Will cattle ranching continue to drive deforestation in the Brazilian Amazon?

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Abstract

Deforestation in the Amazon has expanded since the Brazilian government began promoting the occupation of the region in the late 1960's. Since the late 1970's Brazil has enacted policies against deforestation with mixed results. By 2008, 15% of the original forest had been cleared. The debate about climate change, however, has facilitated policies and market pressures against deforestation. Cattle ranching, which accounts for about 75% of the area deforested, has been a major target of policies that have helped to reduce the deforestation rate by 45% in 2009 in comparison to 2008. Is this situation sustainable or is deforestation likely to rebound due to growing food demand? We used the scenario method to consider this question.

We projected three possible scenarios considering predominant trends such as concerns about climate change and about the negative impacts of environmental law enforcement on the livelihoods of small landholders and outcomes of critical uncertainties such as changes in forest and environmental laws, payment for avoided deforestation, level of concentration and informality of the meatpacking industry. In the low deforestation scenario, pressure and incentives for forest conservation from market and public policies would be consistent. In a scenario with medium deforestation, there would be no significant change in the Forest Code and the government would continue command and control policies mostly against large landholdings. However, neither the government nor the market would provide incentives for environmental compliance. Legal deforestation could grow throughout areas made accessible by new transport infrastructure. The high deforestation scenario would be similar to that of medium deforestation, with the exception that Congress and the courts would reduce forest protection by changing laws and reducing protected areas. We conclude with considerations of how the understanding of these scenarios could help in combining market and public policies favorable to reach near zero deforestation.

Keywords: Deforestation; Amazon; Brazil; Cattle Ranching; Forest Law; Climate Change

Introduction

Deforestation in the Amazon has expanded since the Brazilian government began promoting the occupation of the region in the late 1960's. By 2009, about 740,000 km^2 had been cleared (INPE, 2010) corresponding to about 15% of the original forest (IBGE, 2010). Cattle ranching has been the main driver of deforestation accounting for about 75% of the area deforested (Barreto, Pereira, & Arima, 2008 using data from IBGE, 2010). From 1990 to 2008, the cattle herd grew from 25.7 million to nearly 71.5 million head (a jump from 18% to 35% of the total Brazilian herd[2]).

The expansion of deforestation and social conflicts related to occupation of the Amazon became focus of academic research and made headlines despite the fact that a military dictatorship had initiated the occupation plans (Goodland & Irwin, 1974; Denevan, 1973; Mahar, 1989; Ledec, 1985; Veja, 1989). For example by 1979, the Brazilian Senate had initiated an investigation into "Amazon devastation and its implications" (Brasil, 1982). To deal with such concerns, the Brazilian Government had been enacting policies against deforestation since 1965. Nevertheless, deforestation continued largely ungoverned due to market forces, poor policy design and insufficient implementation (Brasil, 1982; Mahar, 1989; Brito, 2009; Greenpeace, 2008). From 2008 to 2009, however, a combination of government policies and environmental campaigns has led deforestation to fall by 45%, resulting in the lowest absolute rate (7,465 km^2) since annual monitoring began in 1988[3]. Cattle ranching have been a major target of such policies (Barreto, Pereira, & Arima, 2008; Barreto & Silva, 2009).

The reaction to such policies has also been strong, including proposals to reduce the legal protection of forests. Therefore, those concerned with the future of the Amazon have to ask: is the decline of deforestation sustainable or is deforestation likely to rebound? We used the scenario method to consider this question for the next five years. The plausible scenarios are the result of the interaction between trends that are well-established (predominant trends) and critical factors that are uncertain (VanDerHeijden, 2005).

In order to determine what are the predominant trends and critical factors that will shape deforestation in the future, it is essential to understand the history of market, policy and other factors in favor and against deforestation. Therefore, we begin the paper with a review of the history of deforestation in the Amazon. In the following section, we describe the predominant trends, the critical uncertainties and then the likely scenarios. We conclude with considerations of how the understanding about these scenarios could help in creating market and public policies to reach near zero deforestation.

The history of deforestation in the Amazon

Since the late 1960´s, deforestation rates have varied sharply due to policy and market changes. Initially, public policies predominantly favored deforestation as part of a grand geopolitical objective: occupying the Amazon to keep out alleged international interests. Later on there was a mix of policies in favor and against deforestation. Only recently, the government has applied more consistent and comprehensive policies against deforestation once cutting forests became perceived as wasteful, connected with serious environmental risks and a barrier to other economic opportunities such as the expansion of ethanol exports. Below we will present this historic evolution.

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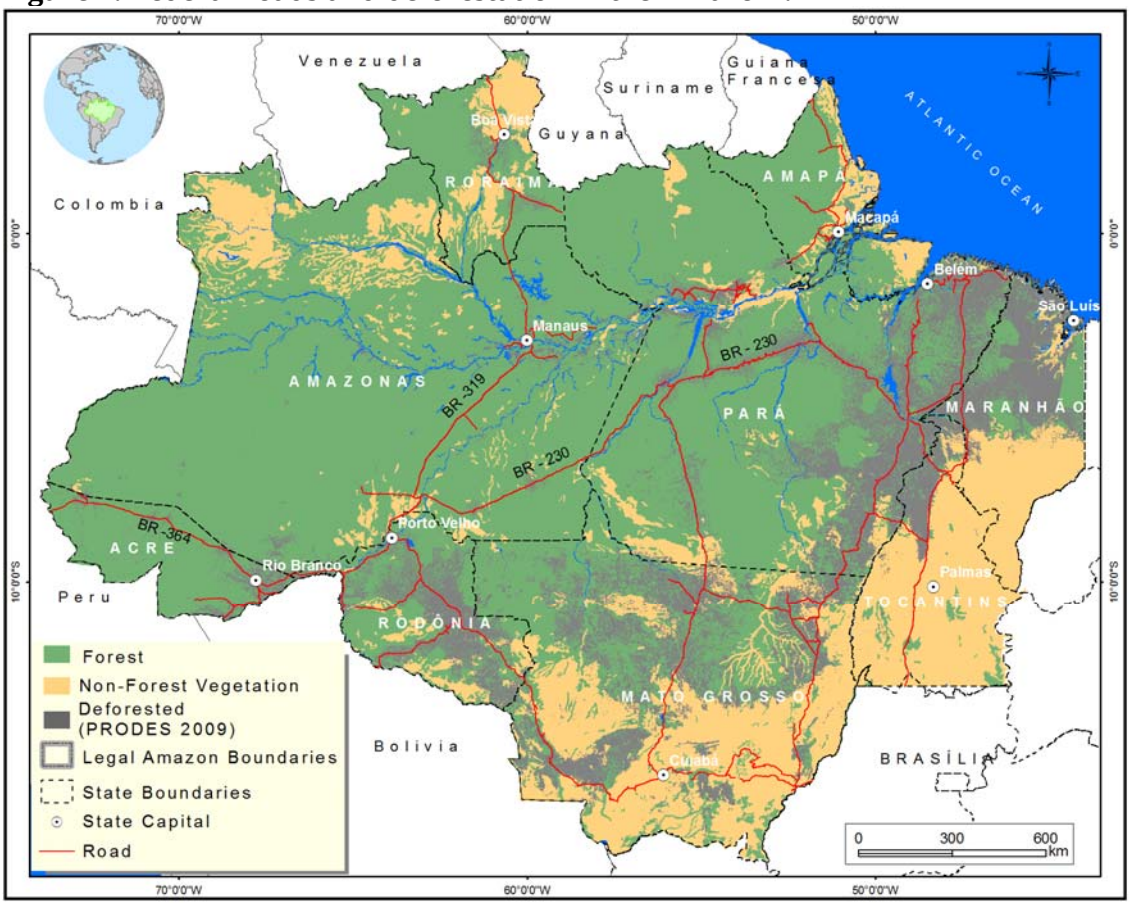
[2] *Estimates based on data from the Brazilian Statistics Bureau (IBGE, 2010)*

[3] *Deforestation data from INPE (2010).*

Policies to occupy the Amazon and deforestation

From the late 1960´s to the early 1980´s deforestation resulted mostly from public policies aimed at occupying the region, including opening roads (Figure 1), concession of rural credit, and tax incentives to agricultural development (Andersen, 1996; Mahar 1989). The government created colonization projects where colonists were promised to receive land titles if they demonstrated that they were effectively using the area (i.e., clearing the land). These incentives also attracted "spontaneous" immigrants from other regions of Brazil. Moreover, the government hired companies to conducted private colonization projects (Oliveira, 2005).

Figure 1. Federal roads and deforestation in the Amazon[4].



By this period, Brazil already had rules to limit deforestation, but they were largely ignored (Brasil, 1982). Since 1965, the Forest Code had established that landowners should maintain at least 50% of each property in the Amazon covered with native vegetation (that is the legal reserve). They could harvest products from the legal reserve, but could not clear it. Moreover, in 1979 the agency responsible for providing fiscal incentives for cattle ranching in the Amazon (SUDAM – Superintendência de Desenvolvimento da Amazônia), promised not to support projects in forested areas. SUDAM was supposed to use satellite images to verify if the proposed areas for

[4] *Map prepared by Rodney Salomão from IMAZON´s geoprocessing laboratory. Sources of information: Vegetation map is from IBGE (The Brazilian Statistics Institute). The area deforested is from INPE. The Legal Amazon is an administrative unit created by the federal government that includes the Amazon Biome and part of the Cerrado (Brazilian savanna). Part of the Cerrado has also been deforested, but researchers are still refining the methods to map the area deforested (See example by Ferreira et al (2007)).*

ranching project were still forested (Mahar, 1989). This was, however, one more rule to be ignored (Mahar, 1989). However, even if the Forest Code had been enforced, they would have been unlikely to change behavior because the penalties for environmental violations were very small – for example, the maximum fine was equivalent to about US $ 3,000.

The continuation of deforestation and associated conflicts led Brazil to initiate other policies against deforestation in the late 1980's and early 1990's. Conflicts abounded because government-funded or spontaneous immigrants occupied or tried to occupy areas informally belonging to indigenous peoples and traditional forest dwellers such as rubber tappers and Brazil nut collectors. In December 1988, the assassination of the rubber tapper leader Chico Mendes by a rancher intensified media coverage about deforestation and social conflicts in the region (Veja, 1989). Additionally, in early 1989, a World Bank report (Mahar, 1989) estimated that the area deforested (nearly 600,000 km^2) was equivalent to 12% of the Legal Amazon, indicating an astonishing deforestation rate since the military government programs had begun. The report proposed that in order to reduce deforestation the government should abolish fiscal incentives and that the land agency (INCRA) should stop regarding land clearing as the sole evidence of land use (Mahar, 1989).

The government reacted first by establishing a 90-days moratorium on the approval of new financial incentives for deforestation during 1988 (Brasil 1988). In 1989, the National Institute for Space Research (INPE) launched a program (PRODES) to monitor deforestation yearly in order to contest the World Bank report (INPE, 1989). The first estimate by PRODES (251,429 km^2) was 58% smaller than the area estimated by the World Bank.[5] Later on, INPE became well respected for its monitoring of the yearly deforestation rates (See Box 1). Despite the controversies surrounding the area deforested, in 1991 the Brazilian President enacted an executive order (Brasil 1991) ending fiscal incentives for deforestation. Moreover, the World Bank pressed State Governments (Mato Grosso and Rondônia) in the Amazon to create Conservation Units to mitigate the effect of development projects (including road paving) that it had funded since the 1980's (Fox & Brown, 1998; Pedlowski, Dale, & Eraldo, 1999). The World Bank adopted this type of conditionality after being heavily criticized for the environmental impacts of its projects in the region. By that time, however, the beneficiaries of occupation policies (immigrants, receivers of subsidies, politicians and government officials) had already gained enough political power and counterattacked. As a result, the government maintained old policies (land distribution) and created new ones[6] that favored deforestation (Prates, 2008; Silva, 2009).

. Moreover, public officials ignored or tried to impede new policies. For example, in Rondônia State INCRA continued considering deforestation as a key criteria for titling land and creating settlements in areas that were to be allocated for the creation of protected areas according to the Economic Ecological Zoning aproved by the State Assembly (Pedlowski, Dale, & Eraldo, 1999) .

[5] *See the controversies about the numbers at http://laudascriticas.wordpress.com/dossie-maquiagem-amazonia/*

[6] *In 1988, the Congress created Constitutional Funds (Brasil, 1988) that allocates subsidized credit to the Amazon.*

Box 1. The systems for monitoring deforestation in the Brazilian Amazon

Brazil possesses one of the most advanced forest monitoring system, named lead by the National Institute for Space Research (INPE – *Instituto Nacional de Pesquisas Espaciais*) (Kintisch, 2007). Deforestation is being monitored at two scales. First, at detailed scales, forest clearings greater than 6.25 hectares is being monitored using Landsat imagery (PRODES program). PRODES (INPE, 2010) is operational since 1988 and produces annual estimates of deforestation rates for the Brazilian Amazon (Figure 1). In 2004, INPE launched DETER (Detecção de Desmatamento em Tempo Real) based on MODIS imagery to detect monthly deforestation greater than 25 hectares (INPE).

In addition to the governmental monitoring system, IMAZON – a private research institute based in Belém – developed an independent Deforestation Alert System (SAD – *Sistema de Alerta de Desmatamento*) for the Brazilian Amazon (Hayashi *et al*, 2010) to foster transparency in the government and private sectors. SAD is also based on MODIS imagery and detects deforestation alerts greater than 12.5 hectares. This system is operational in the Brazilian Amazon since April 2008, but was tested originally in the State of Mato Grosso since September 2006. In addition to report deforestation statistics, Imazon presents detailed spatial analyses of deforestation in Protected Areas, by States and the critical municipalities that most contribute to deforestation. More recently, SAD also reports committed carbon emissions associated with deforestation.

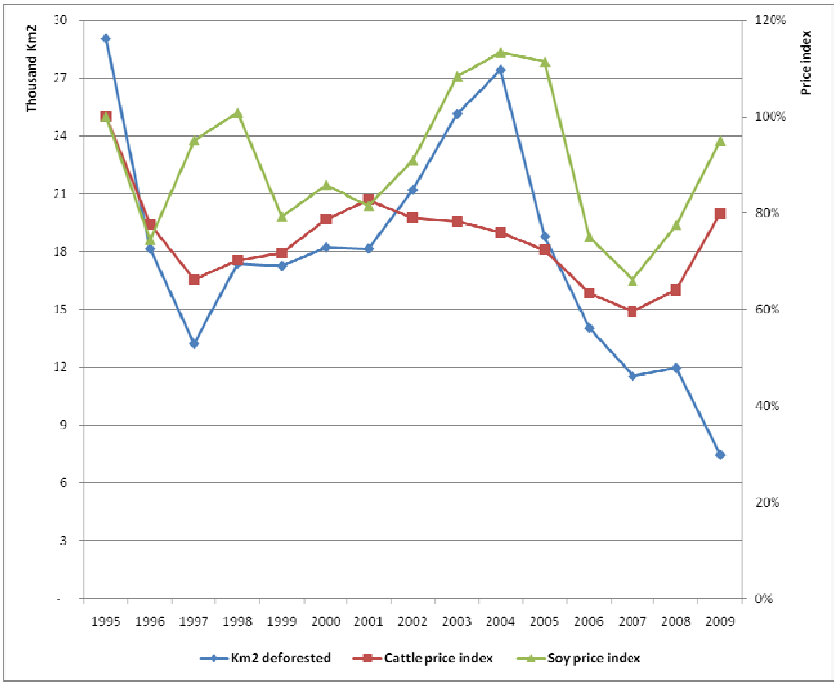
With continuing government support for land occupation and subsidized rural credit, deforestation rates continued relatively high in the following years, but varied strongly according to the variation of agricultural commodities prices (Figure 2). For example, deforestation declined an average of 19% per year between 1989 e 1991 due to a recession that stimulated a reduction of cattle prices. On the other hand, deforestation peaked in 1995 (29,000 km^2) after the price of cattle increased suddenly due to a new economic plan in February 1994[7] that increased the purchasing power of Brazilians.

The international demand for agricultural products also influenced the rates of deforestation once investments in infrastructure had integrated the region with international markets. From 1995 to 2008 meat exports from Brazil grew from 7.2% to 25% of total national production (AgraFNP, 2009; FNP, 2001). The Amazon accounted for 84% of the growth of the Brazilian cattle herd (37 million out of 44 million head) in this period. The growth of soybean production also helped to expand deforestation directly (Morton, DeFries, Shimabukuro, Anderson, & Arai, 2006) and indirectly (by displacing cattle ranching from older pastures in other regions of Brazil to the Amazon (Barona, Ramankutty, GlennHyman, & Coomes, 2010). The suden growth and decline of deforestation between 2002 and 2006 was remarkably associated with the variation of soybean prices (Figure 2).

The importance of agricultural commodities for deforestation was so remarkable that 78.3% of the variability in deforestation rates between 1995 and 2007 was associated with the average prices of cattle and soybeans in the year prior to deforestation (Barreto, Pereira, & Arima, 2008).

[7] *The economic plan (Plano Real) led to a 50% increase in the purchasing power of the minimal wage (Brasil s.d.).*

Figure 2. Deforestation rates and the price index for cattle and soy[8].



A new wave of environmental policies in the mid-1990´s

The Brazilian Government continued enacting new policies against deforestation in response to each new crisis. For example, in response to the deforestation peak of 1995, the Brazilian President increased the legal reserve from 50% to 80% of each private landholding in the Amazon biome[9] by amending the Forest Code using a Provisional Law. In 1998, Congress passed the Environmental Crimes Law, but this law was regulated only in 1999 (Brasil 1999)[10] after a major forest fire occurred in Rondônia State. The regulation established much higher fines – for example, the maximum value of a fine went from nearly US $ 3,000 to about US$ 30 million – and new sanctions such as the confiscation and disposal of goods associated with environmental crimes and the incarceration of criminals. The government increased the number of fines issued based on this legislation. Nevertheless, it collected less than 3% of the value of fines from 2001 to 2005 (Barreto, Pereira, & Arima, 2008). Therefore, forests continued to be vulnerable – especially in private areas.

Simultaneously, the Federal and State Governments continued to create Conservation Units and demarcate Indigenous Lands with international support and taking advantage of critical events. From 1995 to 2003, countries from the G7 supported the Pilot Program to Conserve the Brazilian Rain Forest (PPG7) that helped in demarcating 45.4 million hectares of indigenous lands and 2.1 million hectares of extractive reserves (The World Bank, 2009). In 2005, the assassination of Dorothy Stang, a US born nun (but naturalized Brazilian) helped in breaking political resistance to the creation of more Conservation Units. She was helping smallholders demand the

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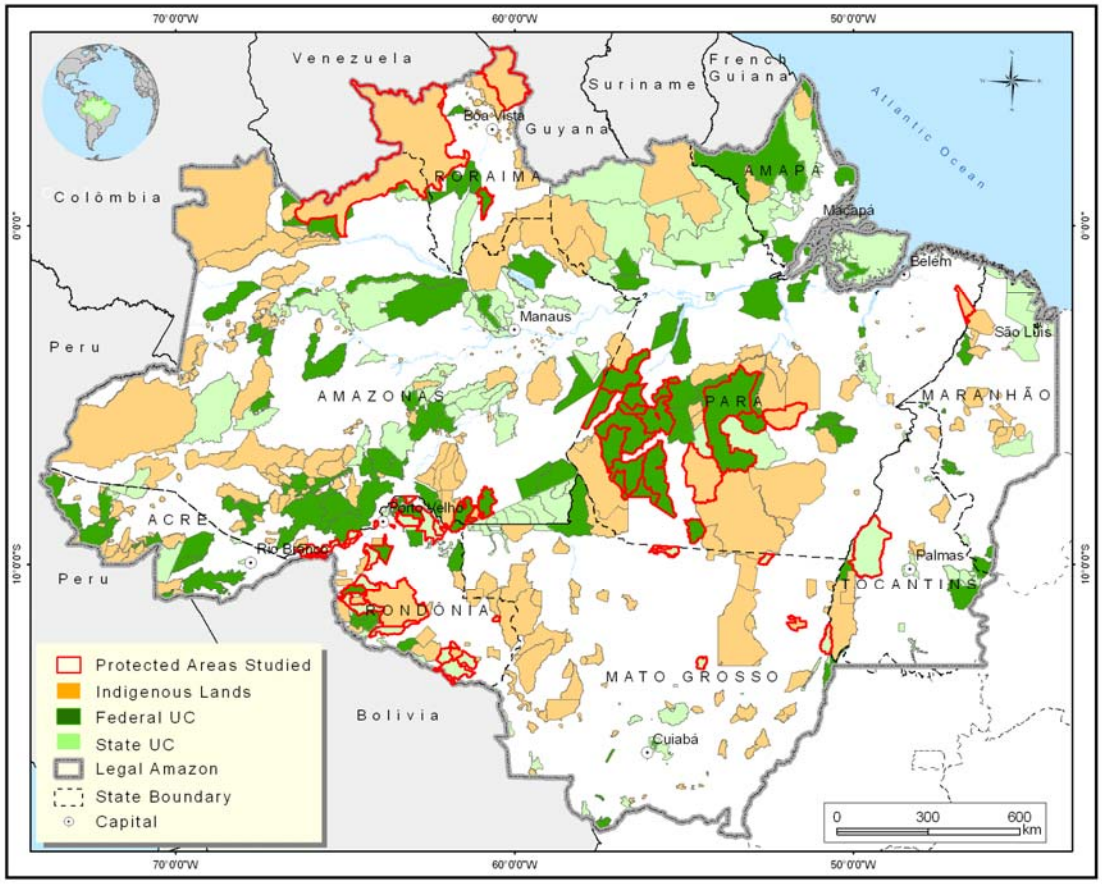
[8] *Sources of information: Areas deforested (INPE, 2010). The authors with data from Fundação Getúlio Vargas (FGVDados) calculated Price Indexes.*

[9] *A Provisional Law (PL) is a law enacted by the Brazilian President and become into effect immediately. It is to be used only for issues of extraordinary priority. Up to 2001, a PL had to be confirmed by Congressional vote within 30 days. Otherwise, the President had to reenact it to maintain its validity. Between 1996 and 2001, the PL related to the Forest Code was reenacted several times (Brasil 2001)*

[10] *The current version of the Executive Order is Decreto 6.514/2008 (Brasil, 2008).*

creation of forest settlements along the Transamazon highway in land disputed by ranchers. In 2006, the Ministry of Environment used this crisis to create new areas that were being blocked by local political elites. Up to 2009, roughly 44% of Brazilian Amazon territory (221 million hectares) was under some form of protection (Figure 3) in public lands (Pereira, Santos, Vedoveto, Guimarães, & Veríssimo, 2010). Several studies have demonstrated that the creation of protected areas have been very effective in avoiding deforestation and fires (Arima, Simmons, Walker, & Cochrane, 2007; Silva, 2009).

Figure 3. Types of Protected Areas in the Brazilian Amazon. The areas with red borders were or are subject to proposals to be degazetted, downsized or downgraded[11] according to Araújo & Barreto 2010.



Besides supporting protected areas, the PPG7 also invested in building the capacity of State Environmental Agencies, in participation of civil society in policy dialogue and in scientific research. Total support reached US$ 428 million (The World Bank, 2009).

Nevertheless, the spike of deforestation in 2002 and 2003 led civil society and supervising public institutions to demand improvements in the design and application of public policies against deforestation. The newly elected federal government conducted a public consultation and in March 2004 and launched the Action Plan for Prevention and Control of Deforestation in the Amazon (PPCDAM in the Brazilian Acronym). This was the first attempt to have a more comprehensive plan to deal with deforestation. The

[11] *To downgrade a conservation unit is to lower its degree of conservation or of use restrictions. The presence of private owners of land is acceptable in some classes of conservation units and they can deforest part of the area.*

plan, coordinated by the Presidential Cabinet (Casa Civil) proposed the integration of 11 Ministries such as Environment, Agriculture, Defense and Justice (Brasil, 2004). Although in practice the Environment Ministry was the one most clearly committed (Greenpeace, 2008), the plan helped in gaining some support from other players such as the Federal Police under the direction of the Justice Minister. For example, in 2005 the Federal Police imprisoned about 80 people during an investigation of fraud related to issuing permits for illegal logging in Mato Grosso State – the champion of deforestation in the previous years (Brito, 2009). Among those imprisoned, were the State Secretary of Environment and the head of IBAMA (The Brazilian Environmental Institute) in Mato Grosso. The combination of these new measures and a decline of agricultural commodity prices (- 38% soya and - 18% cattle) helped deforestation rates to decrease in 2005 and 2006 (Silva, 2009; Barreto, Pereira, & Arima, 2008)

The most comprehensive plan against deforestation.

Another important improvement of PPCDAM was a system (DETER) to detect deforestation monthly (See Box 1). In December 2007, DETER showed that deforestation had doubled in November 2007 as compared to same period in the previous year. Again, this sharp increase of forests clearing coincided with increasing agricultural commodity prices. Environmental officials became concerned about an uncontrolled comeback of deforestation given the projections of significant increase in agricultural commodity prices. To prevent this scenario, in December 2007 the Ministry of Environment convinced the President to launch the most comprehensive plan against deforestation ever. Before detailing this plan, it is relevant to explain the critical trends and events that made it possible.

The first critical trend was the growing concerns about climate change and the importance of the Amazon in this issue, both as a problem and as a potential for solutions. In 2004, the Brazilian government released the national accounting of greenhouses gases showing that 75% of the Brazilian emissions for the Year 1994 were from land use change, especially from Amazon deforestation (Brasil, 2004). Moreover, in 2005 a 40-year record drought in the Amazon affected about 280 thousand people (Brasil, 2005; Ibanês, 2005). This drought also produced shocking images of thousands of dead fish in shallow rivers and lakes. In the popular media, the causes of the drought were associated with climate change and deforestation (see example by Souza & Zanchetta, 2005) (Souza & Zanchetta, 2005). One indicator of this growing debate is the fact that a Google news search for the words climate change Amazon (in Portuguese "mudanças climáticas Amazônia") produced two times more results in 2005 than in 2004.

Additionally, in early 2007 the Intergovernmental Panel on Climate Change (IPCC) reinforced the ongoing debate in Brazil by stating that global warming was unequivocal and very likely a result of human activities (Pachauri & Reisinger, 2007). Therefore, human action was needed to deal with the problem. This scenario increased discussions about two opportunities for Brazil related to reducing deforestation. First, Brazil could become a major exporter of biofuels (especially sugarcane ethanol) given that developed countries were discussing targets for the reduction of emissions. Brazil, however, would have to assure that increased sugarcane plantations would not lead to direct or indirect deforestation in the Amazon[12]. Second, reduced emissions from reduced deforestation and degradation (REDD) could generate credits to be traded with

[12] *See estimates and discussions about the potential negative effects of biofuels on Searchinger et al. (2008)*

governments and private firms from countries with capped emissions. The potential for compensation results from the fact that avoiding deforestation could be cheaper than reducing emissions in other sectors (Stern, 2006). The intensity of the debate in 2007 as indicated by the results of a Google news search for "climate change Amazon" grew fourfold in comparison to 2004.

Another trend was the growing awareness about the environmental services provided by forests. Studies showed that water vapor from the Amazon was important for the formation of rainfall in the central and southern regions of Brazil where most of the agricultural production and a large proportion of the hydropower plants are located[13].

At the same time, new research helped key stakeholders in questioning the social and economic rationale or the wastefulness of additional Amazon deforestation. For example, studies revealed that the financial gains associated with new deforestation contributed relatively little towards sustainable development in the Amazon and very little to the overall Brazilian GDP. In fact, deforestation resulted for the most part in boom-and-burst economic cycles (Schneider et al, 2002). Additionally, research from the well-regarded official Brazilian Agricultural Research Corporation (EMBRAPA) showed that Brazil could increase agricultural production by intensifying land use rather than by clearing additional forests (see example at Assad & Pinto, 2008). The potential for intensification became a key argument used by environmental groups and opinion makers against voices in the private sector and politicians that lobbied against environmental regulation.

While discussions about potential opportunities continued, a significant event in 2006 showed how deforestation could harm agribusiness in Brazil. Greenpeace launched a campaign against trade in soya originating from newly deforested areas in the Amazon. Three multinational companies funded over half of the soya production in Brazil (Greenpeace, 2006) and controlled almost 80% of the European soy crushing capacity (Dros, 2004). Greenpeace explored the connection between labor, land grabbing and deforestation illegalities associated with soy production in the Amazon and consumers in Europe. As a result, major buyers of soy-derived products (including MacDonald's) demanded that importers stop buying soy resulting from new deforestation. In turn, the main buyers in Brazil declared a two-year moratorium against soya produced in deforested areas after 2006. The commitment has been monitored independently and renewed since them (Greenpeace, 2010).

The federal government launched the framework of the new plan in December 2007 (Leão, 2007) and started implementation throughout the first semester of 2008. The main elements of the plan are presented as follows.

More intensive and focused field inspections. The government prioritized field inspection against deforestation in 36 municipalities (out of 760) responsible for 50% of the total deforestation in the Amazon. Field operations that began in March 2008 resulted in fines, confiscation of equipment and goods associated with environmental crimes and embargoes of deforested areas. One of the first operations involved the seizure of about 20,000 cubic meters of illegal logs in Tailândia Municipality in eastern Pará State. In 2008, the federal government increased the number of embargoed areas and confiscated goods by 53% in the 36 critical municipalities in comparison to 2007[14]; whereas in the other municipalities the enforcement increase was equivalent to 11%. The most spectacular operation happened in June 2008, when for the first time the

[13] *The press has reported this issue several times. See example at: http://www.ewhoknow.com/uncertain-future-of-the-flying-river/*

[14] *Estimation conducted by the authors with data provided by IBAMA.*

federal government seized 3,000 head of cattle in an Ecological Station in Pará. Two months later, the government auctioned off the cattle (Barreto & Daniel, 2009).

Economic embargo of areas illegally deforested and liability of the market chain. Environmental law enforcement officials were obliged to embargo the areas illegally deforested. The inspectors went to the field and notified the violators that they were forbidden to sell products originating from illegally deforested areas. They also generated a map of the embargoed area and later posted the maps on the internet.[15] Buyers of products from those areas--for example, slaughterhouses-- became liable for penalties against environmental crimes (Brasil, 2007).

Restriction of credit to landholders noncompliant with environmental and land laws. In February 2008, the National Monetary Council issued a norm requiring public and private banks to stop providing rural credit to farmers not complying with land tenure and environmental regulation. Beginning in July 2008, before providing credit to landholdings equal or larger than 400 hectares, banks were to request evidence that the landholders had initiated procedures for obtaining a valid land title and an environmental license (Brasil, 2008). The first step in this direction would be to register the property in the State Environmental Agency cadastre.

The reaction against these unprecedented measures was also impressive. In Tailândia, for example, sawmill owners and politicians stimulated a riot to expel the environmental officials from the city. The State and Federal Government had to bring in more military personnel and the federal police to conclude the seizure of illegal logs from the municipality. Representatives called the Ministry of Environment to complain about the plan in a public hearing. Some Amazonian State Governor protested directly to the President. One of them (Mato Grosso State) used surveys from his State Environmental Agency to question the DETER information that was used to launch the plan. The President vacillated and even questioned the information from INPE. INPE prepared a report showing the signs deforestation and forest degradation (INPE, 2008). The Ministry of Environment, Marina Silva, resigned when felt that the President was about to weaken her plan (BBC, 2008).

As a result, the President was heavily criticized nationally and the Minister's resignation made headlines in international newspapers (BBC, 2008). The federal government seems to have calculated that the political, economic (ex: backlash against the biofuels production) and reputational costs of rescinding the plan would be too large. The new Ministry of Environment implemented the plan elaborated by the former Minister.

Because of these new approaches Barreto, Arima, & Salomão (2009) found that the decrease of deforestation was more significant in the 36 municipalities that were the focus of field inspections in comparison with the other municipalities. Moreover, they found that decrease of deforestation had begun before the international financial crises exploded in September 2008. Later, INPE estimated that deforestation decreased by 45% from 2008 to 2009 (INPE, 2010).

The pressure against deforestation continued in 2009 and 2010 (Barreto & Daniel, 2009). In June 2009, 17 prosecutors from the Federal Public Prosecutors Office (MPF) in Pará proposed a lawsuit against 21 ranches non-compliant with environmental legislation and against 13 slaughterhouses that bought cattle from such ranches (one of them inside an Indigenous Land). Moreover, MPF demanded that 69 supermarket chains and other industries stop buying cattle products from the slaughterhouses that made purchases from the 21 ranches.

[15] *The list is available at: http://siscom.ibama.gov.br/geo_sicafi/*

In response to the lawsuit and a parallel campaign led by Greenpeace regarding the role of the market of illegal cattle products in Amazon deforestation[16], supermarket chains and other industry sectors suspended procurement from the accused slaughterhouses (Barreto & Daniel, 2009). As a result, on July 8th 2009 slaughterhouses, ranchers and the government of Pará signed legally binding agreements (consent orders or TAC, the Portuguese acronym) with MPF to halt the commerce of cattle from any illegal farm and to increase the compliance with environmental and land tenure regulations (Barreto & Daniel, 2009). For example, slaughterhouses committed that after February 8 2010 they would buy only from ranches registered with the Pará State Rural Environmental Cadastre (CAR). The registry with CAR provides transparency regarding land use because the maps of landholdings as well as data on ranchers are available on the internet. This publicity increases the risk of illegal logging and deforestation being detected by satellite monitoring with the identification of the violators of environmental rules. The State Government of Pará also signed an agreement with MPF committing to provide up to nearly US$ 3 million per year to fund independent audits as to compliance with of all items involved in the consent orders.

Because of the TAC, the total number of farms registered in CAR in Pará increased from about 400 in June 2009 to 24,000 on October 2010[17]. Moreover, the MPF in Mato Grosso, the State that hosts the largest cattle herd in the Brazilian Amazon, has also signed a TAC with two slaughterhouses and is negotiating with others. As a result, by November 1st 2010, 6,999 landholders in Mato Grosso had submitted material to register at CAR.[18]

Additionally, on October 5, 2009, four of the country's principal meat processors, which account for between 30% and 40% of cattle slaughter nationwide, signed a voluntary commitment for zero deforestation with Greenpeace[19]. Besides the pledge not to buy cattle coming from deforested areas after signing the agreement, they promised to demand land title and environmental regularization from suppliers on terms similar to those of the TAC signed in Pará. To begin monitoring they required each rancher to provide a georeferenced point within the ranch. In July 2010, three of the largest meatpacking industry in Brazil (JBS/Bertin, Marfrig e Minerva) reported that they had 12,500 ranches mapped in Mato Grosso (Greenpeace, 2010). Moreover, they reported that they stopped buying cattle from 221 ranches that did not meet the requirements of the agreement; specifically, the ones located inside indigenous land, conservation units and within a 10 km radius of recently deforested areas. Another 1,787 ranchers were under investigation because they were within a 10 km radius of new deforestation or protected areas.

The MPF lawsuit and independent reports (Ver Barreto, Pereira, & Arima, 2008; Amigos da Terra - Amazônia Brasileira, 2008; Greenpeace, 2009) also led to other important responses from the retail and finance sectors. BNDES (The National Brazilian Bank for Economic and Social Development), a government bank which has funded meat processing plants in the Amazon, launched stricter guidelines for funding

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[16] See Greenpeace´s report at: http://www.greenpeace.org/international/press/reports/slaughtering-the-amazon

[17] Data obtained from Pará´s State Environment Secretary website: http://monitoramento.sema.pa.gov.br/simlam/

[18] Data obtained from Mato Grosso´s State Environment Secretary website http://www.sema.mt.gov.br/

[19] The following companies signed the agreement: Bertin, JBS-Friboi, Marfrig and Minerva. Available at: <http://tinyurl.com/y8e32ea>. According to Marcelo Furtado of Greenpeace, the signatories to the agreement account for between 30% and 40% of cattle slaughtered nationwide (Personal communication).

the cattle and beef sector in the region – including a request for independent audits similarly to what has been established by the TAC signed in Pará[20]. The largest retailers in Brazil (Wall Mart, Carrefour and Pão de Açúcar) have hired an international firm (SGS) to establish a tracking system to prevent the sourcing of beef from illegal ranches (Amazônia.org.br, 2009).

This combination of policy and market pressure resulted in a further decrease of deforestation. IMAZON for example has detected a 16% drop in the area deforested according to the MODIS sensor for the period of August 2009-July 2010 in comparison with the same period in the year before (Hayashi, Souza Jr, Sales, & Veríssimo, 2010). If this preliminary estimate in percentage drop – which considers only deforested areas larger than 15 hectares- were applied to the entire deforestation for the previous year – the projected cleared area in 2009-2010 would be around 6,300 km^2.

Will cattle ranching continue to drive deforestation in the Amazon?

Recent pressures on ranching may lead one to believe that the sector will inevitably comply with environmental rules and deforestation will continue to fall. However, it is relevant to consider other scenarios, considering the following predominant trends and critical uncertainties in the next five years.

The predominant trends.

Based on the history described in this paper and in additional information provided below, we have identified four predominant trends that are likely to influence deforestation in the near future.

Growing food demand. The demand for agricultural commodities (OECD-FAO, 2010) is projected to continue to grow. Brazil is projected to display the fastest growth in the agricultural sector (40%) up to 2019 according to OECD-FAO (2010).

Concerns about environmental issues. As we have described, concerns over environmental issues have increased in Brazil and the Amazon is an important part of the debate. It is likely that environmental issues will continue on the public agenda. In December 2009, the Brazilian Government enacted a Climate Change Policy establishing a voluntary target for reducing between 36 and 39 percent of the greenhouse gases emissions projected to 2020 (Brasil, 2009). The government projections indicated that the target of reducing 80% of deforestation would account for 54% to 58% of the total reduction target by 2020[21]. This policy resulted from pressures from civil society, from part of the private sector and from governmental strategic considerations about climate negotiations. For example, one representative of the National Industry Confederation stated that developed countries with emission caps could establish commercial barriers against countries free of emission targets. Therefore, by adopting voluntary mitigation targets Brazil could avoid such restrictions (Mansur, 2009). Moreover, cutting emissions from deforestation would be one of the cheapest approaches to meet the targets. Environmental issues also played some role in

[20] See details of new BNDES guidelines at: http://bit.ly/91WQiH. Coincidentally or not, on June 12, 2009 the International Finance Corporation announced that it had decided to "discontinue its partnership" with the Bertin group. In June 2007, IFC had committed to lending US$ 90 million to support expansion and modernization of that company, including in the Amazon. See communiqué from the IFC at<http://tinyurl.com/yf4xey9>.

[21] The target to reduce deforestation by 80% is available at Brasil (n.d).The target for the others sectors was first published by Mansur (2009).

the 2010 presidential election. The two candidates participating in the runoff election[22], pressed by environmentalists and seeking the green vote, have promised to work towards zero deforestation (Greenpeace, 2010).

Concerns about the socioeconomic impacts of environmental regulation. Some politicians and agribusiness representatives will continue to act to reduce the impacts of environmental regulations on the rural economy and on the livelihoods of small landholders. Up to now, smallholder have been mostly excluded from some policies against deforestation – for example, they have been less subject to field inspections and the credit restriction excluded landholdings smaller than 200 to 400 hectares depending on each municipality. Currently, politicians are using the argument that the Forest Code has to be changed, among other things, because the smallholders are unable to comply with the current version of it.

Pressure for economic growth. The Brazilian economy has entered a cycle of economic growth and income distribution. In order to continue this cycle the government and private sector plan to invest nearly US$ 90 billion in the Amazon up to 2014 including infrastructure (hydroelectric power plants, road paving, etc) and large scale mining projects (Veríssimo, 2010). In the past, these types of projects have helped to expand deforestation. Will the government be able to improve environmental governance in areas surrounding such large-scale projects?

Critical uncertainties.

We considered three critical factors as follows.

Proposals for changing environmental law and for suppressing protected areas. Due to the increased pressure to implement environmental laws, the agribusiness sector is mobilizing to weaken forest protection in private and public areas. They have been successful in some cases, but it is uncertain how far they can go. In July 2010, the agribusiness lobby managed to approve in a committee of the House of Representatives a draft proposal to weaken the Forest Code. For example, smallholders (less than 400 hectares) would be exempt to restore areas illegally deforested. Their proposal is yet to be voted by the House and the Senate. In another case, the State Assembly of Mato Grosso has extended the deadline for ranchers to begin the adoption of the Forest Code from 2010 to 2012. During this period, landholders would be free of penalties against old environmental crimes.

Moreover, the private sector and politicians have proposed degazetting, downgrading or downsizing protected areas in the Amazon in order to expand or consolidate ranching and farming in such areas. The procedures against protected areas have included draft bills to be voted in State and Federal Assemblies as well as court cases. Araújo and Barreto (2010) found 37 such initiatives against 48 protected areas accounting for 11% of the territory of protected areas in the region. Up to July 2010, 114,124 km^2 had been maintained. However, 49,506 km^2 had been reduced, involving 29 protected areas (20% of the areas under threat) and decisions about other 86,538 km^2 were pending.

On the other hand, the proposal to change the Forest Code has been heavily criticized by scientists and environmentalists. About 150,000 people signed a campaign conducted over the internet against the project[23]. Moreover, the success of Marina Silva in the presidential election has led the runoff candidates to promise zero deforestation.

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[22] The former Minister of Environment (Marina Silva) running for president with the Green Party received nearly 20 million votes (roughly 20% of the valid votes) on October 3rd 2010. Although, she was in third place, her votes led the election to a runoff between the other two top candidates.

[23] The number of participants is available at: http://www.avaaz.org/po/salve_codigo_florestal

They, have not given, however, details on how to reach this goal –whether by increasing command and control and/or by increasing support to landholders.

Effective support for the implementation of environmental and land laws. Some landholders have accepted that they must comply with current environmental and land laws. They argue, however, that they need support and compensation. For example, they demand that the government should reduce the transactions costs involved in obtaining an environmental license and that they need compensation for the environmental services associated with avoided deforestation. In fact, our preliminary analysis show that the costs of implementation of environmental laws can be prohibitive to small landholders. It is unclear if the government will be able or willing to provide sufficient and timely support for the implementation of current laws.

Extension of the beef market that is vulnerable to voluntary environmental pressure. The recent pressure against the meat packing industry was facilitated by the fact that the sector is becoming more concentrated and therefore more visible as a target for environmental campaigns by nongovernmental organizations and by the government. As in other cases (Cohen & Konar, 2000; Simpson, Garner, & Gibbs, 2007), the large corporations in the meat sector in Brazil were more likely to commit to best environmental practices. It is uncertain, however, if it will be possible to extend such pressure to the whole meat sector because in 2006 about a third of the Brazilian slaughter was clandestine. In clandestine abattoirs, animals are slaughtered without sanitary and fiscal controls. The uncontrolled market might continue buying from ranchers who deforest.

The scenarios

Low deforestation. Deforestation could continue to decrease to less than 2,000 km^2 per year - a level that would be mostly associated with subsistence agriculture[24]. This scenario would result from the following factors. First, Congress would not change environmental laws in ways that could promote deforestation (amnesties for environmental violators and reduction of the legal reserve). The government would continue effective enforcement of environmental laws and would increase enforcement against illegal abattoirs to eliminate the market for cattle from illegally deforested areas. Moreover, government would reduce the transaction costs to deliver environmental permits, speed up the titling of the land and work to provide financial support, especially for small ranchers. The government could justify the financial support as part of its climate change policy. Beef industries would expand concentration and thus would be even more susceptible to legal and market pressures in favor of zero deforestation. Therefore, even the forests that would become accessible to legal deforestation close to near infrastructure would not be vulnerable to forest clearing for cattle ranching. Ranchers would organize to overcome the barriers to comply with environmental laws. Besides financial support from government, they could also negotiate better prices for cattle coming from ranches free of new deforestation by engaging in certification schemes. In this scenario, they would increase production by investing in productivity to contribute towards further economic growth free of deforestation.

Medium deforestation. In this scenario, deforestation would continue at rates similar or slightly higher than in recent years (7,500 to 12,000 km^2) shaped by the following factors. There would be no significant change in the Forest Code and the

[24] In 2006, IBGE (IBGE, 2010) recorded that smallholders (areas smaller than 100 hectares) in the Amazon harvested 1,660 km^2 cultivated with less than two hectares of annual crops.

government would continue command and control policies mostly against large landholdings. On the other hand, neither the government nor the market would provide additional incentives for environmental compliance. New forest land would become accessible for legal deforestation (e.g. 20% of each property), including areas along new or improved transport infrastructure and areas excluded from legal protection by either court or Congress decisions (protected areas downsized, downgraded and degazetted). Large meat-packing industries could buy from these new suppliers assuming that they would be able to sell to markets that are unwilling to adopt voluntary limits to zero deforestation (part of the national and export markets such as China). Moreover, the government would fail to control the existing clandestine beef market that would be willing to buy from illegal sources. The government would continue avoiding the application of sanctions against illegal deforestation by smallholders. These, in turn, could continue expanding production by deforesting new areas and supplying the clandestine market.

High deforestation. This scenario would be similar to the medium deforestation above, with the exception that Congress would pass law reducing forest protection and the President would accept such changes (for example, by not vetoing the law). In this scenario, deforestation could go back to previous high levels.

Conclusions

Brazil has been successful recently in reducing deforestation by strengthening environmental laws and by increasing the intensity and efficiency of enforcement. Although, concerns regarding environmental issues continue in Brazil, powerful forces that may favor deforestation will be also present in the future, such as growing demand for beef, investments in infrastructure to sustain economic growth and concerns over the economic and social impacts of environmental enforcement. Therefore, deforestation could rebound due to a combination of these forces with the outcomes of uncertain factors: whether the Brazilian Congress and the courts reduce legal forest protection (Forest Code and Protected Areas), whether the government and the market provide incentives for forest protection and the extent of the clandestine beef market.

Therefore, in order to reach near zero deforestation it will be necessary to consider the challenges and opportunities associated with the predominant trends and the "swing" factors. For example, concerns about the effects of climate change could justify the continuation of policies against deforestation. The use of command and control policies, however, seems to have reached a limit because of the potential effect on the livelihoods of smaller landholders. Politicians are increasingly using the smallholder cause in their proposals to reduce forest protection. A possible solution to this situation in a context of limited financial resources is to integrate enforcement against illegal forest clearing on large properties with incentives to small landholders. Forest conservation incentives to smallholdings (which cover less than 30% of the total area but include the majority of landholdings) could reduce the political pressure against legal forest protection. The incentives could come in the form of subsidized rural credit for forest management and/or payments for environmental services such as REDD. Discussions for a climate change agreement are a unique opportunity for obtaining national and international support for forest conservation that would complement the successful command and control policies recently applied in Brazil.

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