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Is Brazil now in control of deforestation in the Amazon?

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Is Brazil now in control of deforestation in the Amazon?

Le Brésil maîtrise-t-il (enfin) la déforestation en Amazonie ?

François-Michel Le Tourneau

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Résumés

English Français

Depuis une dizaine d'années, les surfaces déforestées en Amazonie diminuent chaque année et le déboisement en 2014 a représenté moins de 20 % de celui de 2004. Doit-on en déduire que le Brésil maîtrise désormais le phénomène de déforestation ? Répondre à cette question implique d'exposer la complexité du phénomène de déforestation. Celui-ci possède en effet de nombreuses dimensions : économique (qui défriche, pour gagner quoi ?), sociale (question de l'accès à la terre, conflits fonciers), environnementale (impacts sur le climat, effets locaux, biodiversité) et même géopolitique (rôle du Brésil sur la scène mondiale, négociations sur les émissions...). La taille de la région considérée est un autre élément de complexité car les facteurs en jeu ne sont pas uniformes. Malgré ces difficultés, nous proposons ici une synthèse des principales questions liées à la question du déboisement. Nous abordons dans un premier temps l'historique du phénomène, sa répartition géographique et ses conséquences. Nous nous intéressons ensuite aux causes et aux acteurs du phénomène. Enfin, nous présenterons les actions menées depuis dix ans par le gouvernement fédéral brésilien pour le maîtriser. La conclusion sera l'occasion de réfléchir sur les limites des politiques actuelles et sur les défis qui restent à relever.

Entrées d'index

Mots-clés : Brésil, Amazonie, changement climatique, gaz à effet de serre, déforestation

Keywords : Brazil, Amazonia, Deforestation, Greenhouse Effect Gases (GES), Climate change

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Conclusion: is Brazil now in control of deforestation in the Amazon?

Texte intégral

- 1 Since 2005, the total area deforested annually in the Amazon diminishes almost every year and, in 2014, it was only 20% of what it was in 2004. Does this mean that Brazil finally controls deforestation? What are the mechanisms which have made this achievement possible? What are the consequences on climate change issues?
- 2 To answer these questions, one has to dig into the complexity of deforestation as a multi-dimension phenomenon and to deal with economic (who deforests and why) as well as social (access to land, land conflicts), environmental (impacts on climate, biodiversity) and geopolitical issues (the role of Brazil in global negotiations on climate change and greenhouse gases emissions). The size of the Amazon rainforest adds to this complexity since the factors at play are not the same across such a vast area.
- 3 Despite these difficulties and keeping in mind that the general trends must be nuanced by the specific dynamics of each region, we will offer a synthesis of the principal issues linked to deforestation in the Brazilian Amazon region. The first part will deal with the history of deforestation over the past 50 years, its current geographical distribution and its consequences. We will insist on the existence of several geographically or historically distinct deforestation fronts.
The second part will analyze the motives for deforestation and the stakeholders implied. Thirdly, we will show how resolute action taken by the Federal government has helped to curb the phenomenon. In conclusion, we will highlight the challenges which are yet to be met before deforestation may be considered under complete control.

Progress, affected places and impacts of deforestation in the Amazon

A rapid history of deforestation in the Amazon

- 4 Forest clearings exist in the Amazon since man has dwelt in the rainforest, as all types of agricultural activities imply the opening of gardens, at least temporarily. Denevan (1992) and Barlow *et al.* (2012) showed that there are vast extensions of dark earth soils, probably created by the continuous presence of past Indigenous civilizations with high population densities (at least by Amazonian standards) and relatively perennial agricultural activities. Moreover, the impact of Indigenous peoples on the forest structure and on species distribution may be high or critical in some regions (Posey, 1984; Balée, 1993 et 1999; Rival, 2006).
- 5 Therefore, what is new in the Amazon rainforest is not the opening of clearings but the permanent removal of the forest cover and the abandonment of rotational slash and burn systems that allowed the constitution of dense and diversified secondary forests in favour of intensive and permanent production systems. Combined with a scale never reached before the XXth century, this process has led to a rapid shrinking of forest covered areas and is designated as "deforestation". It is a rather recent trend that only began in the early 1970s. Before this date, opened areas concerned less than 1% of the region.
It is only in the Bragantine area near Belem that there was an almost continuous and vast (30,000 km²) territory where the forest cover had been severely depleted at the end of the XIXth century, in an unsuccessful attempt to develop small scale farming in this region. There were also patches of deforestation along the Amazon river and a few other major rivers, due to the installation of cacao plantations during the XVIIIth and XIXth centuries or to

steamboat companies that needed fuelwood for their ships in the late XIXth and early XXth centuries. However, most of the other economic cycles that impacted the Amazon rainforest until the late XXth century did not significantly alter the forest cover, as they were principally linked to the collection of forest products (wild cocoa, nuts, latex, etc).

- 6 The process of deforestation started in the 1970s, along with the renowned National Integration Plan by the Medici government. This plan had three main lines of action: the construction of big infrastructures, especially a road network (the famous Transamazonian or BR-230 road); the colonization of vast areas by small scale farmers who arrived from southern or northeastern parts of the country (Bursztyn, 2010) ¹; and a program of fiscal incentives which allowed firms to invest in the Amazon part of the taxes they were due to pay. Its objective was to foster economic development, following the motto of "integrating the Amazon (to the rest of Brazil) in order not to lose it (to supposed foreign interests)" ². The clearing of significant portions of the Amazon rainforest almost immediately attracted attention, as illustrated by the famous book written by Goodland and Irwing (1975), whose title summed up the controversy: "From green hell to red desert". In parallel, the first remote sensing images were used to show the progress of deforestation, especially in Rondônia (figure 2), but the interpretation methods of the Brazilian Space Research Center (INPE) at that time generated a significant underestimation of the affected areas up until the early 1980s (Fearnside, 1982). After 1974, the PIN was replaced by other programs (POLAMAZONIA in 1974, then POLONOROESTE in 1980) that adopted the same orientations and were consequently also responsible for the escalation of deforestation up to the late 1980s (Droulers, 2004).

¹ In order to be able to create large settlements, the federal government decided to federalize a str (...)

² The motto of the National Integration Plan was "integrar para não entregar".

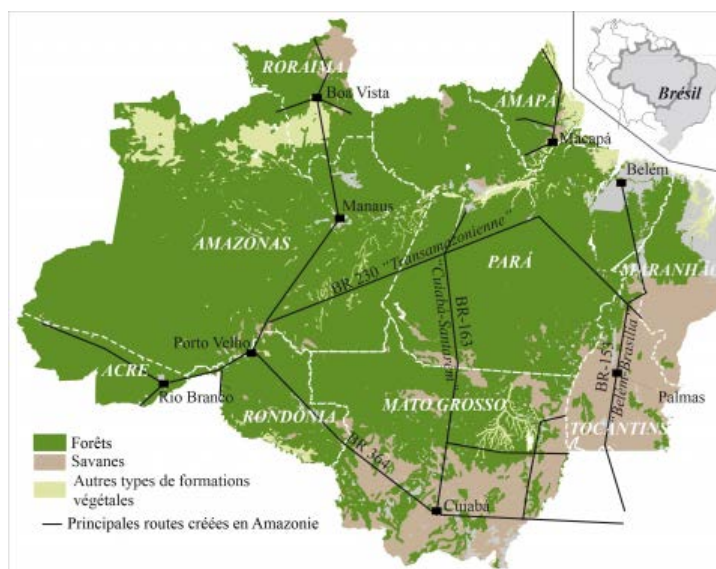
Which Brazilian Amazon?

All statistics concerning the Amazon are ambiguous since the term "Amazon" refers to several distinct realities: the "Amazon biome", which is the dense tropical rainforest area from the North of Brazil (about 4 million km², but it contains a number of distinct ecological regions); the Amazon river basin, which leaves outside its limits the Tocantins river basin whose lower part is undoubtedly Amazonian; the "legal Amazon region" (Figure 1) which is an administrative boundary created in the 1950s in order to administrate a federal fund aiming at fostering the economic development of the Amazon but which includes approximately 1 million km² of the savannah ecosystem of central Brazil (*cerrado*). The majority of regional statistics on the Amazon are based on the third definition, but not all the geographical data are. For instance, the deforestation figures produced by INPE do not take the *cerrado* into account...

Furthermore, the administrative organization of Brazil is incompatible with these three definitions as the North region, which encompasses a large portion of the Amazon, also includes the Tocantins state, mostly covered by savannah, but excludes Maranhão (included in the Northeast region) and Mato Grosso (included in East-center region), two states with important rainforest areas. Moreover, although some states are almost completely included in the Amazon biome (Amazonas, Pará, Acre, Rondônia), others also include areas with different ecosystems (Amapá, Roraima) or have over half their surface area covered by savannahs (Mato Grosso, Maranhão, Tocantins).

In this paper, unless mentioned otherwise, we will refer to the Amazon as the "legal Amazon" region.

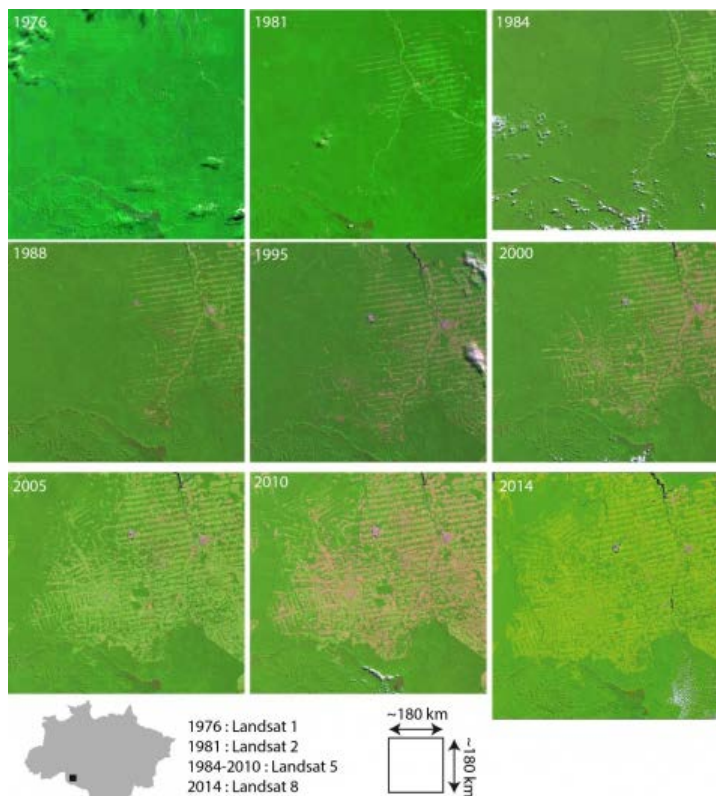
Figure 1: States, biome types and main roads of the "legal Amazon"



Agrandir Original (jpeg, 908k)

- 7 After the 1980s, international pressure compelled President Sarney to implement a monitoring program of the Amazon rainforest as part of the "Nossa natureza" (our Nature) federal initiative. The figures produced at that time revealed the unprecedented scale that deforestation had reached: 10% of the whole Amazon rainforest had disappeared in less than two decades. The yearly statistics available from that time on allow for a close monitoring of deforestation trends since 1990 (Figure 3). If deforestation seemed to recede at the beginning of the 1990s, reflecting the economic difficulties Brazil faced during that period of time, it increased sharply from 1995 onwards, possibly indicating the intense economic growth linked to a high demand for beef meat. Another peak was registered in 2003 which corresponds to the expansion of soybean production in Mato Grosso (see section "Motives and stakeholders of the Amazon deforestation").

Figure 2: Progression of the forest frontier in the region of Ariquemes (Rondonia) ³



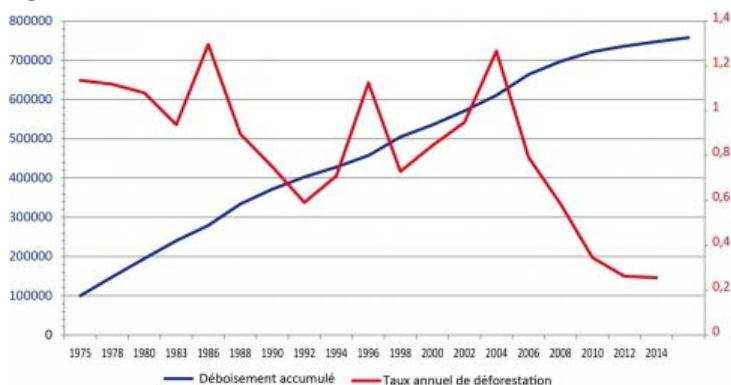
Agrandir Original (jpeg, 660k)

³ Depending on the characteristics of the sensors, it is impossible to reconstitute exactly the same col (...)

- 8 After this peak, the deforestation rate decreased almost continuously. In 2012, the total annual deforested area accounted for approximately 5,000 km² (figure 3), that is about 0.2 % of the total forest area. Since then, even if

there have been fluctuations, the phenomenon seems to have stabilized around this value, as if it were a kind of threshold which would require further changes to be exceeded. Although the diminution of the deforestation rate is undoubtedly a success, we must also note that the total deforested area is still growing. It has increased twofold since 1988 and is now about 750,000 km² or 18% of the total forest area. The ecological impact on the Amazon is therefore far from being reversed.

Figure 3: Total deforestation and annual rate, 1975-2014



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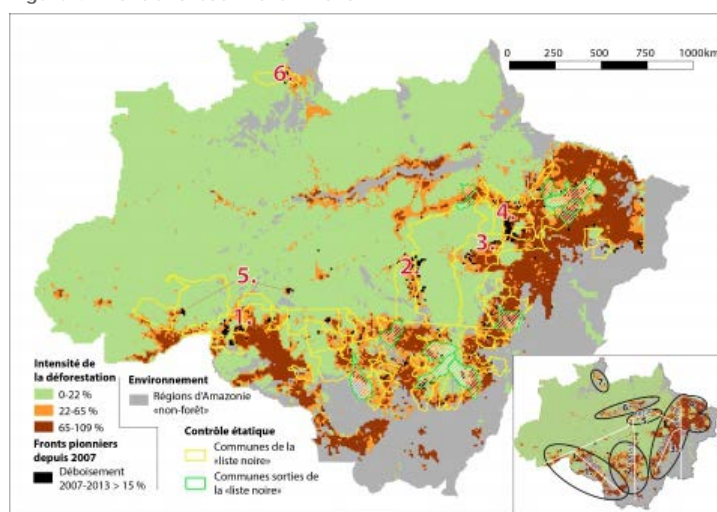
(Source of data: INPE ⁴)

⁴ The data published by the INPE before 1988 are imprecise and must be interpreted with caution. Just (...)

A geographical overview of deforested areas

- 9 Deforestation is not distributed equally over the Amazon, and its causes may vary from one place to another. Figure 4 shows that it is more concentrated in the southern part of the region and that it gradually spreads towards the north. This configuration is closely related to the construction and the improvement of transport infrastructures. The connection with the rest of Brazil thus seems a crucial variable: roads bring in migrants, machinery or agricultural inputs, and they are fundamental in order to export timber or beef meat.
- 10 Such a distribution of deforestation, in which the affected area has a crescent shape when looked upon on a regional map, with one tip in the Acre state and the other near Belém, has led commentators to name it “the deforestation arc” (*arco do desmatamento*). Yet this phrase masks the inherent diversity inside the supposed arc. In fact there are multiple deforestation fronts in the Amazon, with a variety of rates and histories. Moreover, the factors sustaining each of them vary with each period of time, being very different in the 1970s and in the 2000s for instance.

Figure 4: Frontier areas in the Amazon



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- 11 Figure 4 displays the current situation ⁵. Three main regions of massive deforestation appear:
- 12 1. The BR-364 or Brasília-Acre road. Deforestation here was initiated by public colonization then intensified by several programs of road improvements and

⁵ This map was built by the author using the INPE deforestation map and calculating the deforestation (...)

- other investments. The region is dominated by small and medium properties (in Amazonian terms) in the western part, and by large properties in the Chapada dos Parecis region (eastern part), one of the major regions for soybean production in Brazil.
- 13 2. The North of the Mato Grosso state. The whole region is dominated by large scale mechanized agriculture and big properties, and is the main soybean production region in Brazil. The Cuiabá-Santarém road (or BR-163) is its spine. In the western part of this region, small scale public or private colonization and correlated cattle ranching activities have been the driving forces for deforestation.
- 14 3. The southeastern part of the Pará state, Tocantins, western Maranhão and northeast Mato Grosso. This region corresponds to the PA-150 and Brasília-Belém roads, which have structured the expansion of farms and deforestation since the 1960s. It is a complex region where the motives for deforestation are the expansion of forestry activities, the growth of cattle ranching⁶, agrarian reform and colonization settlements as well as population movements due to the construction of major dams and land conflicts. Large scale mechanized agriculture exists but is not dominating, even if it increases in post-front areas such as Paragominas county.
- 15 4. The Bragantina zone, where deforestation took place at the end of the XIXth century, but also intensified after 1970.
- 16 All of these regions are still active in terms of deforestation but most of the forest cover has already been removed. For this reason, the late Brazilian geographer Bertha Becker (2005) suggested that they were "consolidation fronts", whilst S. Nasuti (2010) and M. Droulers (2004) preferred to refer to them as "post-fronts".
- 17 In addition to these main fronts, there are other smaller regions in which deforestation is important:
- 18 5. The Transamazonian road (BR-230) area. It was the other major public colonization area of the 1970s after Rondônia and is famous for the widespread "fishbone" pattern displayed on satellite images (which are also present in Rondônia, see Figure 2).
- 19 6. The Amazon valley, especially in the vicinity of Santarém and Alenquer. Deforestation there is not continuous, but nonetheless spreads over vast areas. Its origin may be anterior to the 1970s (like in Alenquer) but it intensified at the end of the XXth century, especially around Santarém, which has become a beacon for big farmers and soybean production because of the competitive advantage given by the possibility of exporting directly to foreign markets through the Santarém port (which can receive open-water ships).
- 20 7. The center of Roraima. Also "opened" during the public colonization projects of the 1970s-1980s, this area has become much more active since 2000, expanding cattle production in small or big properties.
- 21 Figure 4 also displays black areas which are those where massive deforestation took place between 2007 and 2013. They indicate contemporary deforestation fronts (red figures on the map):
1. The Porto Velho region, where population has expanded because of the construction of the two hydroelectric power plants of Jirau and Santo Antônio.
 2. The BR-163 area in the state of Pará. This road is being paved, and will probably be a major corridor for the exportation of soybean. Such a perspective attracts farmers who want to install new properties near this essential infrastructure (which drastically diminishes exportation costs), and thus fuels land speculation.
 3. The São Felix do Xingu region, in southeastern Pará. This area is still a very active region in terms of deforestation, despite the plan of the Federal government to control land appropriation there.
 4. The region of the Novo Repartimento and Pacajá counties, on the Transamazonian highway. Located near the Tucuruí dam, they concentrate colonization settlements and is considered as a "wild west" in the Amazon.
 5. A few counties of the Southern part of the Amazonas state. It is a region with a dominant forest cover, and public smallholder settlements are an important factor that explain the rise of deforestation there.
 6. The western part of center Roraima, where the forestry industry is very active and sustains the deforestation dynamic.

⁶ Between 1970 and 2010, the number of cattle heads in the São Felix do Xingu county alone raised fro (...)

The different uses of deforested land

22 Until recently, there was little information about what forested areas became after they were cleared. In 2010, the TERRACCLASS program of the INPE started to investigate the uses of deforested areas. Data on land use is now available for 2008, 2010 and 2012 (table 1). They show very clear general trends, although the interpretations must be made cautiously since methodological problems generate about 12.4% of “undetermined”, “other” or “mosaic” areas in 2012:

- A general dominance of pastures, even if it diminishes slightly over the period (from 63.2 % in 2008 to 59.2 % in 2012) ;
- A significant proportion of secondary forests (23 % in 2012);
- A small but growing presence of annual crops (5.3 % in 2012).

Table 1: Land use in deforested areas according to the TERRACCLASS project

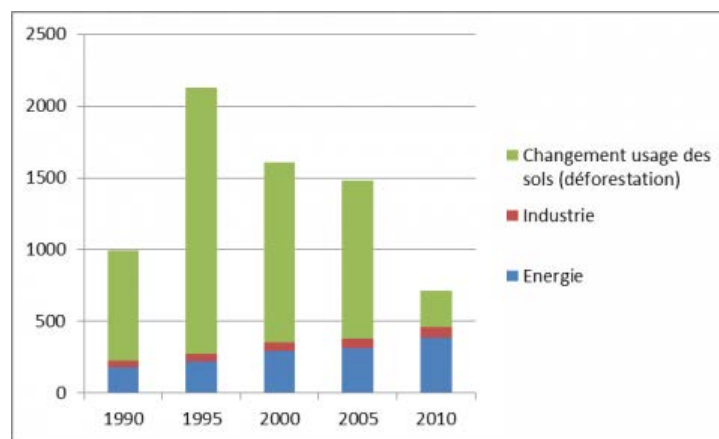
	2008 (km ²)	2008 (%)	2010 (km ²)	2010 (%)	2012 (km ²)	2012 (%)
Agriculture	34927	4,9	39977	5,4	42346	5,7
Urban areas	3818	0,5	4473	0,6	5340	0,7
“Mosaic of uses”	24416	3,5	17962	2,4	9590	1,3
Pastures	447158	63,2	459465	62,5	442401	59,2
Secondary forests /regeneration	150815	21,3	165229	22,5	172189	23,0
Other	477	0,1	2730	0,4	6112	0,8
Non-observed	45406	6,4	45849	6,2	69132	9,3
TOTAL	707017	100,0	735685	100,0	747110	100,0

(INPE, 2014)

The consequences of deforestation

- 23 The consequences of deforestation are multiple and are observed on different scales. Locally, deforestation implies a rise in average temperatures and a diminution of average rainfall. Soils, when not adequately managed, may become sterile or wear away due to erosion. Water streams, when deprived of their original forest cover, lose part of their volume and may dry out during the dry season. Also, the activities that take place in deforested areas impact the environment. For instance, the intensive production model established in the big farms of north Mato Grosso is responsible for polluting rivers with pesticides, even hundreds of kilometers downstream and inside natural reserves, as is the case in the Xingu Indigenous Park. Moreover, soil erosion may have serious consequences because it modifies water composition, turning once crystal clear streams into muddy rivers, and consequently drastically impacting their fauna and flora. The phenomenon of “forest degradation”, whose rate exceeds that of deforestation and could already concern over 2 million km², also has important effects since the affected forests undergo important disturbances that make them less able to provide for environmental services (Foley *et al.*, 2007).
- 24 The consequences at both regional and global scales are closely monitored today as the issue of global climate change is under scrutiny. The role of the Amazon as a regulator of the regional or continental climate is now frequently pointed out (Nobre, 2014). According to the “flying rivers” theory, water vapour streams in the atmosphere transport massive quantities of water from the Amazon to the south of the continent. The recurring drought in southern Brazil and even in Argentina could therefore be linked to deforestation in the Amazon.
- 25 Global consequences are primarily focused on the liberation of greenhouse gases, CO₂ in particular, which themselves contribute to global warming. Deforestation has been the main cause of GHG emission in Brazil and has put the country in the top 10 of GHG emitters. As Figure 5 shows, there has been significant changes in the last decade and the net total CO₂ emissions nowadays is inferior to the 1990’s, even if fossil fuel emissions and industrial emissions are increasing. But the question of CO₂ emissions can also be viewed as the creation of a liability: Galford *et al.* (2011) showed that the agricultural transformation of Mato Grosso from 1901 to 2011 emitted 4.8 billion of metric tons of CO₂ whilst the remaining forests were only able to capture 300 million of metric tons, yielding a net emission of 4.5 billion of metric tons. At the beginning of the 2000s, deforestation in Matos Grosso was still emitting more CO₂ than the total Brazilian vehicle fleet.

Figure 5: Brazil CO₂ emissions by sector



[Agrandir](#) [Original \(png, 13k\)](#) ↓

(source MCTI, 2013)

- 26 Finally, the most important consequence of deforestation is probably how it affects the future of the remaining forest in the Amazon. The Amazon rainforest typically functions as a closed system in which nutrients and minerals are recycled rapidly due to the diversity and complexity of the whole ecosystem but also because its dense vegetal cover maintains high and almost constant air humidity, providing optimal conditions for all the microorganisms involved. Deforestation and degradation processes alter these conditions and some scientists wonder if the tipping point, after which the entire system will collapse, has not already been reached. A modification of the local climate, with an extended dry season for instance, would drastically affect the composition of the Amazonian flora, and cause the margins of the forest to turn into more or less dense savannahs. Needless to say, since the climate of the Amazon affects the rest of the continent, this would reverberate in other regions of South America and could be a threat to agricultural activities as a whole. Another matter of concern is the impoverishment of the fauna, mainly of the most hunted mammal species, but also of invertebrates. This too may disturb the forest ecosystem and make it less efficient (Dirzo *et al.*, 2014).

Motives and stakeholders of the Amazon deforestation

The motives for deforestation

- 27 The motives for deforestation in the Amazon are generally the same nowadays than what they were during the past two decades (Le Tourneau, 2004). However, their importance varies according to the time period.

Land speculation and land value

- 28 Brazilian land laws and the absence of a reliable cadastre are two main factors that contribute to deforestation. Firstly, land laws in Brazil allow all citizens to settle on undeveloped public lands and to claim ownership if they make private use of them and “improve” them, the transformation of a forest into agricultural fields being the easiest way of proving such an “improvement”. Secondly, most land titles are precarious and this incites landowners to prove their presence, usually by also converting the rainforest into pasture. As Araujo *et al.* (2010) confirm, land tenure insecurity is consequently a critical cause of deforestation. Taravella (2007) explained that the consolidation of land rights is a key element of the *fazendeiros’* strategy in the region of São Felix do Xingu.
- 29 Land speculation may also play a role as a deforested area always has more value than a forested plot of land. A landowner, whether small or big, is therefore guaranteed to make significant profit by deforesting, first by selling the timber and other valuable resources and then by selling his property for a better price once converted into agricultural land or (more frequently) into pasture. He may also gain money in the process by raising cattle. Even if it is widely criticized, this mechanism where the rainforest is considered a liability rather than an asset still prevails in the Amazon, and land speculation continues to be a lucrative business: land prices have risen by 25% on average in the Northern region of Brazil in 2013, and by approximately 50% in the regions concerned by infrastructure projects (especially in the BR-163

region), compared to 15% in the rest of the country. According to Bowman *et al.* (2012), between 9 and 13% of the Amazon region could potentially be the object of land speculation.

- 30 The link between deforestation and land speculation may explain why the TERRACCLASS project detected so much forest regeneration in deforested areas: in many cases, landowners are not really interested in long term economic activities and do not see to their maintenance after the initial clearing.

Cattle ranching

- 31 Marginal until 1970, cattle ranching is one of the main economic activities in the Amazon today. The figures are impressive: the number of cattle heads increased from 8.5 to over 80 million between 1974 to 2015, and the regional share from 9.2% to almost 38%⁷ of the Brazilian herd. Such a growth is linked to the transformations of the agricultural geography in Brazil. The Southern and Center-West regions experienced a steep rise of mechanized large scale crop production, which probably contributed to the resettlement of cattle ranching in the Amazon, where cheap lands were available. Confirming this hypothesis, Bowman *et al.* (2012) stated that 83% of the growth of the national beef herd from 1990 to 2007 was located in the Amazon. The improved structuration of the beef productive chain has also played a role (Pacheco and Pocard-Chapuis, 2012).
- 32 The "beef's feet" has thus been a fundamental driver of deforestation in the Amazon, since cattle ranching is mostly extensive and necessitates the opening of very large areas. It is no surprise that deforested areas are mainly used for pasture, as shown by the TERRACCLASS.
- 33 As an economic activity, cattle ranching has a number of advantages in the Amazon. It is relatively easy to set up, it is not concerned by most of the environmental difficulties linked to the rainforest environment (cattle are immune to most of Amazonian fungus or diseases) and its market is dynamic because of the ever-growing local and national demand. It is thus a somewhat risk-free business for investors and farmers, all the more so because, as we explained, turning a property from forest into pasture will give it value. Furthermore, in isolated areas, cattle can be walked to the market whereas agricultural production needs a functioning transportation network. Finally, cattle breeding may be developed by virtually every type of landowners, from the smallest to the biggest, even if there are feasibility thresholds. Both categories are generally associated to several types of arrangements (pasture rent, sharing agreements⁸, etc.), which creates solidarity and structures social networks in a similar way that patronage networks structured the Amazon riverbanks in the past⁹. Because it relies heavily on cash transactions, cattle ranching is also an ideal activity for money laundering (Venturieri *et al.*, 2004).
- 34 Regions of agricultural colonization, where smallholders are dominant, tend to favor dairy production, which is more economically feasible for small farmers. Areas of dairy production are beginning to emerge, especially in Rondônia. Big land owners, however, invest more into meat production. Even if cattle ranching implies numerous factors, which makes the analysis very complex, it appears as an important cause of deforestation. To illustrate this, Espindola *et al.* (2011) pointed out that between 1997 and 2007, pasture areas in the state of Pará grew from 58,249 to 90,433 km².

⁷ These figures concern the whole Legal Amazon. Until the 1970s, cattle ranching was almost exclusive (...)

⁸ For instance, the owner of the pasture may let cattle from an investor in his property for free, in (...)

⁹ The majority of the families who settled along a river was affiliated to a patron, to whom they bou (...)

Cash crops and mechanized agriculture

- 35 As a result of the growing demand from external markets, large scale cash crop production is the other feature of the Amazonian agricultural revolution which began with soybean cultivation. From the early 1990s onwards, it started expanding on the savannah plateau of southern Mato Grosso before entering the rainforest in the regions of Sorriso and Lucas do Rio Verde (Arvor *et al.*, 2009 ; Dubreuil *et al.*, 2010). At the turn of the 21st century, soybean cultivation had reached the regions of Santarém and Rondônia as genetically modified species better adapted to the Amazonian climate were developed. After the mid-2000s crisis when soybean prices fell dramatically, big farmers started to modify their cultivation system by including a larger variety of crops in order to be less dependent on a unique product. They now also grow corn or cotton, with two or three harvests a year¹⁰. Soybean production in the Amazon today implies modern and intensive agriculture based on large farms.
- 36 The rapidity and strength of the development of this agriculture system raised fear that it too would cause massive deforestation. The federal government consequently took steps (see "Federal government policies against

¹⁰ Such auxiliary crops may become the main focus depending on the prices of commodities.

deforestation¹¹) to prevent the conversion of the rainforest into fields for mechanized farming, and to limit the penetration of soybean cultivation in forest areas. Nevertheless, soybean still leads to deforestation for two reasons. The first reason is that it has an indirect effect, the intensive use of lands for its cultivation having pushed the cattle ranching front to the North. The second one is that transporting soybeans has become a national problem. Most of the production is flown at a very high cost to southern Brazilian ports. Eager for a “northern escape route”, soybean producers put political pressure on the government to pave the BR-163 road up to Santarém and to invest in several alternative fluvial routes. Massive improvements have been made on these infrastructures and huge sections of rainforest have now become much more accessible, which will probably have important consequences in terms of deforestation, as already observed in southern Pará near the BR-163 road.

Infrastructures and population migration

- 37 The link between roads and deforestation is very strong. According to Barber *et al.* (2014), 95% of the deforestation is located less than 5 km from a road. However, it is important to distinguish different types of roads: roads within colonization settlements, informal trails created by loggers and big landowners as well as big infrastructures developed as part of governmental plans. These differences are sometimes limited as private interest groups may at times unite to construct informal (and illegal) large road infrastructures on hundreds of kilometers, as is the case of the famous Trans-Iriri road in the Amazonian “Middle-earth” region ¹¹ (Arima *et al.*, 2005).
- 38 Big infrastructure projects in the Amazon generally (there are some exceptions) have important consequences in terms of deforestation in the surrounding regions. First of all, their presence open the access to areas which were previously isolated and difficult to be reached, attracting landless peasants and land speculators. Moreover, these lands see their value increase sharply since they are now connected to eventual markets. Finally, the construction of roads creates pressure on the surrounding rural areas. This phenomenon can clearly be observed today on portions of the BR-163 road in Pará, but also in the region of Altamira with the construction of the giant Belo Monte dam. It has also been observed during the 2000-2010 period around Porto Velho with the construction of the Santo Antônio e Jirau power plants. The extensive program of the future construction of hydroelectric power dams in the Amazon (Le Tourneau, 2015) will probably lead to the appearance of new deforestation fronts in regions which are still isolated, particularly in the Tapajos region.
- 39 However, it is also possible that the impacts of infrastructure projects on deforestation may be fewer than expected. The roads which have been developed on the northern margin of the Amazon river (Manaus-Porto Velho highway, Balbina dam, Macapá-Oiapoque highway, etc.) have in general generated much less deforestation than those developed in the southern part of the Amazon, probably because they are less connected to migratory flows from southern Brazil. Moreover, the projects being planned nowadays try to avoid or to mitigate the resulting deforestation. Future dams may be conceived like off-shore installations, and constructed without an access road, the employees being brought in and back by boat or plane. In the case of the construction of the Belo Monte dam, the BNDES ¹² bank has claimed the inclusion of systems aiming at the monitoring and control of deforestation in a vast region as a condition for its 30 billion R\$ loan.
- 40 Aside from big infrastructure projects, part of the Amazon deforestation has been associated with spontaneous migration from other regions in Brazil. Between 2000 and 2010, around 1.8 million migrants have settled in the Legal Amazon states, compared to 1.5 million from 1990 to 2000 (table 2). The migration of farmers from other regions seeking new lands is therefore still a driver of deforestation. However, the figures do not make the distinction between migration towards rural areas and migration towards urban zones. The former is probably of lesser importance and may be estimated to about 30% of migration flows (considering that 70% of the Amazon population is urban), that is a total of 500,000 persons in the last decade. A change in the regions of emigration may be observed. Maranhão and other regions of Brazil diminished in importance whilst migration from other parts of the Amazon grew. Long distance migrations have therefore been replaced by regional circulation, land-seeking farmers trying to find empty plots to obtain land titles in the midst of a general consolidation of the land tenure situation. The county of Novo Progresso, which experienced massive deforestation in the last decade, is interesting in this respect. It has received a massive and sudden influx of families who had been previously relocated due to the construction of the Tucuruí dam but who were not satisfied by the zone which had been chosen for them. After waiting for an official solution, they finally used the trails opened by forestry operators and spontaneously colonized a

¹¹ This expression is used to designate the lands located between the Xingu River and the BR-163 road. (...)

¹² National bank for social and economic development. It is the Brazilian public investment bank.

neighboring region (Fearnside, 2008). However, the diversity of migratory profiles (Arnaud de Sartre and Sebille, 2008) makes it difficult to generalize on this subject.

Table 2: migratory flows towards the Amazon in 2000 and 2010

Originating region	States									TOTAL
	Rondônia	Acre	Amazonas	Roraima	Pará	Amapá	Tocantins	Maranhão	Mato Grosso	
2010										
Amazon	71840	22960	110866	33075	165380	67191	56353	89220	109579	726464
Maranhão	5337	328	10436	13798	152025	8118	41796	39588	25697	297123
Rest of Brazil	80689	11406	55823	16889	139658	11808	93586	141221	257468	808548
TOTAL	159876	34694	177125	63762	457063	87117	191735	270029	392744	1834145
2000										
Amazon	51767	15444	90114	40463	65051	67471	33452	44403	55703	463868
Maranhão	5242	356	10660	26187	155642	11540	47344	0	11287	268258
Rest of Brazil	116253	8168	44218	17115	134509	10046	89261	84282	295118	798970
TOTAL	175262	23968	144992	83765	355202	89057	170057	128685	362108	1533096

(source IBGE)

Is deforestation legal or illegal?

- 41 Deforestation is not prohibited in Brazil and it is precisely because Brazilian laws authorize it that the federal government has refused to sign an international pledge to prohibit it before 2020. The forest code, which is the general text defining land use rules in Brazil, protects two categories of forest areas within private landholdings. The first ones are the "permanently protected areas" (*área de proteção permanente* - APP), essentially riparian forest along water streams, sources of rivers and slopes which may be subject to erosion. The second one is the "legal reserve", a portion of the property which must be maintained in native vegetation (but which may be used economically)¹³. In 1965, a revision of the forest code¹⁴ by the military power ruling the country at the time established this portion to be no less than 50% of the property. In 1996, in order to curb the escalation of deforestation, this proportion was augmented to 80%. In 2012, the 80% proportion was maintained in the revision of the forest code¹⁵, but two major alterations were made in its definition. Firstly, the the two categories are no longer considered separately and APP areas are now included in the calculus of the legal reserve area. Secondly, this 80% proportion may be lowered to 50% in states or counties if more than 65% of their surface area is classified as protected areas or Indigenous lands and if the local government decides so. 80 counties in the Amazon are concerned and the state of Pará will soon be too...
- 42 According to the law, farmers may legally deforest up to 20%, in some cases 50%, of their properties (in general, authorizations must be asked to local environmental agencies). Illegal deforestation is the deforestation which exceeds these limits or which is done in APP areas. It may then be heavily punished (especially since the 1998 Environmental Crimes Law) and should normally be compensated for by replanting in the zone concerned. However, the 2012 forest code reform proclaimed an amnesty for the illegal clearings done by certain types of landowners before 2008, for reasons of "realism". It is true that when the 50% threshold in legal reserves was augmented to 80%, farmers who had deforested up to the former limit and who were thus complying with the law, had not been taken into account. As a consequence, they were suddenly considered as outlaws although they had not purposely violated the rules. According to Soares Filho *et al.* (2014), the recent alteration of the legal reserve definition lowers by 58% the total area to be replanted nationally, mostly in the Amazon, and an additional 88 million of hectares may now be deforested legally. If the law still requires replanting, it now authorizes that this be done with exotic species or by buying forest areas in other places (although in the same biome) and preserving them. What may consequently appear now are regions where deforestation is concentrated and where legal thresholds are not respected, and others where the excess deforestation is compensated and where most economic activities will be prohibited *de facto*.
- ¹³ This notion appears in the 1934 edition of the code. At that time its proportion was 25% of the pro (...)
- ¹⁴ Law 4 771 of September 15th, 1965.
- ¹⁵ Law n° 12.651 of May 25th, 2012.

Who is responsible for the deforestation?

- 43 According to P. Fearnside (2008), nine categories of stakeholders linked to deforestation could be identified at the end of the 2000s: migrants, colonists that took part of governmental programs, ranchers, traffickers setting up money laundering schemes, wildcat gold miners, employees lured into contracts analogous to slavery, land title forgers (*grileiros*) and foresters. All these categories may interact with one another depending on local or regional contexts.
- 44 Deforestation in a given area generally starts with the degradation of the forest by foresters who are only interested in the most precious woods. The forestry frontier thus precedes the deforestation frontier. Foresters may also be called by land claimers or colonists who gain a starting capital by selling the timber cut on their properties. In some cases, the foresters enter previously undisturbed regions and this leads to conflicts with Indigenous or traditional populations. According to the NGO Imazon which monitors forest activities, in 2010, approximately two thirds of the timber collected came from areas where timber extraction is prohibited. The extraction process disturbs the ecosystem but it also creates a number of trails which allow squatters to settle deep into the forest. The opening of a precarious trail is sometimes the only compensation they obtain in exchange of the timber extracted from their "property".
- 45 Once accessible, an area may be occupied by landless peasants or by big landowners. The former may eventually be expelled by the latter, either by being compelled to sell their ownership claim or by being forced to leave at gunpoint. Land title forgers also frequently expel the first claimants in order to gain control over big tracts of land that they can then sell to investors. Those may be ranchers, but also traffickers or wildcat gold mining entrepreneurs who are interested in using the informality of land transactions and associated economic activities to set up money laundering schemes. However, if informality and illegal activities are linked in many parts of the Amazon, the links between the corruption of local authorities and deforestation is not clear at a global level (Cassandro and Porto Junior, 2012). It is more evident at a local level, as the case in Mato Grosso illustrates, where a series of scandals showed the implication of politicians and big landowners in illegal timber exploitation or the occupation of public lands.
- 46 Once an area is occupied, deforestation occurs rapidly as the claimants wish to show their presence and to consolidate their claim, but also to increase the value of their land. Smallholders generally clear the land themselves. Big farmers may contract specialized firms which provide an underpaid workforce to do the job, sometimes keeping their employees in a situation considered as modern slavery¹⁶. The areas where such situations take place are typical frontier areas, where violence and impunity rule. Land concentration also frequently happens at that stage, a number of smallholders choosing to sell their plot after having deforested and transformed it into pasture.
- 47 The deforestation process may then come to a point of stabilization if the landowners choose to adopt middle or long term land management objectives. Ranchers may sell their properties to big farmers who develop mechanized agriculture, or even become farmers themselves. On numerous occasions, land owners do not invest in them, leaving their property barely active, usually because of judicial disputes. The program of agrarian reform stipulates that such properties can be seized by the INCRA and redistributed to landless peasants (who may first squat the properties and obtain official ownership afterwards). In general, such new settlements trigger a new deforestation cycle, especially inside the legal reserves that had been respected until then.
- 48 The question of knowing who is more responsible between smallholders and big landowners is an endless debate with obvious political implications. The latter blame the former in order to demonstrate that the agribusiness model is an efficient way of managing Brazilian forests. Some big farms do actually have perfectly preserved legal reserves. On the other hand, smallholders, and especially members of movements linked to the agrarian reform, request land redistribution and are opposed to land concentration. They insist that the same criteria cannot be applied to the small-scale farms of 30 hectares and those of 30,000 hectares: deforesting 20% of a 50-hectares property only leaves 10 hectares to develop economic activities, which is a very small surface for a family plot in the Amazon, especially with a traditional slash and burn system where a portion of the land must be kept in fallow.
- 49 Although it is impossible to know precisely who to blame for the deforestation because of the lack of a reliable cadastre (see below the section on the Environmental rural cadastre), some studies tried to produce estimations based on the crossing of deforestation data with agricultural censuses and other land tenure information. Godar *et al.* (2012) used the information on agricultural census blocks to elaborate a profile for each block, based on the dominant type of land tenure. Their study revealed that the blocks with a

¹⁶ See Théry *et al.*, 2012. As an example, in the county of Pacajá, which is on the "black list", 47 ca (...)

majority of large properties are the biggest contributors to the deforestation (48% of the total deforestation happened in blocks where properties bigger than 500 hectares are most numerous), but they also correspond to the areas where the reduction of deforestation has been the greatest. Blocks with a large number of smallholders do not contribute as much to deforestation (12% of the total deforestation happened in blocks where properties under 100 hectares are in the majority), yet the decline of deforestation in those areas has been less significant. Such findings may explain why the steps taken to contain deforestation are proving less efficient nowadays since they are mainly aimed at big farmers and ranchers.

- 50 All the studies that focus on the correlation between the size of landholdings and deforestation seem to underline a certain logic. In the region of the Transamazonian highway, Godar *et al.* (2012) showed that the absolute volume of deforestation is higher in large estates, but that the surface area being deforested increases when the property size decreases. Big landowners therefore orient their properties towards large-scale production but they nevertheless save a sufficient portion of land to more or less respect the legal reserve. Smallholders need to deforest almost all of their estate for them to be profitable. However, as Brondizio and Moran (2012) pointed out, different logics may appear depending on the scale of observation and on the regional context. The complexity of these strategies complicates modelization attempts and the observation of current trends (Dalla Nora *et al.*, 2014).
- 51 Other studies focus on areas for which more precise information (eventually georeferenced) is available, such as the settlement projects of the agrarian reform plan implemented by the INCRA. These schemes have been considered as responsible for an important share of the total deforestation (Le Tourneau and Burzstyn, 2010), 21% according to the INCRA in 2008. In fact, the installation of colonists in general leads to deforestation. However, it must be noted that for the last two decades, the land allocated for settlement projects are generally expropriated large properties that have already been partially deforested rather than closed forest areas. The deforestation resulting from agrarian reform settlements is therefore not linked to the colonists themselves.
- 52 Another type of land has also been scrutinized: protected areas. Studies demonstrate that Indigenous territories and strictly protected areas such as national parks and ecological stations are less encroached by deforestation (Nolte *et al.*, 2014). Protected areas “of direct use”, where the permanent presence of populations and a number of economic activities are permitted, small-scale deforestation is observed, which raises concern that those areas could gradually be destroyed by their inhabitants. In many cases, these inhabitants are no longer able to rely on traditional activities for their subsistence and they are compelled to turn towards other more profitable activities such as cattle ranching. This situation has been well documented in the emblematic Chico Mendes extractive reserve (Souza, 2013).

Federal government policies against deforestation

- 53 As shown in Figure 3, the past decade saw an almost constant decrease in the deforestation rate in the Brazilian Amazon: the rate was only 20% in 2014 of what it was during the peaks of 1995 or 2004. There has been an intense academic debate on the causes of those peaks and on the responsibilities of given sectors like soybean cultivation, but the reasons for the decrease seem much clearer and consensual. They are linked to the firm actions of the Federal government at different scales and in distinct areas (Assunção *et al.*, 2012; Arima *et al.*, 2014). In this section, we will review the different components of this action, initiated in 2004 as part of the “plan to control deforestation in the Amazon” (*Plano de Ação para a Prevenção e Controle do Desmatamento na Amazônia Legal – PPCDAm*; see MMA, 2014), coordinated by the ministry of the Environment headed by Marina Silva at the time. However, not all the subsequent actions were produced within this plan. They were the fruit of a political agenda which has gradually extended to all the divisions of the Federal government and which produced a wide array of initiatives. This is why, long after its emblematic ambassador was dismissed, deforestation control still remains a major issue in governmental policies.

Monitoring and sanctioning tools

- 54 The first element of the anti-deforestation plan concerns information and monitoring. Since 1988, Brazil maintains a program of satellite monitoring of the rainforest that reports deforested areas. This program, called PRODES, produces an annual report that indicates the tendencies of the past year.

17 Based on a thorough methodology, PRODES data are the reference on this subject, even if desforested (...)

Since 2002, the report, as well as highly precise geographical information, have been accessible online for free ¹⁷. Although it is a very precious instrument, it has several inherent limits. First of all, the data are published annually, which makes it unusable to detect deforestation while it is being done. Secondly, it is based on a binary logic (forest/deforested) and only searches for clear cuts in the rainforest. In order to complement it, the Brazilian Institute for Space research (INPE) has developed two more instruments. The DETER, based on the MODIS sensor, uses coarser but more frequent images allowing the detection of on-going deforestation ¹⁸ on a daily basis. The DEGRAD is a new model of image processing which uses the same sensors as the PRODES but which focuses on forest degradation. Brazil has also been very active in spatial research in order to have its own observation satellite ¹⁹, but the technical and operational obstacles have not yet been completely overcome.

¹⁸ This only concerns areas superior to 25 hectares. Some farmers therefore fragment the areas they wa (...)

¹⁹ Up until now, sources used in deforestation monitoring programs have been NASA satellites and senso (...)

- 55 On the basis of the information provided by those systems, legal instruments have been mobilized, and controls on the field have been intensified. One particularly efficient legal tool is the “law on environmental crimes”, voted in 1998, which instituted heavy penalties (1,000 R\$ per hectare, raised to 5,000 R\$ in 2005) for illegal deforestation. The number of fines which were applied increased sharply during the last decade, but their contribution to the decrease of deforestation must be put into perspective as only a very small proportion of them are effectively paid (less than 0.2%, according to the IBAMA 2012 report) and as the control of deforestation has been transferred from the Federal administration to state agencies in 2012 on (except on federal lands). State agencies are not always as strict as the federal administration on illegal deforestation.
- 56 Specific actions that targeted the counties with the most deforestation have been much more efficient. Based on the PRODES data, 36 counties were identified and underwent important restrictions (for instance, loans for agricultural activity were banned) until their situation was normalized. The expected results of this “black list” were not only a massive reduction of the deforestation, but also the creation of a georeferenced cadastre that took stock of all properties. The mechanism proved efficient. 11 counties have succeeded and were erased from the list, and former “champions” of deforestation became “green counties”, such as is the case in Paragominas in Pará.
- 57 Using the same argument that loans are necessary for the expansion of agricultural activities, the Central Bank of Brazil took a resolution in 2008 that denied further loans to farms that did not have a clear official land title. According to a study (Assunção *et al.*, 2013), about 2.9 billion of R\$ were withheld between 2008 and 2001 (90% in cattle ranching operations), contributing in a very efficient way to limit the capacity of big landowners ²⁰ to increase deforestation.

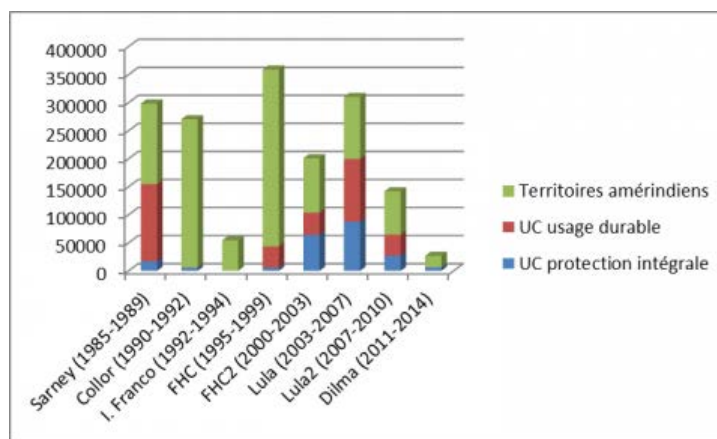
²⁰ The credit program for family agriculture, PRONAF, was not included in this measure 3.545/2008.

Zoning, regularization of land claims and creation of protected areas

- 58 The second axis of the PPCDAm program deals with a better control of land issues. As we have seen, in the absence of a cadastre, identifying the owners of illegally deforested lands or judging legitimate claims are difficult. A number of initiatives have been set up to tackle those issues.
- 59 First of all, governments chose to control the situation by establishing zoning and by creating protected areas of various types (environmentally protected areas as well as Indigenous territories) at the federal, state and even county levels. Even if these dynamics have slowed down since 2009, around 500,000 km² of federal protected areas have been created in the Amazon since 2005 (figure 6), and this enterprise has been reproduced at both state and county levels. For example, the state of Pará has created 150,000 km² of protected areas in the same period of time. According to Taravella (2007), one reason for the success of such measures is that they break the mechanism of land speculation. Potential buyers are discouraged to acquire claim titles (*posses* ²¹) since those may be finally invalidated if localized in protected areas. The value of those lands therefore diminishes considerably and it is hereafter no longer profitable for the claimer to deforest them.

²¹ Land claims or legitimate squats: Brazilian land laws authorize any citizen to claim ownership of n (...)

Figure 6: The creation of Federal protected areas in the Amazon by presidential mandate 1985-2004

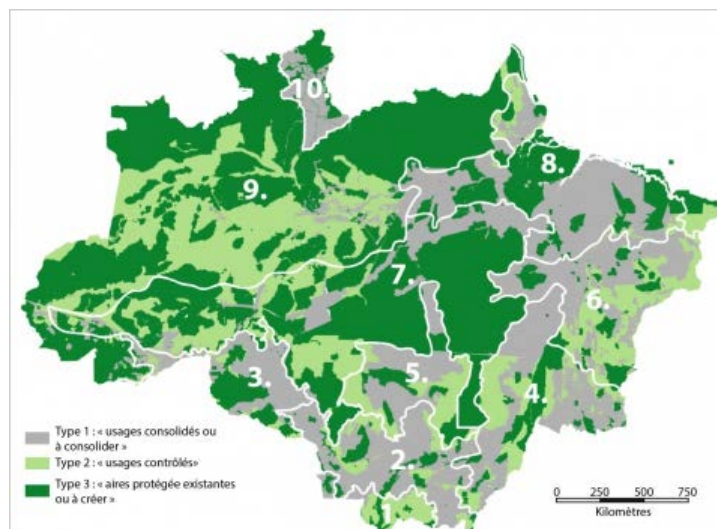


Agrandir Original (png, 28k)

(source of data: ISA)

60 The federal government also pushed for the adoption of zoning plans by state governments in which the use for each area is specified. These plans were then assembled in a “macro-zoning plan for the legal Amazon” which is to orient public policies. Its adoption has been an important step: for the first time, Brazil explicitly stated which parts of the Amazon were open to agricultural development and which were reserved for environmental conservation. The zoning plan is based on two different scales. The first designates the use of relatively small areas classified in three different categories: already deforested areas, areas where economic activities are allowed with the condition of maintaining the forest cover and areas reserved for conservation (Figure 6). The second scale presents a regionalization of the Legal Amazon in ten “macro-regions”, each one corresponding to a well-defined strategy (figure 6 and table 3).

Figure 7: The “macro-zoning” of the Legal Amazon



Agrandir Original (jpeg, 304k)

(source MMA)

Table 3: Regions defined in the macro-zoning of the Amazon (see figure 6).

N°	Description
1.	Pantanal protection, promotion of local culture, traditional activities and tourism
2.	Regularization and innovation of the agro-industrial complex
3.	Planning and consolidation of the logistical integration with the Pacific
4.	Redefinition of productive systems in the Araguaia-Tocantins area
5.	Diversification of the agricultural, forestry and cattle ranching frontier
6.	Reinforcement of polycentricism at the crossroads of Pará, Tocantins and Maranhão states
7.	Containment of expansion fronts through the creation of protected areas and the promotion of alternative land use
8.	Reinforcement of coastal cities, mining regulation and diversification of the economy

9.	Protection of the forest heartland by developing productive activities
10.	Reinforcement of the Amazon-Caribbean integration corridor

- 61 At the regional scale, such zoning policies were repeated in the most sensitive areas. Two “forest districts” were created, one in the region of the Carajás mine and one along the BR-163 highway. In the latter case, a “sustainable BR-163” plan has been launched with even more detailed orientations.
- 62 Another line of action has been the attempt to clarify land tenure with the regularization of land claims (*posses*). In 2009, the “legal land” (*Terra legal*)²² program was launched to deliver land titles under certain conditions. It mainly focused on 43 counties with high deforestation rates and its final objective was the regularization of 150,000 pre-2004 claims on federal lands, for an estimated total area of over 15 million of hectares. States governments were also prompted to do the same on state controlled lands.
- 63 The last instrument used regarding land issues is the creation and maintenance of a unified land cadastre named “environmental rural cadastre” (CAR), which is currently being set up, with special attention paid to “blacklisted” counties. When completed, this geographical database will considerably simplify environmental monitoring and environmental law enforcement in every property. In case infractions are detected, compensatory measures will be required from land owners who will be clearly and easily identified.
- 64 All these measures have proven to be effective if one judges by the reduction of deforestation. However, a number of obstacles limit their overall efficiency: zoning plans are not rigorously applied; the regularization of land claims within the Terra legal project is very slow (because of thorough control processes in order to prevent or to limit fraud) and only 4% of the claims had been processed in 2014; the constitution of the CAR is also very slow.

²² Based on law 11.952/2009

Sectorial negotiation policy

- 65 The mobilization of the federal government in deforestation control plans had the effect of rallying other public or private sectors, and two of these sectors have had decisive effects (Nepstad *et al.*, 2014).
- 66 The first sector involved is that of big farmers and agribusiness firms engaged in soybean cultivation and trade. Because this crop has had a very bad reputation as a driver of deforestation, they have feared that such an accusation would threaten their image and bar their access to certain foreign markets, especially in Europe. Furthermore, the whole soybean complex is firmly structured and capitalized, which made a collective reaction possible. In 2006, under the supervision of the federal government, an “environmental pact” was signed between NGOs and two unions of soybean producers that controlled 94% of the crop trade in Brazil. The goal of this agreement was to contain soybean cultivation to areas already used for this purpose. It thus prohibited soybean farming in parts of the Amazon that had not already been deforested at that time (converting already deforested areas such as pastures into soybean fields was however possible). It also instituted a “soybean workgroup” in which the partners were to meet regularly and monitor the application of the deal. Signed for a limited period of time, the agreement has been renewed several times. It is monitored by satellite imagery (Rudorf *et al.*, 2011) and is generally respected by the farmers. The perspective now is to transform it into a permanent mechanism based on the rural cadastre program (CAR). The overall results have been significant since, according to Macedo *et al.* (2011), only 2% of the expansion of soybean cultivation in Mato Grosso has taken place in newly deforested areas.
- 67 Pressure remains high however, especially now that new varieties better suited to the Amazonian climate are being developed. The surface area planted with soybean in the Amazon has increased more than twofold between 2002 and 2014 (table 4) and although 84% of soybean fields are located in Mato Grosso still, they are expanding northward, in Pará along the BR-163 road, and westward, in Rondônia. In the Northern region of Brazil, which is almost completely included in the rainforest biome, the surface area dedicated to soybean cultivation has risen from 0.8 to 3% between 2002 and 2013. As most of these new soybean fields occupy former pastures, new land will probably be sought to raise the cattle that grazed in these pastures, and, as an indirect result, parts of the rainforest will be cleared. Local initiatives try to control this trend by enforcing environmental rules. In Pará, a deal was made in 2014 under the supervision of the state Public Ministry in order to exclude from the soybean market farmers who did not respect environmental norms.

Table 4: Soy-bean cultivated areas in the Amazonian states

State	2002	2013	Variation
Acre	0	60	-
Amapá	0	4 550	-
Amazonas	1 717	20	-8585 %
Maranhão	238 173	564 546	+237 %
Mato Grosso	3 818 231	7 931 905	+207,8%
Pará	2 648	189 746	+7165,6%
Rondônia	28 914	179 886	+622,1%
Roraima	0	14 900	-
Tocantins	107 377	536 545	+499,7%
TOTAL	4 197 060	9 422 158	+224,5%

(source: IBGE)

- 68 One of the major elements concerning the deals concluded with soybean farmers and traders is that the modification of their practices occurred due to client pressure. Inspired by this model, the Federal Public Ministry (MPF) started in 2009 an effort to regulate beef production in the Amazon. Instead of trying to identify the farmers responsible for illegal deforestation, which proved to be a frustrating and time-consuming task, it concentrated its attention on slaughterhouses and big supermarkets, threatening them of heavy fines if they sold meat produced in illegally deforested areas. This action was further extended in the "legal meat" program (*Carne legal*) in which firms and representative associations of the meat sector were invited to sign "good practices" commitments²³ in order for sanctions taken against them to be lifted. In the state of Pará, the Public Ministry has doubled this program by another one named "green counties" (*Municípios verdes*) in which farmers who comply with the rural cadastre program may have access to credit with better rates at the *Banco do Brazil* bank.
- 69 These deals have progressively spread over the whole Amazon region. Today, they involve more than 97 slaughterhouses, including very important firms of the meat sector like JBS, the biggest meat producer and processor in Latin America. They have led to a reorganization of the whole meat sector with, for instance, the implementation of livestock traceability in order to prove the origins of the meat processed and sold by supermarkets. However, this system is far from being perfect as cattle may be bought from one property but have been raised in another, possibly an illegally deforested one. Moreover, the new system has a cost which may be too important for small farmers.
- 70 Besides from these deals, direct negotiation also took place between farmers associations and NGOs (which had been suspected of collaborating with firms and the private sector in general for a long time) in order to promote "good practices" and gain environmental certification. The Nature Conservancy pioneered such agreements with its "greener soybean" (*Soja+verde*) program in the Tele Pires region of Mato Grosso where the multinational firm Syngenta is implanted. The deal imposes that farmers reforest riparian forest areas that have been illegally cleared if they want to sell their production to Syngenta. Other major NGOs, such as the Socioambiental Institute (ISA), have also proposed deals to farmers in order to reduce the environmental impact of farming.

23 These deals also had social conditions, especially pledges to eradicate modern slavery.

Payment for Environmental Services (PES) schemes

- 71 The role and importance of the Amazon ecosystem at the local, continental and even global scales (see "Progress, affected places and impacts of the deforestation in the Amazon") clearly justifies the adoption of programs that reward environmental services and that would consequently add value to forest areas and constrain the phenomenon of land speculation that encourages deforestation. However, the effective implantation of such programs proves to be quite tricky. As underlined by Wunder *et al.* (2008), given the size of the Amazon, there is little chance that the funds available will allow the extension of such programs over the whole region. Choices must therefore be made, even at the cost of establishing territorial injustice. According to the same authors, the best strategy is probably to exclude either the forest heartland, where the pressure to deforest is low, and the agricultural frontier, where the rewards which may be offered would not be high enough to compete with the profits made from cattle ranching or land speculation. Such programs could accordingly target the fringes of the frontier, where they could orient local activities towards conservation. In their

study of the Cruzeiro do sul area, Eloy *et al.* (2012) came to a similar conclusion and pointed out that if PES programs continue to target the areas where deforestation is high (which is the current tendency), they may miss the opportunity of preventing it in places where it is only beginning and where pressure is lower.

- 72 In general, PES programs have not met an enormous success in Brazil. A pioneer program (PROAMBIENTE) was set up by civil society organizations and later adopted by the environment ministry in 2003. Limited to 12 regional poles with a few hundreds of families each, it encountered many difficulties and did not end up being generalized. However, as Hall (2008) explained, its weaknesses may serve to illustrate the difficulties found in setting up this kind of program in the Amazon.
- 73 The next attempt was carried out at the state level. In 2007, the state of Amazonas created the *Bolsa Floresta* program, similar to the *Bolsa família* model which was being deployed nationally at the time. It was designed to provide a supplementary income for the inhabitants of state protected areas, provided they respect a number of rules and restrictions on certain economic activities. Since 2011, the federal government has been deploying a similar program nationally, entitled *Bolsa verde*, in order to benefit inhabitants of the federal protected areas. These people have also been included since 2010 in the program of agrarian reform and they are able to access special credit programs for housing improvement or the development of economic activities. By bringing new perspectives to their inhabitants, such incentives may certainly diminish the pressure put on protected areas. However, as Wunder *et al.* have noted, they do not confront deforestation directly since they target areas where it is already prohibited by law.
- 74 Since 2008, the discussion around PES schemes has evolved in international fora with the creation of REDD and REDD+ mechanisms (Cancún conference, 2010). Brazil was interested in the prospects of funding within this framework, but did not formally commit. Instead, the government chose to bypass the UN program by creating the "Amazon Fund" intended to receive donations to support alternatives to deforestation. An agreement with Norway, in which the Nordic country gave \$1 billion as part of its efforts to promote climate change mitigation, made this Fund one of the biggest in the world. However, its management by the BNDES does not seem optimal: being used to manage large industrial projects, the Bank seems to have difficulties with the types of actors involved in alternative projects (NGOs, local communities and associations). By the end of 2014, 5 years after its creation, the Fund had approved only 69 projects for a total of slightly more than 1 billion R\$, approximately half the donations received²⁴. Some of its thematic components, for example the one labeled "control and monitoring", are primarily used to finance projects already implemented at the federal level, or to fund the transfer of the Brazilian technology on forest monitoring to other tropical countries. In 2013, a reorientation of the Fund to improve accordance with the directions of the PPCDAm program was initiated.

24 Considering an average quotation of 2 R\$ for one US\$, the fund has received more than 2 billion R\$.

Table 5: Commitments of the Amazon Fund, by subject area

Component	Value (millions of R\$)	Proportion
Sustainable production	203,6	26 %
Control and monitoring	375,4	49 %
Land planning	69,4	9 %
Scientific and technological development	123,2	16 %
TOTAL	771,7	100 %

(source: Amazon Fund, annual report 2013)

- 75 Following in the footsteps of the federal Government and the creation of its own REDD mechanism, Amazonian states have also perceived the potential of this type of funding and have implemented local REDD+ programs (and funds to receive donations), such as Mato Grosso. However, their action is not yet very effective, principally due to the lack of financial resources. According to Gebara *et al.* (2014), the absence of a clear coordination by the federal government also complicates the negotiations between stakeholders. The interests of the Amazonian states indeed vary according to their profile: whilst Mato Grosso can earn considerably by "selling" avoided deforestation, Amazonas should rather insist on the maintenance of carbon stocks and on the reduction of forest degradation.

The role of foreign policy

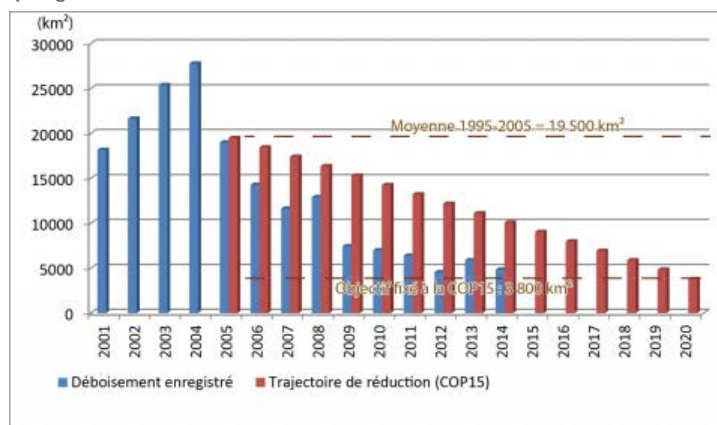
- 76 In the case of Brazil, the issue of deforestation is closely linked to negotiations on climate change for two reasons. First of all, deforestation is by far the first

source of CO₂ emissions in Brazil. Secondly, Brazil considered that signing binding agreements on CO₂ emission reductions would lead to international interferences on its domestic policy in the Amazon; it consequently firmly refused to go ahead with these negotiations to shield its sovereignty.

- 77 However, this situation has changed significantly in the past decade. Having apparently managed to control deforestation, Brazil was able to present an excellent carbon balance, with a 38.7% reduction of its emissions between 2005 and 2010²⁵. As these good results in the Amazon offered room for political manoeuvres, the Lula Government pledged in 2009 a reduction of Brazilian emissions of about 38% by 2020. Transcribed in the "National emissions policy", this objective implied an 80% reduction of deforestation in the Amazon in comparison to the average deforestation between 1995-2005, that is less than 3 800 km² per year (Figure 8). Brazil is today ahead of these objectives, but there are nevertheless remaining hurdles. Getting below the 5,000 km² threshold of annual deforestation will be not simple because it seems to represent the limits of effectiveness of the current measures.
- 78 Moreover, several elements indicate that CO₂ emissions will still be higher than predicted. Some studies show that emissions due to deforestation have been underestimated by 20% because of the failure to take into account the effects of forest fragmentation (Putz *et al.*, 2014). Others indicate that degraded areas could store up to 40% of CO₂ less than intact forests do (Berenguer *et al.*, 2014): the process of forest degradation by selective logging or by fire is therefore a significant source of emissions. Finally, forest degradation and global warming could have triggered a change in the Amazon rainforest ecosystem which could now absorb less carbon than it emits (Davidson *et al.*, 2012), or issue important quantities of natural CO₂ during drought periods (Potter *et al.*, 2011).

25 This diminution is mainly driven by the control of the conversion of forest areas to agriculture, a (...)

Figure 8: The reduction of deforestation since 2001 and the COP15 Brazilian pledge



Agrandir Original (jpeg, 174k)

Conclusion: is Brazil now in control of deforestation in the Amazon?

- 79 Since 2004, deforestation rates in the Brazilian Amazon have decreased sharply, and this trend has been constant for a decade. In 2014, the deforestation in absolute terms was about 20% of what it used to be in the early 2000s. But it is still too soon to call it a victory.
- 80 First of all, even if the rhythm is slower, an average of 5,000 km² of forest is cut down each year, a considerable area. This means that the ecological and climate impacts will continue to expand. A situation of equilibrium or recuperation which would guarantee that the Amazon rainforest will exist in the future has yet to be reached.
- 81 Secondly, although the control measures seem to have generally yielded results, they have been much less efficient in given regions, as is the case for instance around the BR-163 highway, despite the implementation of a specific plan. The hold of the Federal government on the situation is therefore elusive in certain places and a climate of violence continues to characterize some areas of the Amazon.
- 82 Thirdly, some of the policies that were applied seem to have contradictory impacts. For instance, the attempt to regularize land claims may lead to deforestation in the future as former squatters will be entitled, as legal owners, to deforest up to 20% of their plots (a limit which may be extended to 50% in some cases). Similarly, the policy of forest concessions applied to

very large forest blocks may dramatically increase forest degradation, in which the ecological balance is heavily disturbed even if the forest cover remains in place.

- 83 Last but not least, the next challenge will probably be to overcome the alternative between repression and control or deforestation, and to design sustainable and feasible production systems in the Amazon, whether in deforested areas or in forest regions. Concerning deforested areas, the Federal government claims that subsidies for sustainable production are already included as a third step in its plan for controlling deforestation and that intensification is already happening in certain sectors like soybean cultivation. The potential for such measures is very high: according to Barreto and Silva (2013), if a quarter of Amazonian cattle ranching farms were as productive as their European counterparts, it would be possible to supply the projected increase in meat demand for the next ten years without deforesting more areas. Moreover, there are many degraded lands which could be made productive again. The Federal government has committed to restore 15 million hectares of such lands, but how this will be done (and where) is still unclear. However, these initiatives do not seem to sufficiently tackle the main issue at stake, which is that despite its fundamental importance in global and local climate, the Amazonian rainforest on its own has no evident economic value. Many pilot programs put in place during the 1990-2000 period were designed to valorize NTFP and did not gain enough momentum to trigger a new economic cycle, with the exception of very few market niches, insufficient to improve the livelihood of more than a handful of local communities.
- 84 To switch from the zero-deforestation policy to a true and sustainable forest economy is clearly the next challenge for the Amazon.

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Notes

1 In order to be able to create large settlements, the federal government decided to federalize a strip of 100 km along every federal highway to be constructed in the Amazon (decrees 1.164/1971 and 1.473/1976).

2 The motto of the National Integration Plan was "*integrar para não entregar*".

3 Depending on the characteristics of the sensors, it is impossible to reconstitute exactly the same colors in all the images. However, the compositions chosen here show forest areas in green and deforested areas in pale green, yellow or pink. The progression of the frontier over more than 100 km in this region is obvious.

4 The data published by the INPE before 1988 are imprecise and must be interpreted with caution. Just as Fearnside (2003) did, we added 100,000 km² to the INPE data, representing the pre-1970 deforestation.

5 This map was built by the author using the INPE deforestation map and calculating the deforestation rate in 10x10km cells, and adding other useful information such as the localization of the "black list" counties.

6 Between 1970 and 2010, the number of cattle heads in the São Felix do Xingu county alone raised from 500 to 1,300,000 ...

7 These figures concern the whole Legal Amazon. Until the 1970s, cattle ranching was almost exclusively concentrated in the savannah part of this region. Its progression in rainforest areas has been even more dramatic.

8 For instance, the owner of the pasture may let cattle from an investor in his property for free, in exchange for which both he and the investor share the calves born during the contract.

9 The majority of the families who settled along a river was affiliated to a patron, to whom they bought goods from and to whom they sold their production. The patron was expected to provide assistance (medicine, loans, protection against legal disputes) in exchange. Frequently, and especially during the rubber boom, this system, called *aviamento*, evolved into a brutal domination by the patrons.

10 Such auxiliary crops may become the main focus depending on the prices of commodities.

11 This expression is used to designate the lands located between the Xingu River and the BR-163 road, which represent a forest island in the middle of two very active frontier areas.

12 National bank for social and economic development. It is the Brazilian public investment bank.

13 This notion appears in the 1934 edition of the code. At that time its proportion

was 25% of the property, regardless of the region.

14 Law 4 771 of September 15th, 1965.

15 Law n° 12.651 of May 25th, 2012.

16 See Théry *et al.*, 2012. As an example, in the county of Pacajá, which is on the "black list", 47 cases were noted and 661 workers freed between 2000 and 2012.

17 Based on a thorough methodology, PRODES data are the reference on this subject, even if deforested areas must be superior to 6.25 hectares to be detected, depending on the resolution (30 meters) of the images used and on the method of interpretation. The program also only uses one image for each scene. If this image is partially covered by clouds, the deforestation may be underestimated, and, in areas where images are almost always partially covered with clouds, this may lead to false interpretations. Another limit of the INPE procedure is that as it requires a lot of time to process all the images (8 months) and there has been no retroprocessing of the data. The measure of deforestation is therefore very imprecise before 1988, and even more before 1980 when the resolution of the sensors was coarser.

18 This only concerns areas superior to 25 hectares. Some farmers therefore fragment the areas they want to deforest in blocks of less than 25 ha in order to avoid detection.

19 Up until now, sources used in deforestation monitoring programs have been NASA satellites and sensors.

20 The credit program for family agriculture, PRONAF, was not included in this measure 3.545/2008.

21 Land claims or legitimate squats: Brazilian land laws authorize any citizen to claim ownership of non-designated public land if he resides on it and "improves" it, in a limit of 50 hectares by claim. Before a permanent land title is emitted, the claimant is considered as a *posseiro*, i.e. legal squatter.

22 Based on law 11.952/2009

23 These deals also had social conditions, especially pledges to eradicate modern slavery.

24 Considering an average quotation of 2 R\$ for one US\$, the fund has received more than 2 billion R\$.

25 This diminution is mainly driven by the control of the conversion of forest areas to agriculture, a sector which represented 65% of the Brazilian emissions in 2000, 55% in 2005 and 23% in 2010. Such figures also show that the emissions from other sectors have increased, especially those linked to the energy sector (+21% between 2005 and 2010).

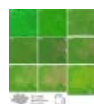
Table des illustrations



Titre **Figure 1: States, biome types and main roads of the "legal Amazon"**

URL <http://cybergeog.revues.org/docannexe/image/27484/img-1.jpg>

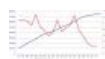
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Titre **Figure 2: Progression of the forest frontier in the region of Ariquemes (Rondonia)**³

URL <http://cybergeog.revues.org/docannexe/image/27484/img-2.jpg>

Fichier image/jpeg, 660k



Titre **Figure 3: Total deforestation and annual rate, 1975-2014**

Crédits (Source of data: INPE⁴)

URL <http://cybergeog.revues.org/docannexe/image/27484/img-3.jpg>

Fichier image/jpeg, 148k



Titre **Figure 4: Frontier areas in the Amazon**

URL <http://cybergeog.revues.org/docannexe/image/27484/img-4.jpg>

Fichier image/jpeg, 3,0M



Titre **Figure 5: Brazil CO2 emissions by sector**

Crédits (source MCTI, 2013)

URL <http://cybergeo.revues.org/docannexe/image/27484/img-5.png>

Fichier image/png, 13k



Titre **Figure 6: The creation of Federal protected areas in the Amazon by presidential mandate 1985-2004**

Crédits (source of data: ISA)

URL <http://cybergeo.revues.org/docannexe/image/27484/img-6.png>

Fichier image/png, 28k

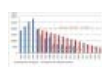


Titre **Figure 7: The "macro-zoning" of the Legal Amazon**

Crédits (source MMA)

URL <http://cybergeo.revues.org/docannexe/image/27484/img-7.jpg>

Fichier image/jpeg, 304k



Titre **Figure 8: The reduction of deforestation since 2001 and the COP15 Brazilian pledge**

URL <http://cybergeo.revues.org/docannexe/image/27484/img-8.jpg>

Fichier image/jpeg, 174k

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