effort. By contrast the *cerrado*, located in the southern part of the state, had a downturn in clearing rate of 32.7%, while the forest zone in the far north had a downturn of 31.9%. The greater decline in the transition area as compared to the forest appears to be best explained by the level of enforcement, while the contrast of these areas with the *cerrado* probably results from frontier age.

Trends at the county level reveal differences depending on the predominant land use and the age of the frontier. In old soybean areas (e.g., Fig. 5a, where 75.3% of the county

had been cleared by 2001), the exhaustion of forest areas suitable for clearing was already causing clearing rates to decline before the 1999 initiation of the licensing program. Following beginning of the program, clearing continued at its (relatively) low plateau. In contrast, in a newer soybean frontier (Fig. 5b), with 32.8% of the county cleared by 2001, clearing rates were increasing strongly prior to the program, but the trend reversed thereafter.

[Fig. 5 here]

In old ranching areas, (e.g., Fig. 5c, where 72.2% of the county had been cleared by 2001), clearing rates were declining prior to 1999 and continued the same declining trend thereafter. In new ranching areas (e.g., Fig. 5d, where 5.1% of the county had been cleared), clearing rates were increasing prior to initiation of the program, and the trend reversed thereafter. As with the soybean areas, the reversal is suggestive of an effect from the control program.

County-level trends in settlement areas also indicate reversals in newer areas, although the effect is likely to be due to larger ranches located in the same counties. In an old area of small-farmer settlements (Fig. 5e), where 38.4% of the county had been cleared by 2001, the rate of loss was declining prior to 1999 and continued the same declining trend thereafter. In a newer settlement frontier (Fig. 5f), with 16.6% of the county cleared by 2001, clearing rates were increasing prior to initiation of the program in 1999, and the trend reversed thereafter.

Trends in counties with contrasting levels of enforcement effort also indicate an effect of the program. In an area where virtually no enforcement was carried out through 2001 (Fig. 5g, 20.1% cleared by 2001), clearing rates were declining prior to initiation of the program in 1999, but the decline did not continue at the same rate thereafter. In an area with a high level of enforcement effort (Fig. 5h, 44.5% cleared by 2001), clearing was declining slightly prior to 1999, but the decline increased sharply after initiation of the enforcement program.

EXTENSION TO OTHER STATES

On 26 February 2002, Brazil's minister of the environment announced that a "system of licensing of rural properties" would be extended to all of Amazonia based on the experience in the Mato Grosso. Important differences are evident among the states as to official commitment to reducing deforestation. Acre and, until recently, Amapá have had a reputation for being the states that give greatest priority to the environment, while Maranhão, Rondônia and Roraima give the least. At the local (county) level, some mayors have adopted governance policies that could act to complement state and federal efforts (13). In any state, this priority can change radically as different governors come and go. One way to provide protection of the system against unfavorable state governments would be to have a federal center in Brasilia, such as IBAMA or some other part of the Ministry of the Environment, process the data on clearing and/or maintain a mirror image of the data

base from the state-level agencies. This would help to reduce some of the differences among states and among gubernatorial administrations within any given state.

In Brazil's October 2002 elections, Blairo Maggi, the largest soybean entrepreneur in Brazil (and probably in the world), was elected governor of Mato Grosso for the 2003-2006 period. While this change is likely to result in a weakening or loss of political commitment to the environmental licensing program at the state level in Mato Grosso, federal authorities and the judicial system continue to have responsibility for enforcement of environmental laws throughout Brazil, including Mato Grosso. Regardless of the fate of the licensing system in Mato Grosso, its demonstration of the ability of government to limit deforestation has important implications for all of Amazonia.

CONCLUSIONS

The trends in Mato Grosso suggest an effect of licensing and control in reducing clearing rates. Together with programs to enhance the attractiveness of activities that maintain forest cover, including tapping the value of the environmental services of standing forest, licensing and control programs are essential to the government's ability to redirect development in the region along more sustainable and less environmentally damaging lines. While deforestation in Brazil's Amazon region is by no means "under control," the events in Mato Grosso show that government action is capable of slowing forest loss (14).

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FIGURE LEGENDS

Figure 1 The nine states in Brazil's 5×10^6 km^2 "Legal Amazon" region.

Figure 2 FEMA technicians examine satellite image (left) and deforestation permit (right) in the field on an inspection mission in Ipiranga do Norte County. The pink areas in the satellite image are cleared fields (mostly soybeans), the green is forest and the brown areas to which the technicians are pointing are recent clearings. The man at the left is pointing to a legal clearing authorized by the deforestation permit being held by the man at the right (the yellow line indicates authorized clearing and the white line the "legal reserve"). The man at the back is pointing to a clearing in a neighboring property with no FEMA permit. (Photo by P.M. Fearnside).

Figure 3 Deforestation (clearing of forest and transition) in Mato Grosso (♦) compared to the rest of the Legal Amazon region (□) based on INPE (2) estimates.

Figure 4 Annual rate of loss of original vegetation in Mato Grosso, based on FEMA data. Both the rate of loss of forest (□) and transition (□)(i.e., deforestation) and the rate of *cerrado* clearing (□) declined throughout the period. Because clearing rates were already declining since before the beginning of the program in 1999, examination of smaller areas is needed to separate program effects from those of frontier aging.

Figure 5 County-level trends in loss of original vegetation in areas with different land-use types, frontier ages and enforcement histories: **a** Rondonópolis, an old soybean frontier; **b** Ipiranga do Norte, a new soybean frontier; **c** Colider, an old ranching frontier; **d** Aripuanã, a new ranching frontier; **e** Alta Floresta, an old small-farmer settlement frontier (also including some large ranches); **f** Juruena, a new small-farmer settlement frontier (also including some large ranches); **g** Cáceres an area with a low level of enforcement effort, and **h** Sinop, an area with a high level of enforcement effort.

ABSTRACT

Controlling deforestation in Brazil's Amazon region has long been illusive despite repeated efforts of government authorities to slow the process. From 1997 to 2000, deforestation rates in Brazil's nine-state "Legal Amazon" region continually crept upward. Now, a licensing and enforcement program for clearing by large farmers and ranchers in the state of Mato Grosso appears to be having an effect. The deforestation rate in Mato Grosso was already beginning to slacken before initiation of the program in 1999, but examination of county-level data suggests that deforestation in already heavily cleared areas was falling due to lack of suitable uncleared land, while little-cleared areas were experiencing rapid deforestation. Following initiation of the program, the clearing rates declined in the recent frontiers. Areas with greater enforcement effort also appear to have experienced greater declines. Demonstration of government ability to enforce regulations and influence trends is important to domestic and international debates regarding use of avoided deforestation to mitigate global warming.

BIOGRAPHY

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Fig. 1


BRAZIL
RORAIMA
AMAPÁ
AMAZONAS
PARÁ
MARANHÃO
ACRE
RONDÔNIA
MATO
GROSSO
TOCANTINS
0 100 200 300 km

Fig. 2

Fig. 3

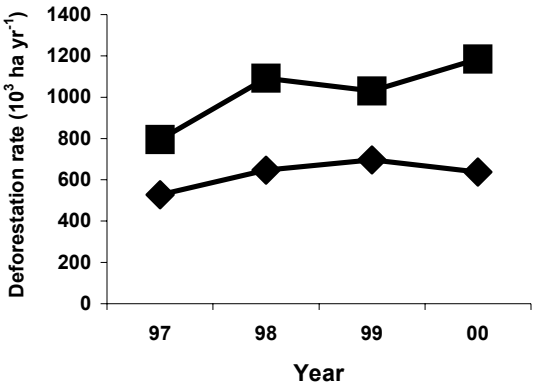

Deforestation rate (10^3 ha yr^{-1})
1400
1200
1000
800
600
400
200
0
97
98
99
00
Year

Fig. 4

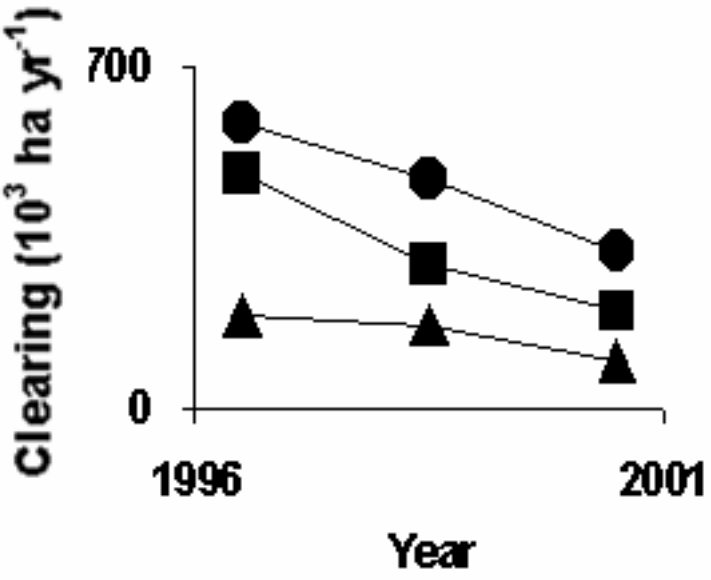
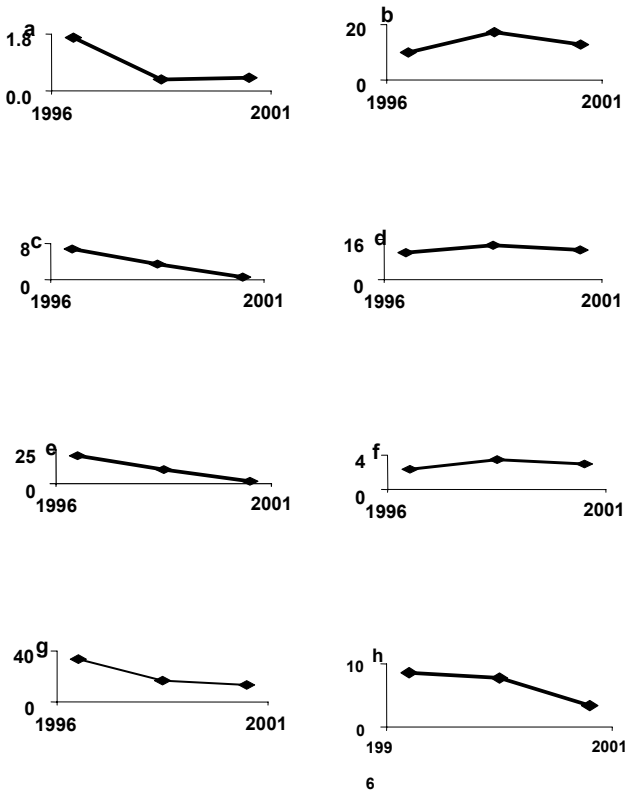


Fig. 5


a
1.8
0.0
1996
2001
b
20
0
1996
2001
c
8
0
1996
2001
d
16
0
1996
2001
e
25
0
1996
2001
f
4
0
1996
2001
g
40
0
1996
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h
10
0
199
6
2001
Year