The State of the Amazon
Indicators

The Amazon Frontier Advance:
from boom to bust

Danielle Celentano & Adalberto Veríssimo

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ADA	Amazon Development Agency
Cimi	Indigenous Missionary Council
CID	International Classification of Diseases
CNBB	National Council of Brazilian Bishops
Contag	National Confederation of Agricultural Workers
CPT	Pastoral Land Commission
CVRD	Vale do Rio Doce Company
EAP	Economically Active Population
FJP	João Pinheiro Foundation
FOB	Free on Board
FSC	Forest Stewardship Council
Funai	National Indian Foundation
Funasa	National Health Foundation
GDP	Gross Domestic Product
HDI	Human Development Index
Ibama	Brazilian Institute of the Environment and Renewable Natural Resources
IBGE	Brazilian Institute of Geography and Statistics
ILO	International Labor Organization
Incra	National Institute of Colonization and Agrarian Reform
Inpe	Spatial Research Institute
Ipea	Applied Economic Research Institute
ISA	Socioenvironmental Institute
MDIC	Department of Development, Industry and Foreign Trade
MF	Department of the Treasury
MMA	Department of the Environment
MS	Department of Health
MST	Landless Workers Movement
MTE	Department of Labor and Employment
Oema	State Environmental Organization
OIS	Organization of Ibero-American States
PAC	Accelerated Growth Program
PIN	National Integration Project
Rais	Annual Report on Social Information
SPVEA	Superintendence for the Plan for Economic Valorization of the Amazon
Sudam	Superintendence of Amazon Development
UC	Conservation Unit
UN	United Nations
UNDP	United Nations Development Program

SUMMARY

The advance of the frontier in the Amazon has been marked by the degradation of natural resources, violence, and rapid economic growth, although this growth has been unsustainable in most municipalities in the region. In fact, in this model of land occupation, the economy follows a "boom-bust" pattern. In the first years of economic activity a rapid but ephemeral growth in income and employment occurs (boom), often followed by environmental, economic, and social collapse.

The rates of rural conflicts and murders related to land disputes remain high, and are spatially correlated with deforestation and the opening of the frontier for agriculture, cattle ranching, and predatory logging. In turn, the HDI of the region (0.705) has increased in recent years, largely due to improved indicators for access to education. Even so, this index has remained below the Brazilian average. The municipalities with a higher contingent of migrants from southern and southeastern Brazil show a higher HDI than the rest, which provides evidence of an imported HDI.

Although the growth in GDP in the Amazon has outpaced the national average in recent years, it still represents only 8% of the Brazilian economy. *Per capita* GDP (US$ 2.32 thousand) grew only 1% per year in the last few years in the Amazon, remaining 40% less than the Brazilian average. Furthermore, only 21% of the economically active population had formal jobs in 2004, with the majority being in the public sector.

An analysis of violence and socioeconomic aspects along different frontiers of occupation and deforestation in the Amazon (non-forested, deforested, under deforestation pressure, and forested) demonstrates that economic development in the region follows the boom-bust pattern as proposed by Schneider *et al*. (2000). In the short term, economic indicators (GDP and employment) are rising and the HDI is favored by income generation and the attraction of immigrants. But the costs are high: violence, degradation of forests, and deforestation. In the long term, already highly deforested regions exhibit a decrease in rates of violence and lower socioeconomic indices compared to regions where deforestation is now occurring.

INTRODUCTION

The advance of the frontier in the Amazon is a dynamic, voracious, and heterogeneous process. This process is a relatively recent phenomenon, and was stimulated in the 1960s and 1970s by government incentives to occupy the Amazon and integrate it with the domestic market. In the 1980s and 1990s there was decrease in public investment in infrastructure and other projects in the region. However, the occupation of the frontier intensified with the boom in logging activity associated with the growth of cattle ranching, agribusiness, and speculation in public lands.

At the beginning of the 21st century, the forces acting in the Amazon have become more complex. They include, on one hand, investments that could potentially amplify deforestation, such as public expenditures (primarily for infrastructure and credit), the expansion of agrarian reform settlements, and the entrance of private capital to meet the demands of the global market in the areas of mining, cattle ranching, and timber exploration. On the other hand, initiatives now exist for conservation and sustainable use of natural resources, such as the creation of Conservation Units, the combating of illegal occupation of public lands, and improvement in the environmental enforcement, licensing, and monitoring system.

The advance of the frontier is marked by deforestation, degradation of natural resources, and rural violence. In little more than three decades, deforestation increased from 0.5% of original forest territory to almost 17%, reaching approximately 700,000 square kilometers in 2006. At least 14% of these deforested areas were found to be degraded and abandoned (Arima *et al*. 2005). Furthermore, extensive areas of forest have suffered degradation as a result of predatory logging activities and forest fires.

The predominant model of occupation in the region (predatory logging and conversion of land for agriculture and cattle ranching) tends to result in a local economy that follows the "boom-bust" pattern. In other words, the first years of economic activity see rapid and ephemeral growth (*boom*), followed by a significant decline in income, employment, and tax revenue (*bust*) (Schneider *et al*. 2000)[1]. Income falls due to the collapse of timber exploitation, and as a result of economic conversion of land for agriculture and cattle ranching activities, which do not sustain the same generation of income and jobs. The low profitability of farming and cattle ranching results primarily in regions with greater rainfall indices, where low fertility of soils and the proliferation of crop pests and disease are more frequent, especially in the case of grain crops (Schneider *et al*. 2000).

On the other hand, in relatively drier areas of the Amazon (in general, corresponding to savannahs), where rainfall is less than 1,800 mm/year (approximately 17% of the territory) and the conditions for agriculture are relatively more favorable, the "boom-bust" theory does not necessarily apply (Schneider *et al*. 2000). For example, the grain-producing region in north-central Mato Grosso, situated in a transition zone between savannah and dense forest has, until now, maintained a strong economic performance, despite having lost a great majority of its forest cover. In addition, it is probable that municipalities with economies based on mining can avoid economic collapse even after the exhaustion of forest resources, due to the fact that

the income generated by mining activities is significant, and may potentially be used to establish a more diversified and competitive economy.[2]

The "boom-bust" theory, on a regional scale, can be tested by comparing economic and social indicators of Amazonian zones that have already lost a large portion of their forests with zones that are still rich in forests. If the "boom-bust" process is occurring as predicted by the model described by Schneider *et al*. (2002), new occupation frontiers should have better economic growth indicators than old frontiers. To test this hypothesis, in "*The State of the Amazon: Indicators*" we compare 11 indicators related to violence, economy, and HDI among the different occupation zones of the Amazon. Prior to the comparison by zones, we analyze the evolution of these indicators at the state and municipal level[3].

Precautionary Note

For the analyses of this study we adopt the scale of States, municipalities, and occupation zones (Figure 1). However, there are 29 municipalities in the Amazon whose territorial extension is at least 30 thousand square kilometers (an area greater than the State of Alagoas). In these cases, the municipal data do not capture the differences in the dynamic of human occupation and deforestation patterns. To obtain a more accurate portrayal of the spatial patterns of frontier occupation and deforestation, census data that correspond to the collection and analysis unit of IBGE should be used. Unfortunately, due to unavailable data and temporal shifts in data, it was not possible to adopt this approach. We emphasize that the analyses presented here, comparing occupation frontiers, are static and, therefore, do not reveal possible variations in "boom-bust" patterns across time. Furthermore, the results of this analysis do not permit affirmation that there will necessarily be a future bust in zones currently under pressure (in the boom phase).

AMAZONIAN OCCUPATION ZONES

The Amazon is a territory with great socioeconomic variation and a differentiated history of occupation. To evaluate the "boom-bust" hypothesis in this study, we divide the Amazon into four large zones, as follows: non-forested, deforested, under deforestation pressure, and forested (Figure 1).[4] These zones were classified according to presence of vegetation cover (non-forested or forested) and level of deforestation pressure. The non-forested zone is composed of municipalities in which forest cover originally represented less than 50% of its territory. The remaining zones correspond to municipalities in which the majority of the original vegetation cover was forest (more than 50% of territory). In this case, the municipalities were grouped by zones in a cluster analysis according to relative deforestation level (% of territory deforested) and the amount of deforestation in 2004.

ZONES OF THE AMAZON

Non-forested.[5] This region is covered by savannah and natural grasslands. It is found principally in the southeastern arc of the Amazon (except for some areas in the north of Amazonas and Roraima) and totals 1.2 million square kilometers (24% of the total area of the region). A large part of this zone comprises a region of bygone colonization activity characterized principally by large-scale cattle ranching and agriculture with an emphasis on grains.

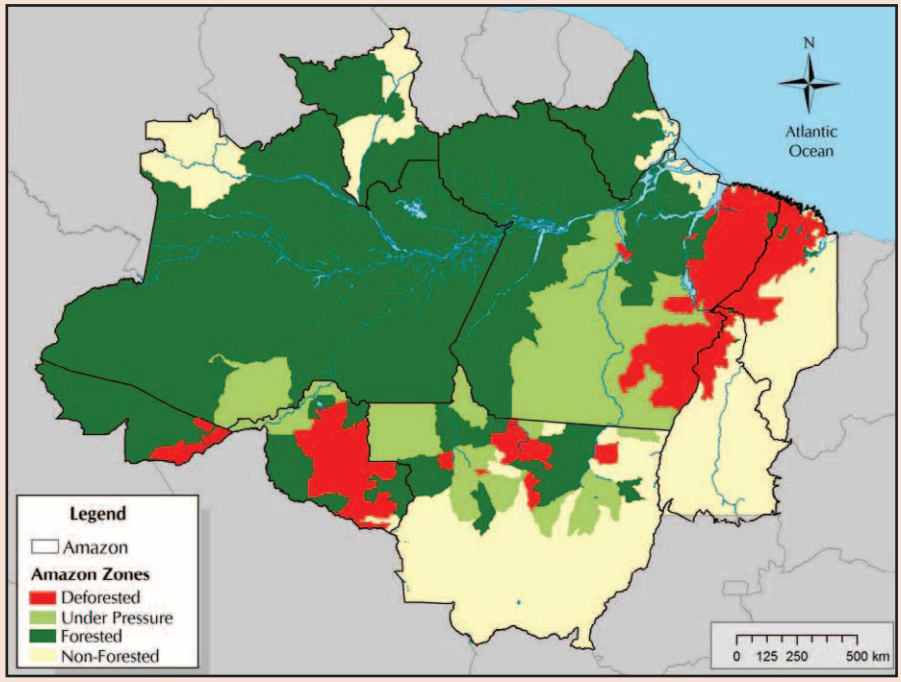


Figure 1. Occupation zones of the Amazon.

Deforested. This represents areas originally covered by forest, in which the municipalities have already lost more than 70% of their forested area (excluding Protected Areas). These municipalities are situated along the "arc of deforestation", in a region of former colonization. This zone sums to 0.51 million square kilometers (10% of the Amazon). The principal economic activities in this zone are large-scale cattle ranching and agriculture.

Under pressure. This category corresponds to municipalities situated along new frontiers of deforestation and Amazonian occupation. This zone represents approximately 0.7 million square kilometers (14% of the region). The principal economic activities in this zone are predatory logging and large-scale cattle ranching.

Forested. This represents the most conserved region of the Amazon, with only 5% of forest cover eliminated. It comprises 2.6 million square kilometers (52% of the Amazon). Except for the industrial hub of Manaus, and a few other municipalities with mineral, gas, and petroleum exploration, other economic activities are incipient in the region (i.e. non-timber extraction and logging).

Demographics

The Amazon evolved from relative demographic emptiness in 1960 (only 5.4 million inhabitants) to 11.2 million inhabitants in 1980, and reached 22.5 million in 2004 (12% of the total Brazilian population) (Table 1).[6] The majority (73%) of this population is found in cities, and only 27% is rural (Ipea 2006a).[7] In 1970, the situation was the converse: 64% of the population was rural and only 36% was urban.

The greatest population growth in the Amazon occurred in the decade between 1970 and 1980, when the population grew 5.4% per year. This growth was stimulated by public policies that encouraged migration by means of colonization projects, fiscal incentives for agriculture and cattle ranching, and large mining and infrastructure projects.[8] Between 1991 and 2004, the population of the Amazon region increased at an annual rate (2.8%) greater than that of Brazil as a whole (1.8%). In 2000, the Amazon population had a youthful majority (69% aged 25 years or less) and a lower life expectancy (66 years) than the Brazilian average (69 years) for that year (UNDP 2003).[9]

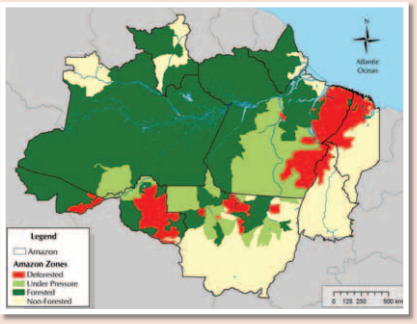
Migration has exerted a strong influence on regional demographic growth. Between 1991 and 2000, the region received about 700,000 migrants. In 2000, 4.3 million inhabitants (21% of the population residing in the Amazon) were migrants. Of this total, about two-thirds had originated from other regions of Brazil, while one-third had come from within the Amazon (intra-regional migration).[10]

The population density in the region in 2000 (3.8 inhabitants/km²) was much lower than the Brazilian average (20 inhabitants/km²). Population density of Amazonian municipalities varies according to their proximity to the river and roads. In 2000, 52% of municipalities in the Amazon had a population density less than or equal to 5 inhabitants/km², while in 44% the density ranged from 5 to 50 inhabitants/km². Only in 4% of the municipalities (capitals and municipalities of former occupation) was the population density greater than 50 inhabitants/km².

Table 1. Demographic profile of the Amazon.

States		Population in 2004 [1]	Migrants in 2000[2]	Urbanization in 2004[1]	Population Density in 2000[3]
		(million)	(%)	(%)	(Inhabitants/ km²)
Acre	AC	0.6	12	68	3.7
Amazonas	AM	3.2	11	77	1.8
Amapá	AP	0.6	32	92	3.3
Maranhão	MA	5.2	8	68	17.0
Mato Grosso	MT	2.8	43	77	2.8
Pará	PA	6.9	17	72	5.0
Rondônia	RO	1.5	53	67	5.8
Roraima	RR	0.4	47	80	1.5
Tocantins	TO	1.3	32	71	4.2
Amazon		**22.5**	**21**	**73**	**3.8**
Brazil		**182.1**	**16**	**83**	**19.9**

[1] IBGE 2004.
[2] IBGE 2000b.
[3] Pnud 2003.



DEMOGRAPHICS IN THE OCCUPATION ZONES

The non-forested zone is the most populous of the occupation zones, containing 36% of the population (7.3 million inhabitants), while the deforested zone encompasses 33% of the population (6.6 million inhabitants) and has the highest population density (10.4 inhabitants/km^2). In the forested zone, the population has reached 5.3 million people (26% of the region) and the demographic density is very low (1.4 inhabitants/km^2). Finally, the zone under pressure comprises only 5% of the Amazonian population (900,000 inhabitants), but this zone has exhibited the greatest population growth in recent years (5% annually) and the highest proportion of migrants (43%).

Table 2 . Demographics in Amazonian occupation zones (IBGE).

Indicators	Amazon			
	Non-forested	Deforested	Under pressure	Forested
Total population (millions of inhabitants)	7.3	6.6	0.9	5.3
Annual population growth between 1991 and 2004 (%)	3	3	5	4
Population density (inhabitants/km²)[1]	4.4	10.4	1.0	1.4
Urbanization Ratio (%)[1]	62	61	59	52
Total migrants (%)	21	23	43	15

[1] Nine State capitals are excluded from the analysis.

Violence in the Amazon

The advance of the Amazonian frontier has been marked by conflicts over land ownership, violence, and predatory use of natural resources. Indigenous peoples, traditional populations, and small-scale farmers have been the primary victims of these conflicts. In addition, thousands of cases of slave labor conditions have been recorded, as well as a significant increase in violence in the cities. Violence provoked by land disputes is increasing in the new occupation frontiers. The State of Pará ranks first in the number of conflicts over land, rural murders, and cases of slave labor, while the States of Roraima, Amazonas, and Acre experience the least amount of pressure from violence related to land conflicts (Figure 2).

In this section, we evaluate the situation of violence in the Amazon countryside and cities by means of the following indicators: conflicts over land, rural murders, work under slave labor conditions, and total homicides.[11]

1. CONFLICTS OVER LAND INCREASE

The number of conflicts over land recorded in the Amazon rose from 156 in 1997 to 328 in 2006 (Figure 3).[12] In 2006, the region claimed 43% of the 761 conflicts registered in Brazil. That year, of 86,000 families involved in land conflicts in the whole of Brazil, 36,000 families were located in the Amazon. In 2006, more than 4 million hectares were

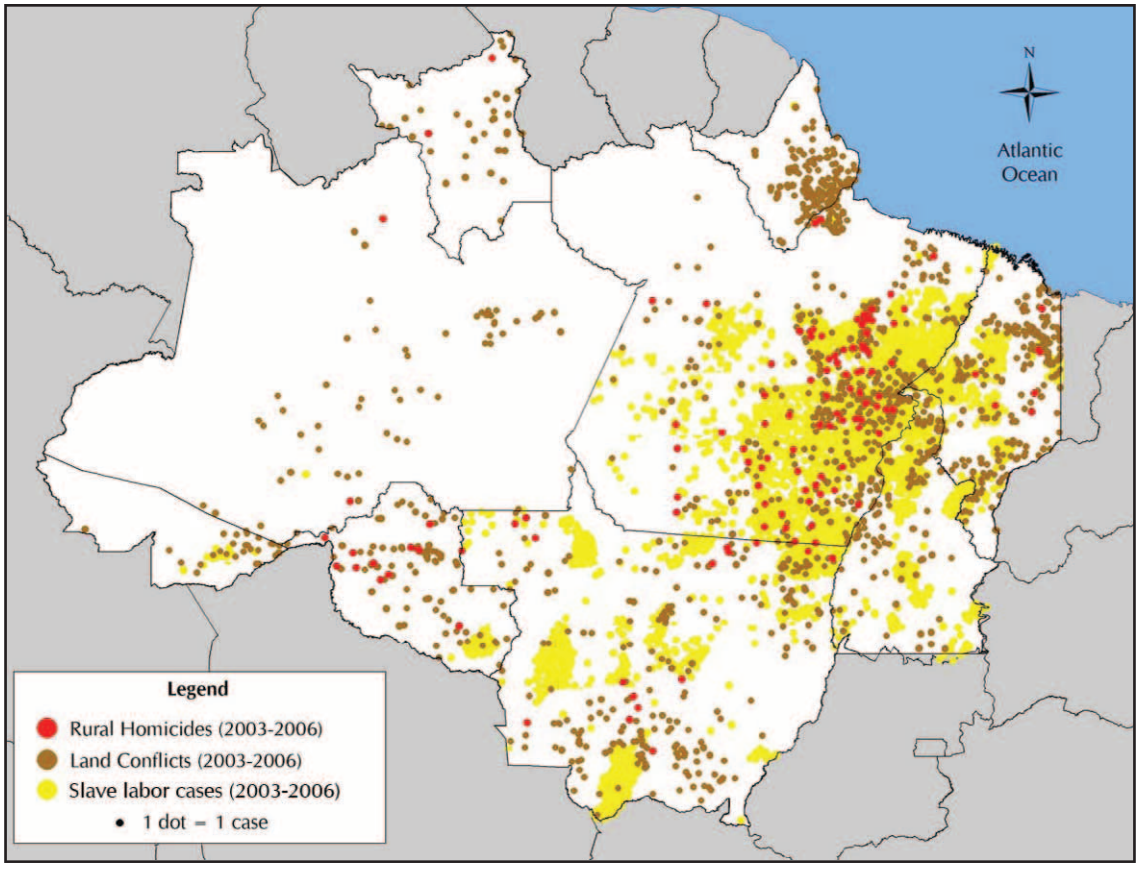


Figure 2. Rural violence in the Amazon between 2003 and 2006 (CPT 2004, 2005, 2006 and 2007).

under dispute in the Amazon (84% of the conflict area in Brazil).[13] Conflicts over land are associated with cases of violence against a person (intimidation, threats, injury, and murder of workers and rural leaders), material damage (houses, crop fields, etc.), and displacement and expulsion of families.

Pará was the leader in rural conflicts in the Amazon between 1997 and 2006. These conflicts were, in large part, motivated by illegal occupation of land (CPT 2006a) (Box 1). In 2005, the record year for conflicts over land in the Amazon (408 cases), Pará claimed 33% of all cases. In that year, the situation was most critical in the south-central (Anapú, Marabá, Parauapebas and São Félix do Xingu) and western part (Altamira) of the State.

In this period, an increase in instances of land occupation in the Amazon was also recorded.[14] According to the CPT (2007b), cases of land occupation rose from 39 in 2002 to 59 in 2006 (15% of the Brazilian total). Furthermore, reports beginning in 2005 have described isolated groups invading private forests and illegally exploiting commercial trees for resale, which is referred to as the "Movement of the Logless" (Arruda 2005). Some of the areas invaded by these groups consisted of managed forests owned by businesses certified by the FSC in Pará.

Box 1. Illegal occupation of Amazonian Lands

By Brenda Brito and Andréia Pinto

Illegal occupation (*grilagem*) is the process of appropriation of public lands in violation of the law by document falsification or by means of corruption. In the past, *grileiros* placed counterfeit property deeds in boxes with crickets (*grilos*) that rendered them yellowed and chewed, to simulate the appearance of old age and, consequently, demonstrate the document's originality, hence the origin of the name. Currently, the *grileiros* that operate in the Amazon use satellite images for negotiations of internet sales of public lands. In recent years, agencies involved in land management have adopted measures to try to curb illegal land occupation. Among them, we highlight the following:

Reregistration. Envisioned in the law since 1964, it was utilized as a measure to combat illegal occupation beginning only in 1997. In 1999 and 2001, Incra called for the reregistration of large properties (≥ 10,000 hectares and 5,000 to 10,000 hectares, respectively). The outcome of these measures remains incomplete, as there remain 57 million hectares for which the processes of reregistration is underway or lacking information. Registration for approximately 20 million hectares was cancelled, and these were set aside to become Conservation Units.

Creation of Conservation Units. The majority of Conservation Units do not permit private property within their borders, which inhibits attempts at appropriation by *grileiros*. In this context, even after the creation of these areas, public power still faces the risk of preexisting illegal occupation in these Conservation Units.

The Pará State Justice Tribunal issued, from 1990 to 2006, more than 16 orders (known as injuctions, or *provimentos* in Portuguese) to **oppose property deeds** with indictments of fraud. One highlight was Injunction (*Provimento*) 13/2006, which opposed all deeds of properties with an area greater than the constitutional limits imposed in 1934, 1964, and 1988 for the acquisition of property without requiring authorization of the National Congress (Currently, areas greater than 2,500 hectares require such authorization). This obstruction provokes restrictions on any type of property transaction until the supposed owners proves the legality of their land to a judge.

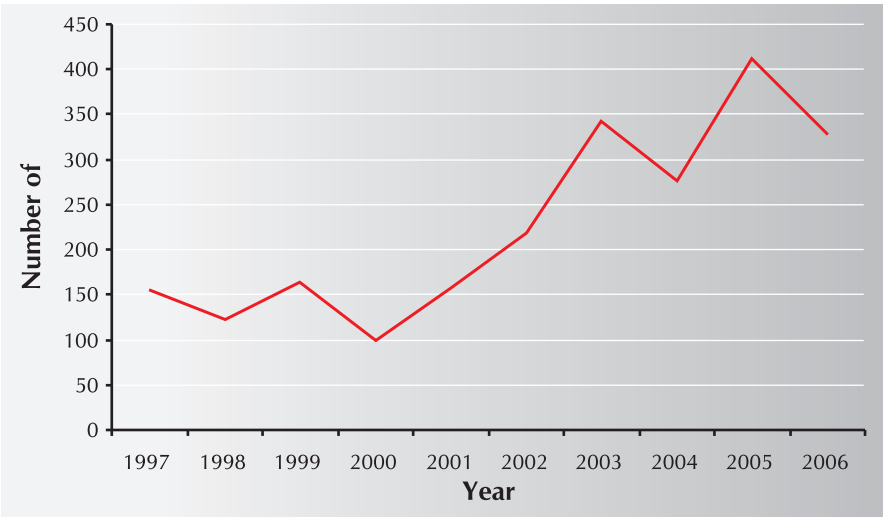


Figure 3. Land conflicts in the Amazon (CPT 2007a).

2. AMAZON LEADS IN RURAL MURDERS

The majority (60%) of the 386 cases of rural murders in Brazil, from 1997 to 2006, occurred in the Amazon. In 1996, the massacre of 19 landless workers in Eldorado do Carajás (Pará) incited worldwide repercussions. Subsequently, rural violence in the region returned to the headlines in 2005 with the murder of Sister Dorothy Stang, in Anapú (Pará). Besides these known cases, rural violence has persisted in the region. The most violent year was 2003, when 56 people were killed. In 2004, there was a drop in the number of such murders, followed by a new outbreak in 2005 and 2006 (with 32 victims in 2006). Among the Amazonian states, Pará accounted for the majority (67%) of murders in the countryside between 1997 and 2006 (Figure 4).

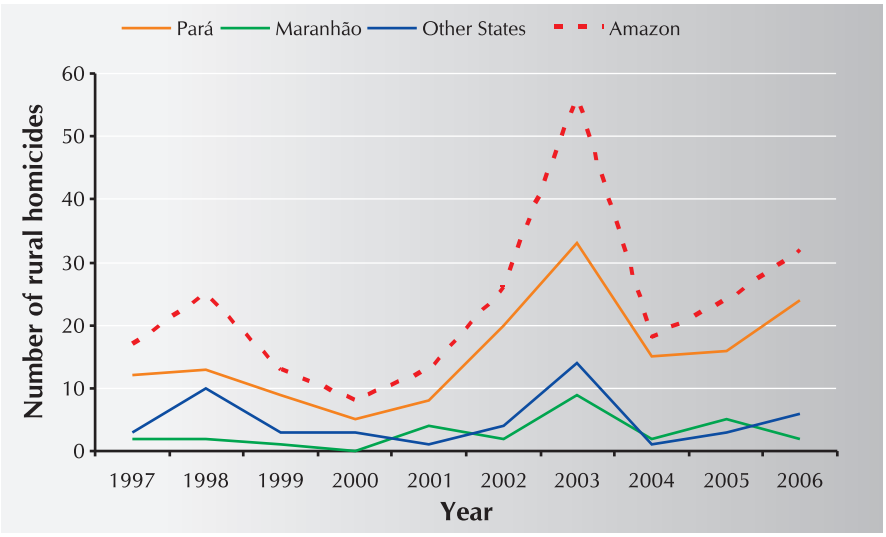


Figure 4. Number of rural murders in the Amazon (CPT 2007d).

BOX 2. Deforestation and Violence in the Amazon

The location of rural murders in the Amazon has a significant positive correlation with deforestation level (Figure 5).[15] The ten municipalities with the highest deforestation in 2004[16] were responsible for 45% of rural murders in 2003 and 2004. Both deforestation and violence result from the absence of public authority and the failure of land management policies along the occupation frontiers, where access to land is "free" and the interested people and groups fight over its control.[17] In recent years, one of the most violent areas in the Amazon was the "Terra do Meio" (Middle Land), in central western Pará. According to the CPT (2004), half of the rural murder victims in 2003 in this region had no link with social movements or the Landless Rural Workers' Movement (MST), and were victims of illegal occupation. To reduce the violence, curb illegal occupation, and contain deforestation in this region, the federal government created a patchwork of Conservation Units there in 2005.

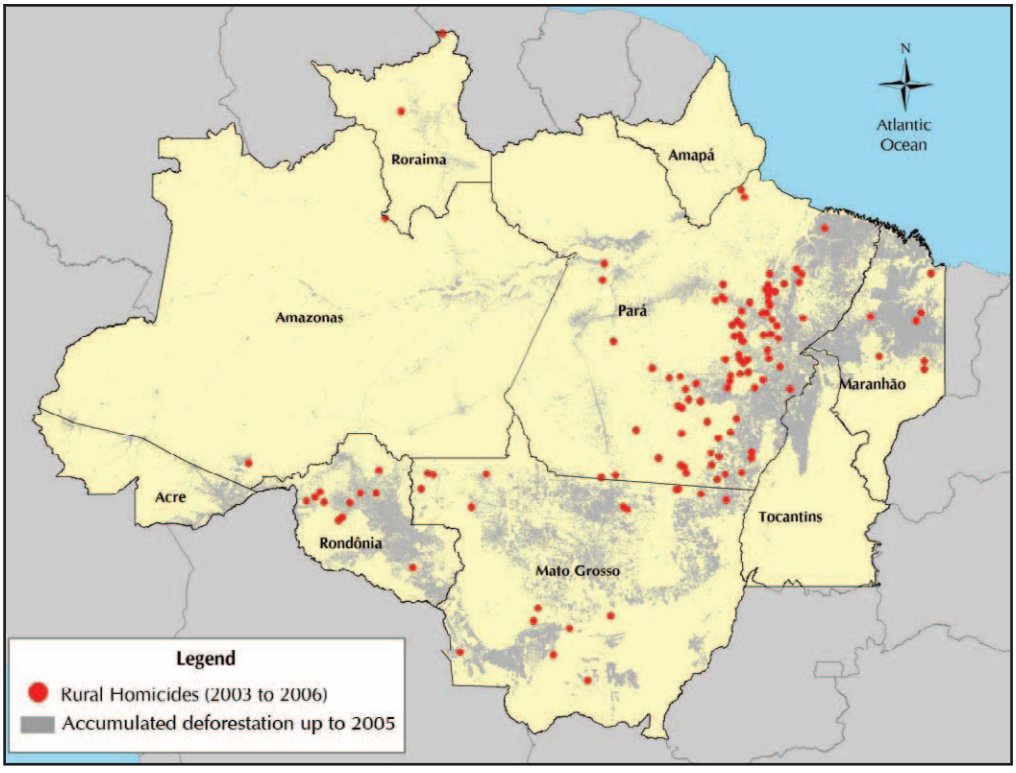


Figure 5. Rural murders from 2003 to 2006 and deforestation up to 2005 in the Amazon. (CPT 2004, 2005, 2006, 2007, Inpe 2005).

3. THE AMAZON LEADS IN SLAVE LABOR[18]

Brazil, the last country in the world to officially abolish slavery (in 1888), recognized in 1995, in front of the ILO, the existence of rural working conditions analogous to slavery. In 2003, the federal government launched the National Plan for the Eradication of Slave Labor.[19] That year, as a consequence of greater enforcement, 238 cases were recorded (95% recorded in the Amazon). Between 2003 and 2006, 1,012 cases of slave labor occurring in Brazil were registered (85% in the Amazon). Pará cataloged the majority of cases in these years, followed by Tocantins and Maranhão

(Table 3). In this period (2003 to 2006), 12,000 people under a forced work regime were liberated in the Amazon, half of which were in Pará. In 2006, alone 2,384 workers under this condition were emancipated in the Amazon (66% of Brazil); 49% of liberations occurred in Pará and 20% in Mato Grosso.

Table 3. Number of slave labor cases in the Amazon (CPT 2007e)

State	Number of slave labor cases[2]			
	2003	2004	2005	2006
PA	149	105	123	133
TO	22	43	41	36
MA[1]	29	28	33	24
MT	23	29	30	22
Other States	4	1	4	4
Amazon	**227**	**206**	**231**	**219**
Brazil	**238**	**236**	**276**	**262**

[1] Includes only Amazonian municipalities.
[2] Sampling intensity influences the number of cases.

One of the mechanisms of the National Plan for the Eradication of Slave Labor is MTE's "Lista Suja" (Dirty List), which identifies the employees, employers, locations of enticement, locations of crimes, and the activities developed on the properties.[20] In 2005, the National Pact for the Eradication of Slave Labor was elaborated[21], with the objective of establishing commercial restrictions on all those involved in the "Lista Suja" (Dirty List), supporting the reintegration of workers, among other actions. According to the ILO (2005), slave workers in Brazil are, in general, illiterate men between 25 and 40 years of age, coming primarily from Maranhão and Piauí, with the majority (80%) working on cattle ranches.

4. VIOLENCE GROWS IN THE CITIES

The number of total homicides grew more than six-fold between 1980 and 2004 in Amazonian municipalities, jumping from 747 to 4,685 cases. In 2004, the average homicide rate in the region (21 homicides/100,000 inhabitants) was lower than the overall Brazilian average (27) (Figure 6). On the other hand, in Rondônia, Mato Grosso, Amapá, and Roraima, the homicide rate was above the national average. Between 2002 and 2004, three out of five municipalities with a homicide rate higher than that of Brazil as a whole were within Mato Grosso, including Colniza - the city with the highest homicide rate in Brazil (OIS 2007) (Figure 7). As with rural murders, the homicide rate in 2002 was positively correlated with deforestation.[22]

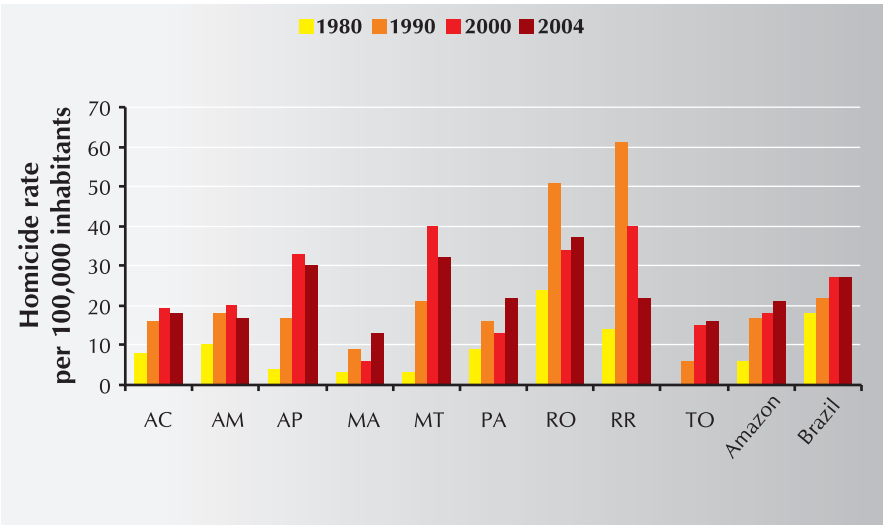
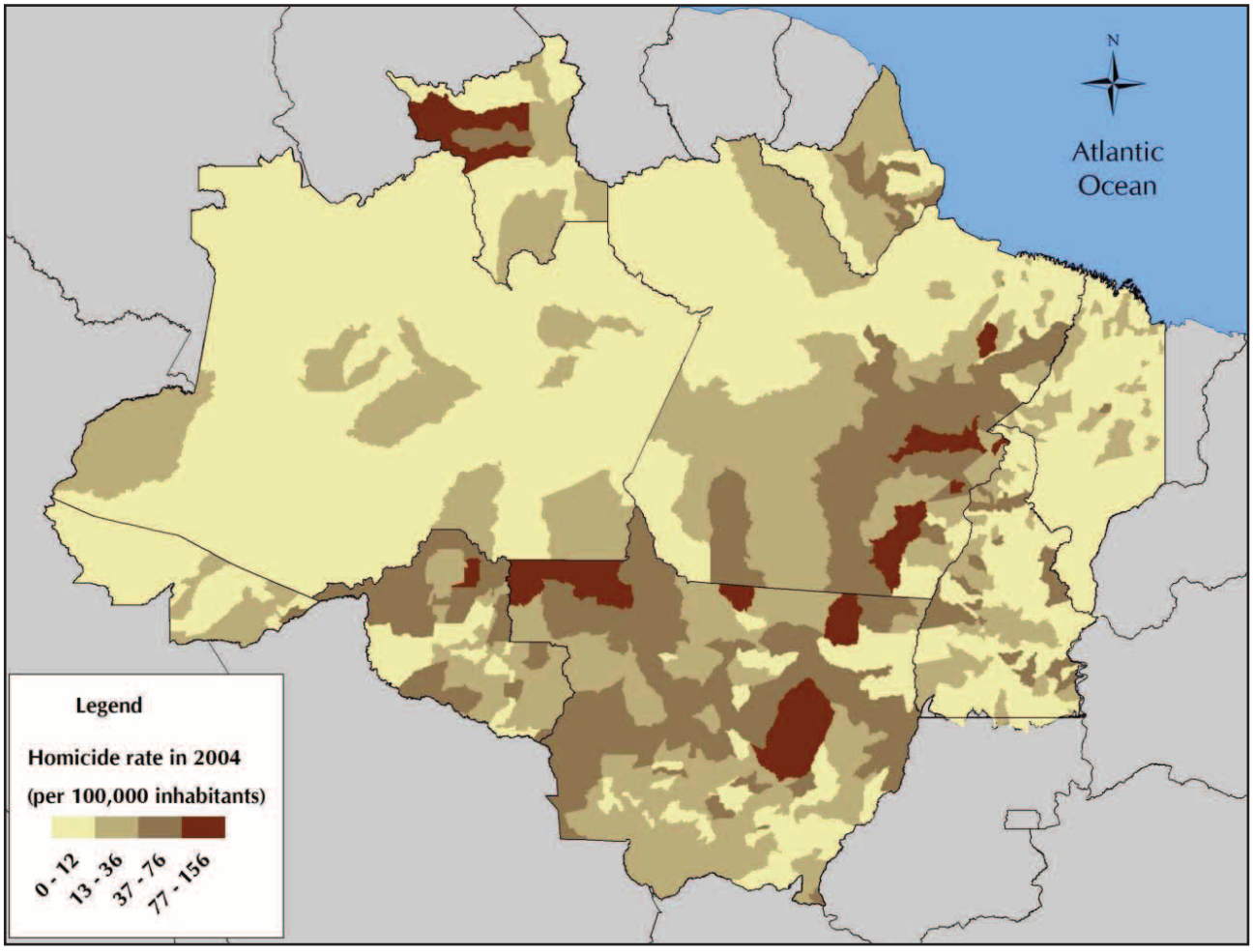


Figure 6. Homicide rate in the Amazon from 1980 to 2004 (Ipea 2006cd, MS 2007).



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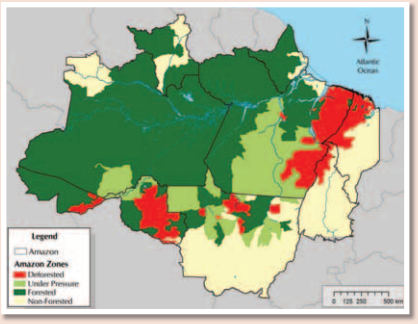


VIOLENCE IN OCCUPATION ZONES

Rural violence is geographically related to the advance of the deforestation frontier. In fact, 43% of all rural murders in the Amazon between 2003 and 2006 occurred in the zone under pressure. The index represents 5.5 cases of rural murders per 100,000 inhabitants. Furthermore, the highest total homicide rate was registered in this zone (62 homicides per 100,000 inhabitants) in 2004, a rate much higher than the regional (21) and Brazilian averages (27).

The indices for conflicts over land and slave labor cases also were higher in the zone under pressure between 2003 and 2006, where 15 conflicts and 137 slave labor cases were recorded for every 100,000 inhabitants. Finally, in absolute terms, the older occupation zones (non-forested and deforested) accounted for the majority of registered cases of conflicts, slave labor, and homicides in the Amazon.

Table 4. Violence in Amazonian occupation zones (CPT and MS).

Indicators	Amazon			
	Non-forested	Deforested	Under pressure	Forested
Number of conflicts over land (2003-2006)	500 (39%)	331 (26%)	150 (12%)	308 (24%)
Conflicts over land (2003-2006) per 100,000 inhabitants	6.9	5.0	15.2	5.8
Number of rural murders (2003-2006)	15 (12%)	25 (20%)	54 (43%)	33 (26%)
Rural murder cases (2003-2006) per 100,000 inhabitants	0.2	0.4	5.5	0.6
Number of slave labor cases (2003-2006)	2,669 (36%)	2,738 (37%)	1,350 (18%)	602 (8%)
Slave labor cases (2003-2006) per 100,000 inhabitants	36.7	41.3	137.0	11.3
Homicide cases in 2004	1,484 (32%)	1,625 (35%)	614 (13%)	962 (21%)
Homicide rate in 2004 per 100,000 inhabitants	20.4	24.5	62.3	18.0

The Amazonian Economy

The first insertion of the Amazon into the Brazilian economy was during the "Ciclo da Borracha" or Rubber Cycle (1879 to 1912). After the collapse of the rubber economy in 1912, the region experienced a period of economic decline until the mid-1960s. In the 1960s and 1970s large investments were made in the region for the establishment of agriculture and cattle ranching, as well as for mining and infrastructure projects. From the mid-1980s to the mid-1990s, government resources were gradually reduced due to the economic recession of that era. On the other hand, the regional economy was driven by a logging *boom* associated with expansion of large-scale cattle ranching. The retraction of federal investments lasted until the mid-1990s, when concern arose over resuming new public investments in the region, taking the form of the Advance Brazil Program. In 2007, the federal government launched the PAC, with large investments foreseen in the region, principally in infrastructure (such as the construction of hydroelectric power plants and highway paving and repair). In this section, we analyze the evolution of GDP and employment indicators.[23]

5. GDP INCREASES, BUT WITH LITTLE IMPACT ON THE NATIONAL ECONOMY

In the Amazon, the GDP (sum total of goods and services produced in the territory) grew at an annual average of 6% between 2000 and 2004 (Figure 8, Table 5). In 2004, the regional GDP reached US$ 51 billion dollars, representing slightly more than 8% of the national GDP. In 2004, the largest State GDP of the region was that of Amazonas (US$ 13.3 billion), which ranked 11th nationally, followed by Pará (US$ 12.7 billion), ranked 13th, and by Mato Grosso (US$ 10.4 billion). On the other hand, Roraima claimed the smallest regional GDP, with just US$ 0.7 billion.

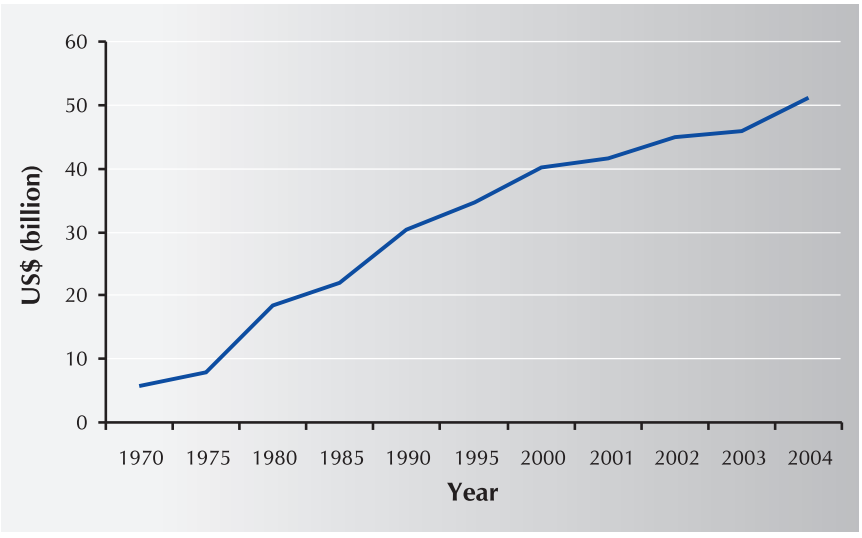


Figure 8. Evolution of GDP in the Amazon between 1970 and 2004 (adjusted for inflation) (Ipea 2007a).

Table 5. Evolution of GDP in the Amazon from 1970 to 2004 (adjusted for inflation) (Ipea 2007a).

States	GDP (in billions of US dollars)				
	1970	1980	1990	2000	2004
AC	0.19	0.44	0.64	0.93	1.20
AM	0.98	4.25	8.43	10.31	13.32
AP	0.16	0.31	0.75	1.08	1.38
MA	1.18	3.22	3.70	5.03	6.14
MT	1.56	2.31	3.87	7.34	10.37
PA	1.57	5.92	9.54	10.33	12.69
RO	0.15	1.03	2.27	3.07	3.62
RR	0.05	0.16	0.52	0.61	0.69
TO	0.00	0.64	0.73	1.34	1.77
Amazon	**5.84**	**18.29**	**30.44**	**40.04**	**51.18**
Brazil	**143.36**	**381.82**	**463.36**	**601.78**	**655.66**

In 2004, the service sector accounted for 43% of the Amazonian GDP (US$ 20.3 billion), while industry represented 38% (US$ 18.1 billion), and the agriculture and cattle ranching sector represented 19% (US$ 9 billion) (Figures 9 and 10).[24] GDP from the service sector was the most significant in all States, with the exception of Amazonas, where the industrial sector accounted for 70%, and in Mato Grosso, where agriculture and cattle ranching represented 41% of GDP.

The most prominent aspect of GDP from the service sector was the contribution of public administration (44% in 2004). In Acre and Roraima, public administration accounted for 63% and 64% of service GDP, respectively. This demonstrates the regional economy's strong dependence on public expenditures.

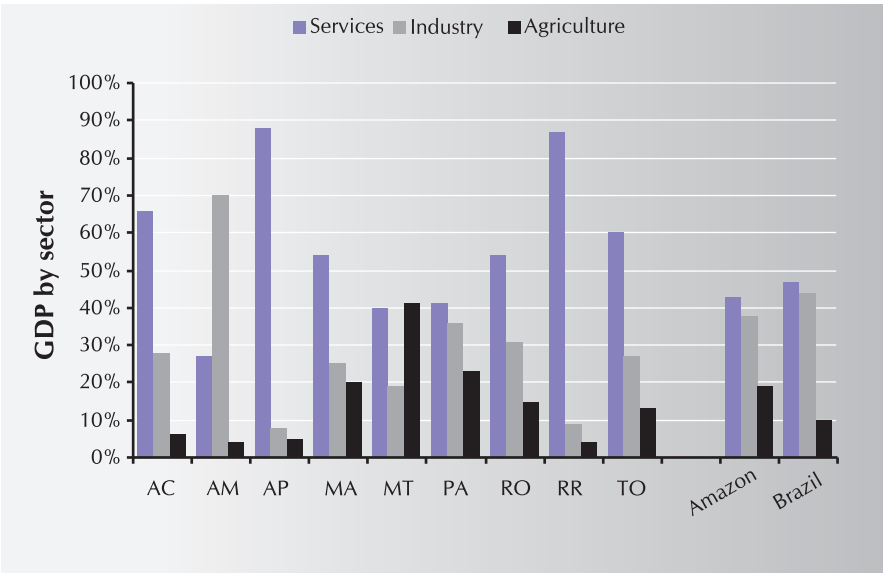


Figure 9. GDP Composition in the Amazon in 2004 (Ipea 2007a).

The industrial GDP of the Amazon rose from US$ 9.1 billion in 1990 to US$ 18.1 billion in 2004 (7% of the Brazilian industrial GDP). Amazonas contributed to 47% of this value in 2004. In turn, the Amazonian agriculture/cattle ranching GDP jumped from US$ 5.5 billion in 1990 to US$ 9 billion in 2004, of which Mato Grosso and Pará were responsible, respectively, for 43% and 30%. Agriculture and cattle ranching GDP in the Amazon accounted for only 15% of this sector's national GDP in 2004.

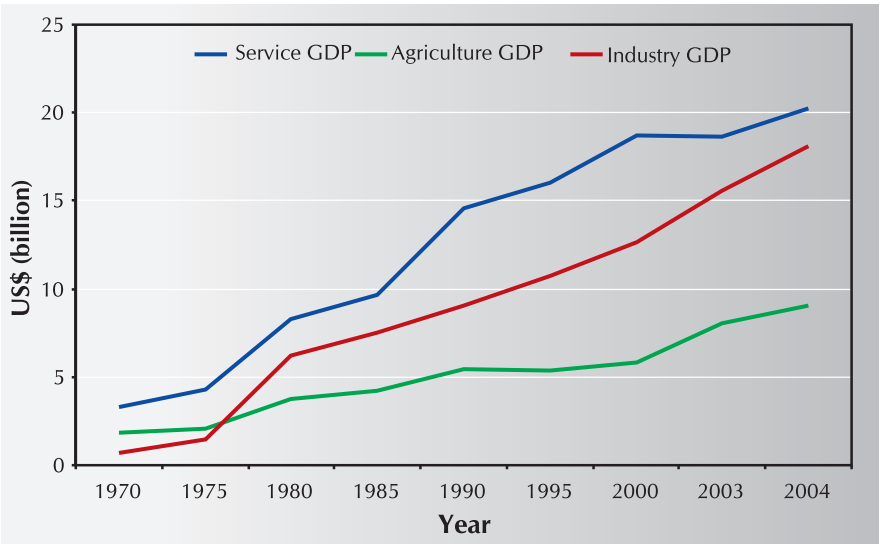


Figure 10. Evolution of GDP in the Amazon by sector from 1970 to 2004 (adjusted for inflation) (Ipea 2007a).

BOX 3. Mining in the Amazon

Mining in the Amazon was initiated in the 1940s with the exploitation of manganese reserves in Serra do Navio (AP). In the 1970s, the mineral regions of Carajás and Trombetas were opened for exploration in Pará. Currently, the largest mining business in the region is CVRD. This mining company, created in 1942 by the federal government and privatized in 1997, had already become the second largest mining enterprise in the world by 2006. Furthermore, other large-scale mining companies are investing in mineral research prior to prospecting (i.e., Mineradora Rio Tinto) and in the installation of mines in the region (i.e., Alcoa).

Mining constitutes only 3% of the Amazon GDP and directly generates less than 2% of all formal jobs in the region (Ipea 2007a, MTE 2006). The sector accounts for 40% of the value exported from the Amazon (MDIC 2007). By virtue of being an exportation sector, mining does not contribute significantly to tax revenue, as is the case with ICMS, in addition to other financial incentives received[25].

Box 4. Amazonian Exportation

Source: MDIC 2007.

Amazonian exportation has increased considerably in recent years. In 2006, the region's exports amounted to almost US$15 billion (11% of the national total). The majority of the exportation in the Amazon that year occurred in the States of Pará (45%) and Mato Grosso (29%).

In 2006, metals and minerals accounted for 40% of Amazonian exports (Figure 11). In Pará and Maranhão, these products (most prominently aluminum, iron, and steel) represented more than 70% of the total value exported. Vegetable products (mainly grains) comprised 19% of exports; 80% of this value was exported from Mato Grosso. In turn, timber products and their derivatives ranked third, with 8% of the total, and were most important in Pará. Animal products comprised only 6% of regional exports. Although cattle ranching for beef production represents the principal land use in deforested areas, the region exports little beef. This tendency could change with the improved control of foot-and-mouth disease in a large part of the region.

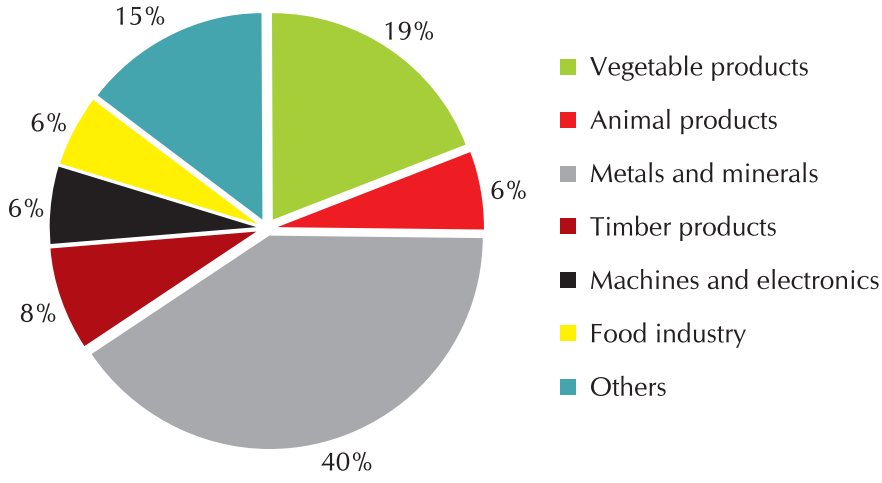


Figure 11. Exportation in the Amazon by sector in 2006 (MDIC 2007).

6. LOW MUNICIPAL GDP

The majority (69%) of municipalities in the Amazon had a GDP less than US$ 25 million in 2003. Of these, 42% were below US$ 10 million. Fifteen percent of municipalities had a GDP between US$ 25 and US$ 50 million, 14% were between US$ 50 and US$ 100 million, and only 2% of municipalities presented a GDP greater than US$ 500 million (Figure 12). In 2003, the average GDP of municipalities in the region was US$ 59.5 million, while the Brazilian average was US$ 112.4 million.

In 2003, Manaus presented the highest GDP among Amazonian cities (US$ 9.4 billion)[26]. Other municipalities with significant participation in the regional economy included the capitals Belém (PA), São Luis (MA), Cuiabá (MT), Porto Velho (RO), Macapá (AP) and Rio Branco (AC). Furthermore, it should be emphasized that the GDP of municipalities with mining (Barcarena/PA), energy generation (Tucuruí/PA), and oil or gas extraction (Coari/AM) is favored primarily by the receipt of royalties that benefit the service sector.

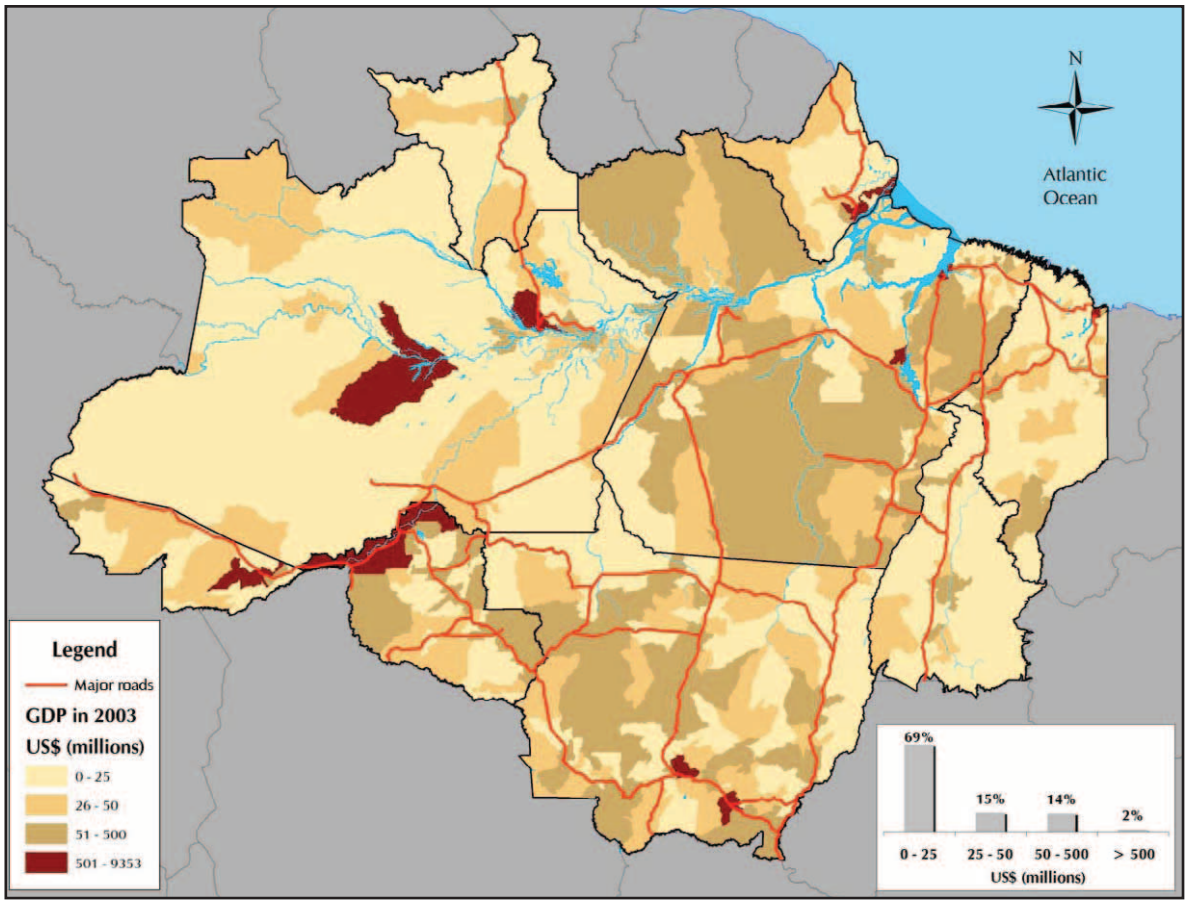


Figure 12. Municipal GDP in the Amazon in 2003 (Ipea 2006e).

7. LOW *PER CAPITA* GDP

The annual *per capita* GDP of the Amazon grew only 1% each year between 1990 and 2004, increasing from US$ 1,970 to US$ 2,320 (Figure 13). In the same period, Brazilian *per capita* GDP also demonstrated weak growth, but remained 40% above the Amazonian average (US$ 3,610 in 2004). If this weak rate of growth were maintained, *per capita* GDP in the Amazon would only reach the 2004 national average by approximately 2050.

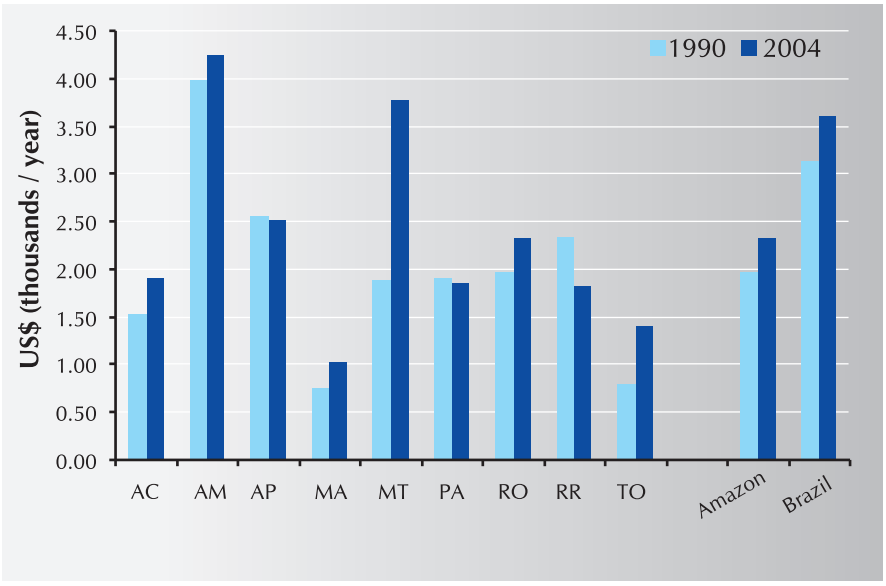


Figure 13. *Per capita* GDP (adjusted for inflation) in the Amazon in 1990 and 2004 (Ipea 2007b).

The States with greatest *per capita* GDPs in the Amazon in 2004 were Amazonas (US$ 4,200) and Mato Grosso (US$ 3,800), while Maranhão and Tocantins represented the lowest GDP values (US$ 1,000 and US$ 1,400, respectively) (Figure 13). Mato Grosso presented the highest annual growth in *per capita* GDP during this period (7%), while that of Roraima dropped 2%, and Amazonas, Amapá and Pará presented no change (0%).

Per capita GDP does not capture the distribution or concentration of income (Box 5). For example, Amazonas presented the highest *per capita* GDP of the region in 2004 (US$ 4,200), a reflection of two municipalities that had an elevated GDP (Manaus and Coari), whereas the other municipalities of the State showed much lower *per capita* values (Figure 13). On the other hand, in Mato Grosso, most of municipalities presented higher *per capita* GDP figures compared to the rest of the Amazonian States.

The majority of Amazonian municipalities (44%) presented a *per capita* GDP between US$ 1,000 and US$ 2,500 per year in 2003, while 28% of municipalities presented a *per capita* GDP of less than US$ 1,000 per year; 21% showed a *per capita* GDP ranging between US$ 2,500 and US$ 5,000, and only 7% of municipalities had a GDP higher than US$ 5,000. In the region, the municipalities with greatest *per capita* GDPs in 2003 (> US$ 20,000) were located in Mato Grosso (Santo Antônio do Leste, Santa Rita do Trivelato, Campos de Júlio, Alto Taquarí and Sapezal) (Figure 14).

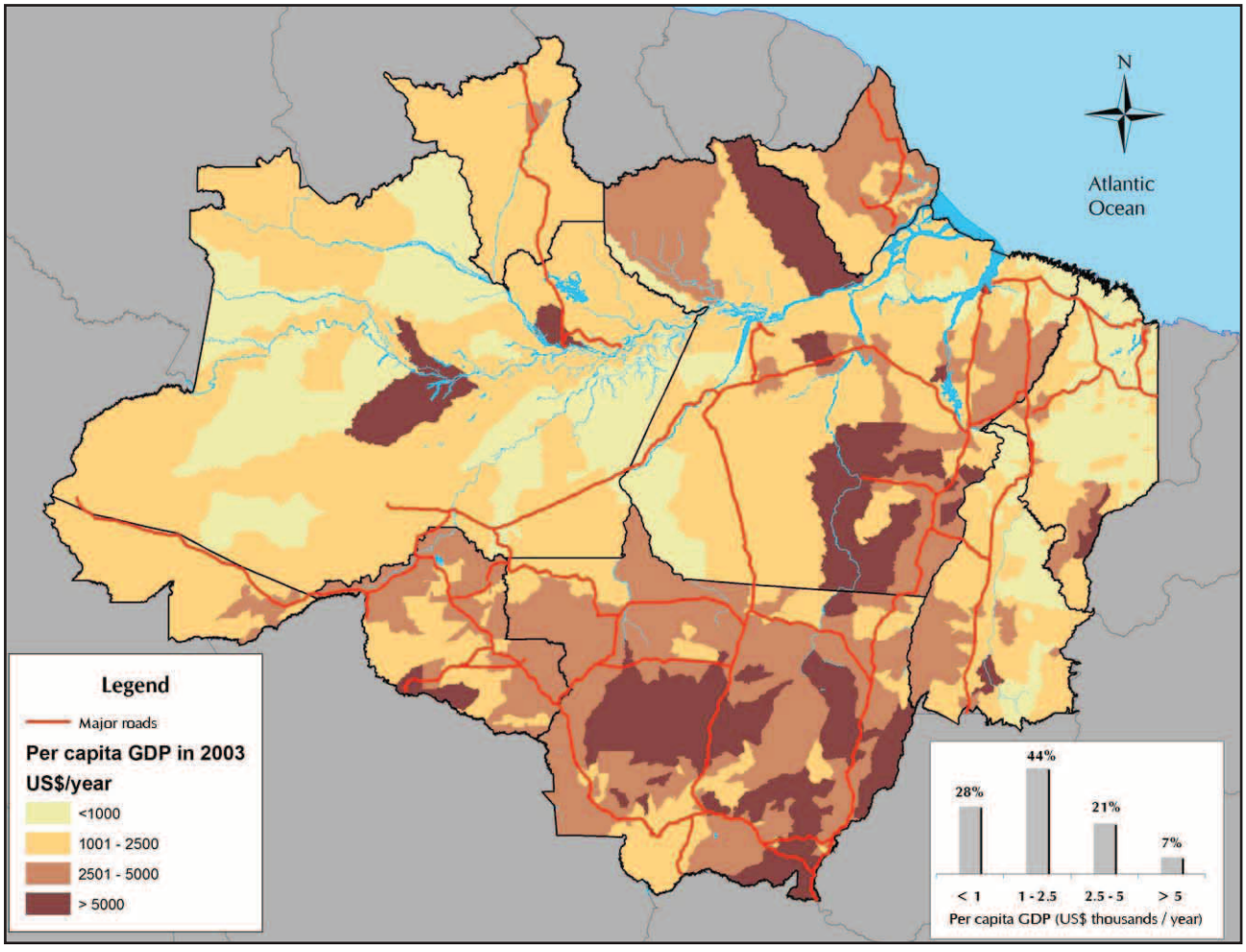


Figure 14. *Per capita* GDP in the Amazon in 2003 (Ipea 2006f).

BOX 5. Concentration of Income in the Amazon

Brazil is among the ten countries with the greatest income distribution disparity in the world (UNDP 2006). In 2005, the Gini Index (coefficient used to measure disparity) was equal to 0.57[27] in Brazil, while that of the Amazon was slightly less (0.54) (Ipea 2006g). The Gini Index has held stable in the region since 1990. However, the disparity in the Amazon has grown compared to that of the 1980s (0.49).

Another method of measuring disparity is to compare the share represented by the wealthiest segment of the population (the richest 1%) of total household income with the bottom half of the population (poorest 50%). According to Ipea data (2007cd) from 2005, the 225,000 richest people in the Amazon earn 12% of total household income of the region, while the 11.3 million poorest people earn practically the same percentage (16%). The State of disparity in the Amazon is similar to that observed in Brazil as a whole.

8. ECONOMICALLY ACTIVE POPULATION AND FORMAL JOBS GROW

The economically active population (EAP) in the Amazon has increased in recent years, increasing from 5.7 million (in 1991) to 8.4 million (in 2000) and, ultimately, to 11.7 million (in 2005).[28] This represents 63% of the Amazon population older than 10 years of age (Ipea 2006h, IBGE 2007).[29] Among the Amazon EAP, 7% (767,000 people) were unemployed in 2004, versus 6% in 1992. In Brazil, unemployment reached 9% of the EAP in 2004. In the Amazon, the States with the highest unemployment percentages were Amapá (13%) and Amazonas (10%). In 2004, only 21% of the EAP in the Amazon had formal registered jobs.

Formal employment grew by 50% in the Amazon between 2000 and 2005, jumping from 1.7 to 2.5 million jobs.[30] In this period, the rate of formal employment increased by 31%, increasing from 83 individuals employed per 1,000 inhabitants in 2000 to 109 in 2005. Mato Grosso had the highest rate of formal employment (178 formal jobs per 1,000 inhabitants), while Maranhão presented the lowest (66). In 2005, the service sector employed 59% of formal workers (primarily in public administration), followed by the commerce (18%) and industry (14%) sectors. On the other hand, agriculture and cattle ranching employed only 5% of the formally employed population (Table 6).

Table 6. Jobs by sector in the Amazon in 2005 (MTE 2006).

Formal Employment in 2005							
States	**Total**	**Rate** (# employed/ thousand inhabitants)	**Agriculture/ Cattle Ranching (%)**	**Commerce (%)**	**Civil Construction (%)**	**Industry (%)**	**Services (%)**
RO	213,176	141.0	4	22	2	13	59
AC	79,431	125.6	3	17	5	6	68
AM	406,393	127.3	1	13	3	26	58
RR	33,749	88.5	2	23	5	7	64
PA	675,857	98.6	4	18	5	15	59
AP	73,110	126.6	1	19	4	7	69
TO	169,121	131.7	7	15	4	7	67
MA	400,154	66.3	3	17	4	8	68
MT	490,115	177.6	13	22	3	15	47
Amazon	**2,541,106**	**109.4**	**5**	**18**	**4**	**14**	**59**

BOX 6. Informal employment and child labor in the Amazon[31]

According to the IBGE (2003), informal employment in Brazil generated an income of R$ 17.6 billion in 2003, and employed 25% of workers in urban areas (13.9 million people) and 70% in rural areas. A World Bank study (2004) estimated that the informal economy in Brazil constituted 40% of the gross national income. In the Amazon we estimate that, in 2004, informal employment may have reached 8 million people (68% of EAP in the region) (Figure 15).

Furthermore, that year 420,000 children between 10 and 14 years of age worked in the region (IBGE 2004).[32] The Brazilian constitution does not permit children less than 16 years old to work. Nevertheless, child labor persists in the countryside and in Brazilian cities. In the Amazon, Maranhão and Rondônia had the greatest percentage of working children (20%), while Amapá had the lowest proportion (4%).

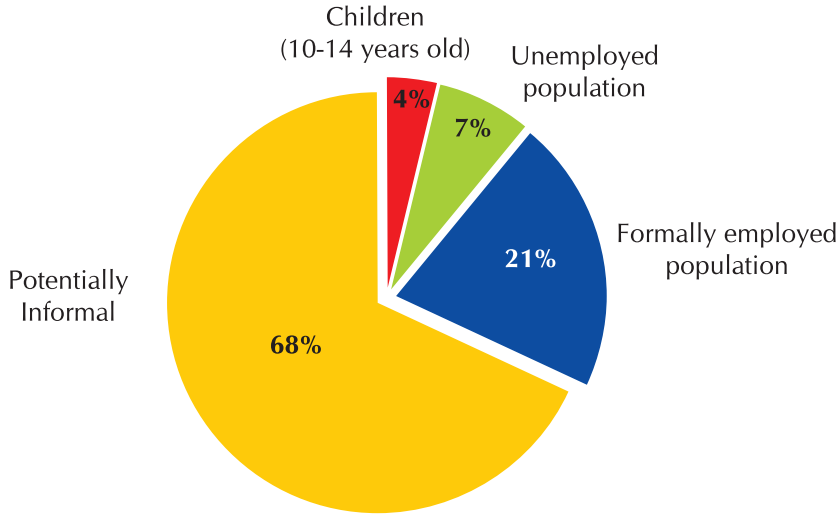


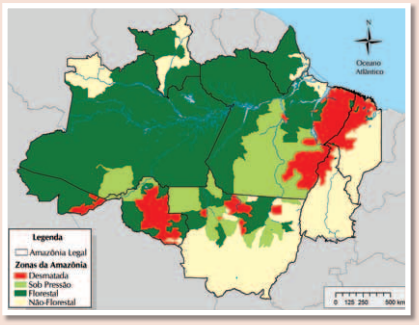
Figure 15. State of the EAP in the Amazon in 2004
(estimated by Imazon based on IBGE 2007, MT 2006).

BOX 7. Worker Wage and Job Security

Sources: IBGE 2004 and MS 2006

The average worker wage in the Amazon (US$ 1.4 / hour) was 15% less than the Brazilian average (US$ 1.6/hour) in 2004. Mato Grosso had the highest wage (US$ 1.7), while Maranhão ranked lowest (US$ 1). In 2004, people with up to four years of education received, on average, US$ 0.9/hour, whereas individuals with more than 12 years of education earned US$ 4.2/hour. In the Amazon (as in Brazil as a whole), the women's wage is surpassed by that of men by an average of 32%.

The Amazon region claims the highest number of work-related deaths in Brazil. In 2004, there were 21 fatalities per 100,000 workers, while in all of Brazil the rate was 12 deaths per 100,000 workers. In addition, these regional numbers are probably underestimated, since accidents are reported only in the formal job market.



THE ECONOMY IN THE OCCUPATION ZONES

An increase in economic indicator scores was observed in the Amazon. The municipalities in the zone under pressure recorded the highest municipal GDP growth between 2000 and 2004 (14% per year), and the largest growth in the number of formal jobs between 2000 and 2003 (83%). These municipalities under pressure have, on average, a municipal GDP (US$ 93.6 million) and *per capita* GDP (US$ 6.3 thousand /year) much higher than those of municipalities in other zones. Furthermore, in this zone there is a higher rate of formal employment in the region (141 per 1,000 inhabitants).

The zone under pressure also registered the greatest expansion of logging activity in the Amazon in recent years (Lentini *et al*. 2005). In 2004, mean indicators of timber production (consumption of logs, generation of direct jobs and gross income from the activity) in these municipalities were three times greater than the Amazonian average.[33] In addition, there is evidence that the timber processed in already deforested regions came from this zone (Lentini *et al*. 2005).

The most deforested municipalities of the Amazon present a lower GDP than the regional average (Figure 1 in the Annex). The 43 municipalities with more than 90% of their surface deforested (all in the deforested zone) are located in the States of Maranhão (21%), Pará (51%), Tocantins (16%) and Rondônia (12%).[34] The average GDP in these municipalities (US$ 23 million) is 60% less than the Amazon as a whole. In addition, 33% of these municipalities presented a drop in GDP between 2000 and 2004. Deforestation did not generate a stable or robust economy compared to that of forested municipalities. In fact, there were no statistically significant differences in average economic outcome between municipalities of the deforested zone and those of the forested zone.

Table 7 . Economy in Amazonian occupation zones (IBGE, IPEA and MT).[35]

Indicators	Amazon			
	Non-forested	Deforested	Under pressure	Forested
Total GDP (US$ billion)	15.9 (32%)	13.0 (26%)	3.2 (6%)	18.3 (36%)
Average municipal GDP in 2004 (US$ million)[1,2]	28.7a	46.1a	93.6b	40.7a
Annual GDP growth between 2000 and 2004 (%)	6.8	4.8	14	7.5
Average per capita GDP in 2004 (US$ thousands / year)[1,2]	3.2a	2.3a	6.3b	2.2a
Formal employment (per 1,000 inhabitants)	114.1	96.3	141.2	94.3
Growth of formal employment between 2000 and 2004[1] (%)	45	46	83	42

[1] The nine State capitals were excluded from the analysis.
[2] Different letters signify statistical difference according to Tukey Test ($P < 0.05$).

HDI in the Amazon

The HDI is used for measuring the quality of life of a population by analyzing income, longevity and education. Each variable in HDI (income, longevity and education) is expressed on an index that varies from zero (worst) to one (best). Total HDI is the mean of these indices. Regions with a low human development index present an HDI less than 0.500, while those regions with an HDI between 0.500 and 0.799 have an average human development index. In turn, regions with a high human development index present an HDI greater than 0.800. Although HDI would be useful for understanding the situation of a region or country, it can mask severe disparities and underestimate the well being of the population (which encompasses more than just these three indicators).

In 2005, Brazil ranked 63rd globally in HDI (0.790), out of 177 countries and territories evaluated (UNDP 2005). By 2006, the position of Brazil had fallen to 69th, but its HDI had increased (0.792) (UNDP 2006). National HDIs are calculated and published by the UN annually, while that of Brazilian municipalities and States has been presented only every ten years. In this section, we present the evolution of HDI in the Amazon.[36]

9. SLIGHT IMPROVEMENT IN THE AMAZONIAN HDI

The Amazon demonstrated a general improvement in HDI: from 0.624 in 1991 to 0.705 in 2000. Despite this, the Amazonian HDI in 2000 was still less than both the Brazilian average that year (0.766), and those of the other regions of the country, with the exception of the northeast (0.681). Compared to other countries of the Amazon Basin that year, the Brazilian Amazon presented an HDI superior only to those of Bolivia (0.648) and Guyana (0.704) (UNDP 2001).

In 2000, Mato Grosso had the highest HDI in the Amazon (0.773) – slightly higher than the national average – ranking 9th among the 27 Brazilian States. On the other hand, the region also reported the worst HDI in Brazil, in Maranhão (HDI 0.636). In addition, other States in the region showed a low HDI in the national ranking: with Amazonas at 0.713 (16th), Tocantins at 0.710 (17th) and Acre at 0.697 (21st) (Figure 16).

10. EDUCATION RAISES HDI

The increase in total HDI in the Amazon is principally due to the accentuated improvement in HDI education scores in the region (Table 8). This variable rose from 0.671 in 1991 to 0.802 in 2000, contributing to 54% of the improvement in region-

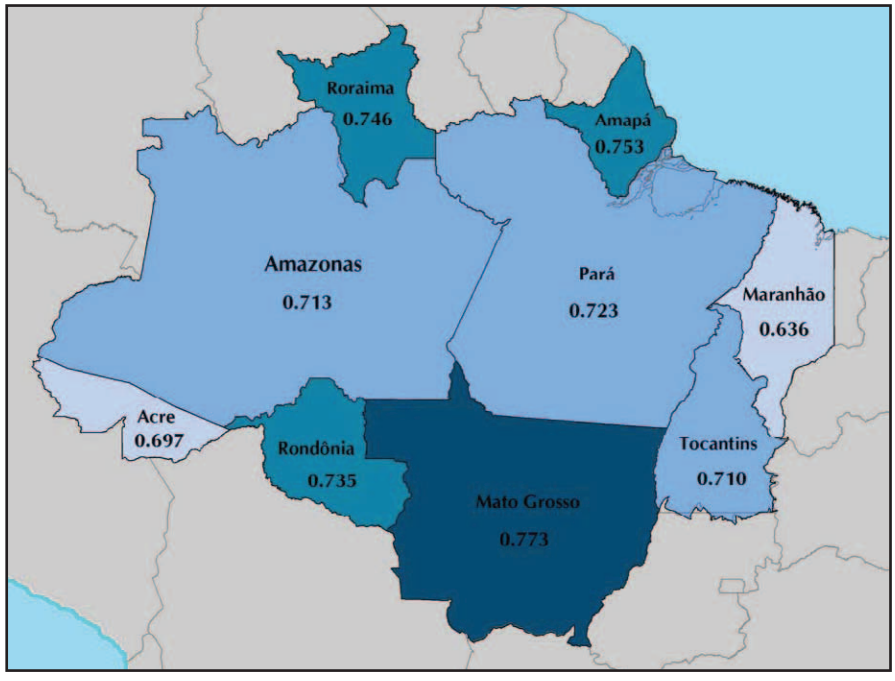


Figure 16. HDI in Amazonian States in 2000 (UNDP 2003).

al HDI. The States of Amapá, Mato Grosso and Roraima stand out with higher education indices than the national average (0.849). Maranhão and Acre possess the worst education indices in the region, claiming 0.738 and 0.757, respectively. The rise in the education index reflects the reduction in the number of illiterate people, and an increase in school attendance in the region. Although access to education has risen for the region's population, the quality of instruction is lower than that of other regions of Brazil, and the rural zones are particularly disfavored (Celentano & Veríssimo 2007).

In turn, the increase in the longevity index (from 0.614 to 0.685) was responsible for 29% of the growth in total HDI. This increase resulted from the growth of average life expectancy among the Amazonian population from 62 years in 1991 to 66 years in 2000, while in Brazil as a whole this value jumped from 65 years to 69 years. In 2000, Mato Grosso possessed the highest life expectancy in the Amazon (70 years), while Maranhão had the worst, not only in the region, but in all of Brazil (only 62 years). The longevity index is a function of a population's life expectancy that, in turn, reflects the health conditions of the population and access to health services.

Finally, the income index contributed only 17% to the total HDI increase, and exhibited a modest improvement, increasing from 0.587 to 0.627 between 1991 and 2000. In 2000, the income index in Brazil was 0.723. Mato Grosso presented the highest income index (0.718), while Maranhão presented the lowest (0.558). The income index droppped in Amazonas and Roraima between 1991 and 2000[37].

Table 8. HDI Indicators (education, longevity, and income) in the Amazon in 2000 (UNDP 2003).

State	HDI		
	Education	Longevity	Income
AC	0.757	0.694	0.640
AP	0.881	0.711	0.666
AM	0.813	0.692	0.634
MA	0.738	0.612	0.558
MT	0.860	0.740	0.718
PA	0.815	0.725	0.629
RO	0.833	0.688	0.683
RR	0.865	0.691	0.682
TO	0.826	0.671	0.633
Amazon	**0.802**	**0.685**	**0.627**
Brazil	**0.849**	**0.727**	**0.723**

11. HDI IMPROVES IN AMAZONIAN MUNICIPALITIES

In 2000, the overwhelming majority (97%) of municipalities were classified with an average human development index (HDI between 0.5-0.8); while 2% of municipalities presented a high HDI (> 0.8) and only 1% had a low HDI (< 0.5) (Figure 17). In 1991, the situation was worse, with 22% of municipalities classified with a low human development index.

The eight municipalities with low human development indices in 2000 were in Acre (Jordão), Amazonas (Ipixuna and Tapauá) and Maranhão (Centro do Guilherme, Lagoa Grande do Maranhão, Governador Newton Bello, Matões do Norte and Fernando Falcão). The municipalities with high human development indices were the capitals Belém (Pará), Palmas (Tocantins) and Cuiabá (Mato Grosso), along with 11 other municipalities in Mato Grosso (Table 9).

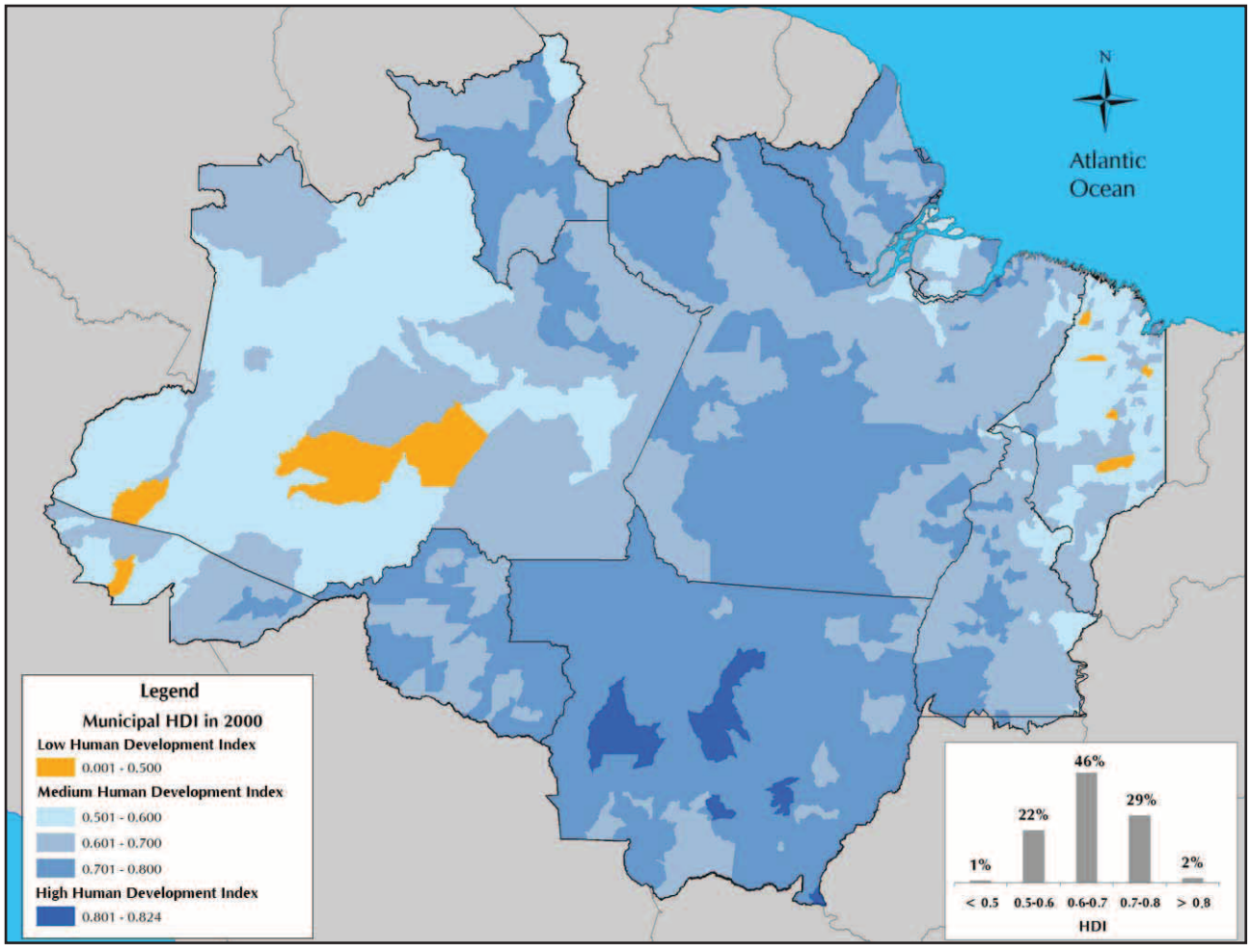


Figure 17. HDI in Amazonian municipalities in 2000 (UNDP 2003).

BOX 8. Traditional populations and HDI

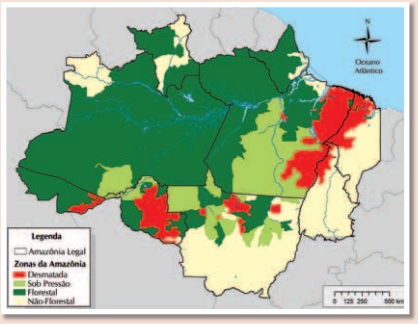
The quality of life of rural municipalities inhabited by traditional populations, indigenous groups, and *quilombolas* may be underestimated by HDI, due to artifacts of the cultural differences and life-styles of these populations. Income and access to conventional systems of education carry different weights when compared to the urban population. On the other hand, cultural preservation and the conditions of access to and quality of natural resources are given greater importance in the quality of life of these populations, which are often extractivist and self-sufficient.

12. HDI IMPORTATION

The phenomenon of HDI importation (transference of HDI from States via populational migration) is highly probable in the Amazon, since the region is one of the principal destinations of migratory flows in the country. Migrants from the more developed regions of Brazil (the south and southeast) may arrive with more advanced educational levels and with better health conditions[38]. Furthermore, a dependence on income and capital for investments is possible. All of these factors influence the calculation and resulting municipal HDI, according to the UNDP method. The municipalities with the highest HDIs in the Amazon constitute a considerable percentage of migrants, with the exception of Belém (Table 9). The population of Sorriso, a municipality in Mato Grosso with the highest HDI in the region, is comprised of 72% migrants (principally from the southern and southeastern regions of the country). The same tendency is observed in other Mato Grosso municipalities.

Table 9. Population origins in Amazonian municipalities with high HDI (UNDP 2003, IBGE 2000b).

Municipality		HDI	Migrants (%)	Origin of Migrants	
				South and Southeast (%)	Others (%)
1º	Sorriso (MT)	0.824	72	79	21
2º	Cuiabá (MT)	0.821	30	56	45
3º	Lucas do Rio Verde (MT)	0.818	67	84	16
4º	Cláudia (MT)	0.813	68	76	24
5º	Campos de Júlio (MT)	0.810	78	72	28
6º	Campo Novo do Parecis (MT)	0.809	63	60	40
7º	Sinop (MT)	0.807	64	76	24
8º	Belém (PA)	0.806	09	16	84
9º	Primavera do Leste (MT)	0.805	50	75	25
10º	Alto Taquarí (MT)	0.804	54	54	45



HDI IN THE OCCUPATION ZONES

All four zones of the Amazon presented an average human development index in 2000, but in the zone under pressure, the HDI was significantly superior (0.713) to the others[39]. This demonstrates that the HDIs of highly deforested regions (deforested zone) do not differ from untouched regions (forested zone), while the zones in which deforestation is occurring tend toward higher HDI.

In fact, deforestation, both absolute and relative, correlates significantly with the HDI of Amazonian municipalities in the year 2000.[40] On the other hand, absolute deforestation levels (quantity deforested in square kilometers) of municipalities demonstrates a positive linear relationship with HDI. That is, the greater the deforestation, the higher the HDI. This increase in HDI is due to the increase in income in these municipalities resulting from economic activities and the arrival of migrants with superior education and capital. On the other hand, relative deforestation (percentage of municipalities deforested) presents a quadratic relation with HDI –municipalities with intermediate deforestation levels have better HDIs than those with extreme levels of deforestation (very elevated or greatly reduced).

The most deforested municipalities of the Amazon present a lower HDI than the regional average (Figure 2 in the Annex). The 43 municipalities with more than 90% of their surface deforested[41] had an HDI of 0.674[42] in 2000, while the regional average was 0.705. Deforestation did not bring a high level of human development to any of these municipalities, and did not represent improved HDIs compared to forested municipalities.

Table 10. HDI in Amazonian occupation zones (UNDP 2003).[43]

Indicators	Amazon			
	Non-forested	Deforested	Under pressure	Forested
HDI[1,2]	0.654a	0.659a	0.713b	0.648a
HDI education[1,2]	0.759a	0.749a	0.760a	0.724b
HDI longevity[1,2]	0.649a	0.670b	0.735c	0.681b
HDI income[1,2]	0.554a	0.559a	0.645b	0.538a

[1] The nine State capitals are excluded from the analysis.
[2] Different letters signify statistical difference according to the Tukey Test ($P < 0.05$).

CONCLUSION

The advance and occupation of the Amazon frontier has been marked by violence and degradation of natural resources. The economy of the region is incipient, and its development follows the "boom-bust" pattern. This occupation pattern does not generate genuine development, which is attested by the critical state of social indicators in the region (Celentano & Veríssimo 2007). The socioeconomic indicators (demographics, violence, economy and HDI) in the Amazonian occupation zones presented in this study strengthen the "boom-bust" theory (Table 11) initially proposed by Schneider (2000).

The analyses indicate that the zone under pressure is undergoing a boom and presents the highest economic growth, but suffers from excessive violence and accelerated deforestation. On the other hand, the deforested zone (experiencing a *bust*) presents the least economic growth. In the case of the forested zone, it is essential to observe that its indicators are similar to those of the deforested zone. Finally, the non-forested zone has a differentiated pattern, since it is located in a drier region with greater agricultural potential compared to forested areas.

The HDI analysis reveals that there is no significant difference between the deforested zone (experiencing a *bust*) and the forested one. On the other hand, the HDI is slightly higher in boom zones (zone under pressure). Our results indicate that the conversion of forest resources in Amazonian municipalities did not result in economic development or in better life conditions for the population.

Table 11. The State of Amazonian occupation zones.[44]

Indicators	Zones			
	Non-forested	Deforested	Under pressure	Forested
Demographics (Source: IBGE)				
Annual population growth between 1991 and 2004 (%)	3	3	5	4
Total migrants (%)	21	23	43	15
Violence (Source: CPT and MS)				
Conflicts over land (2003-2006) per 100,000 inhabitants.	6.9	5.0	15.2	5.8
Rural murder cases (2003-2006) per 100,000 inhabitants..	0.2	0.4	5.5	0.6
Slave labor cases (2003-2006) per 100,000 inhabitants.	36.7	41.3	137.0	11.3
Homicide rate in 2004 per 100,000 inhabitants	20.4	24.5	62.3	18.0
Economy (Source: IBGE, IPEA and MT)				
Average municipal GDP in 2004 (US$ millions)[1,2]	28.7a	46.1a	93.6b	40.7a
Annual growth of GDP between 2000 and 2004 (%)	6.8	4.8	14	7.5
Average per capita GDP in 2004 (US$ thousands)[1,2]	3.2a	2.3a	6.3b	2.2a
Growth of formal employment (2000-2004)[1] (%)	45	46	83	42
HDI (Source: UNDP)				
HDI[1,2]	0.654a	0.659a	0.713b	0.648a

[1] The nine State capitals were excluded from the analysis.
[2] Different letters signify statistical difference according to the Tukey Test ($P < 0.05$).

Deforestation generates both benefits and costs in the short and long term. In the short term, in the zone under pressure, the economic indicators (GDP and employment) improve and the HDI is favored by income generation and attraction of migrants with higher education levels and investment capital. But the high costs in rural violence and deforestation are substantial. In the long term, in the deforested zone, the worst socioeconomic indicators (except for violence) do not differ more than those of forested areas.[45] This represents the worst of the scenarios: exhausted forest resources and the maintenance or aggravation of poverty. Furthermore, the deforestation of the Amazon is the principal source of CO_2 emissions in Brazil, contributing more than 70% of the total emissions of this gas (MCT 2004). These emissions are exceptional for such a modest economy representing only 8% of Brazilian GDP.

The challenge of maintaining the integrity of the Amazon forest is immense and urgent. The threats against the forest persist, and are amplified with the advance of the frontier. In fact, if more profound economic measures are not adopted to increase the value of the standing forest, the "boom-bust" cycle could generate severe environmental impacts simultaneously with the worsening of the social situation in the Amazon. Opportunities exist to promote development based on a use of natural resources that ensures the quality of life for the population, along with a respect for nature, but they must evolve to become the rule of thumb for the social, economic and political life of the region. The boom-bust phenomenon is not inevitable. Alternatives for the sustainable use of the forest have been proposed and are already being executed in the region.

Avoiding the "boom-bust" cycle and the advance of deforestation demands short- and long-term measures. In the short term, it is necessary to invest in municipalities that are already deforested, such that there would be a recuperation of the productive base and a consolidation of agriculture and cattle ranching, reforestation, and other economic activities. To achieve this it is necessary to improve infrastructure, establish a credit policy, increase access to social services (education, health, housing and sanitation), and promote land tenure in these areas. In the municipalities under high pressure, the immediate challenge is to reconcile the conservation of forests with the generation of employment and income, which is necessary to expedite measures that support the adoption of forest management on different scales (land classification, credit, training, technology, etc.) and to establish mechanisms to pay for environmental services[46] provided by the Amazon for the rest of Brazil, as well as the world. In forested areas it is necessary to intensify the adoption of public policies that restrict the advance of the frontier, such as the creation of Protected Areas.

In the long term, changes must occur in the economic base of the region. The dominance of primary activities with low aggregate value must be replaced with an economy in which forest products and services have increased value, and the income from these activities contributes to improving the quality of life of the population. For this to occur, it is necessary to readdress the paths of development in the Amazon and to significantly increase investments in science and technology.[47] Initiatives aimed at drastically reducing deforestation, and even halting it completely (a moratorium) must be pursued in the short term. This effort must convene not only the government, but also the private sector, social and environmental organizations, as well as all of Brazilian society.

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NOTES

[1] Exception made for municipalities and regions rich in mineral resources and those with high agricultural potential.

[2] Nevertheless, studies demonstrate that in the majority of the world's countries, mining also contributes to a "boom-bust" economy, due to the volatility of this type of income, decline in competition with other economic activities, corruption, and institutional problems (Bulte *et al*. 2005). This phenomenon is known as the "mining curse".

[3] We have selected indicators of violence and economy because they have a direct relationship with the opening of the frontier and the conversion of natural resources. The HDI partially synthesizes the social gains from this process, and it is related to education, income and health. Other socioeconomic indicators of education, health, and poverty could complement this approach, but other reports give more specific treatment to the evolution of these indicators in the Amazon (Celentano and Veríssimo 2007). Some of the municipal indicators used are not contemporaneous with the same State indicator.

[4] **Method for classification of zones:** Initially, we classified all Amazon Legal municipalities into forested and non-forested. Forested municipalities encompassed areas with original forest cover of greater than 50%, according to the map of vegetation types (IBGE 1997), while the non-forested areas had less than 50% forest cover. We divided the forested municipalities into three categories according to pressure of deforestation. Amazon deforestation is mapped annually by Inpe by means of analysis of Landsat satellite images. Initially, we utilized the Inpe deforestation map and the IBGE map of municipal limits for the year 2001 to calculate relative municipal deforestation (% deforested) up to 2004 (Inpe 2005, IBGE 2001). For analysis of relative deforestation, we excluded the existing protected areas (UC and TI) created up to 2004 (ISA 2005, Ibama 2006), considering that in these areas deforestation is prohibited and, even when it occurs, it tends to be greatly reduced. Next, we grouped the forested municipalities of the study area into three zones: deforested, under pressure, and forested. The zones were created by means of a statistical analysis through grouping of K-means (*K-means Cluster analysis*), which creates the most statistically distinct groups possible by means of a combination of response variables (Hardigan 1975; Härdle & Simar 2003). The forested municipalities in the study area were grouped into three categories according to relative deforestation (%) and amount of deforestation in 2004 (km²). The result of this analysis was mapped with ArcGis 9.0.

Characterization of Amazonian zones.

Indicators	Amazon			
	Non-forested	Deforested	Under pressure	Forested
Number of municipalities (IBGE)	366	218	26	164
Area (in thousands of km²) (IBGE)	1,218.8 (24%)	513.5 (10%)	690.2 (14%)	2,626.1 (52%)
Total Deforestation up to 2005 (%) (Inpe 2005)	-	56	16	5
Areas Protected up to 2006 (%) (Isa 2005)	28	23	50	49

[5] We employ the term non-forested to classify all municipalities with more than 50% of vegetation cover composed of savannah or natural grasslands. Nevertheless, we caution that there are large variations between different types of savannah in Brazil. Some specialists classify the savannah as having a forest-like physiognomy.

[6] **Methods:** Data for total, urban, rural, and migrant population composition, including sex, race, and indigenous population, are collected by the IBGE by means of demographic surveys, and are published on the internet (on the IBGE, Ipea or UNDP websites). We collected these data for the States and municipalities of the region when available. The results referring to Legal Amazon are represented by the sum or arithmetic mean of the States. The total population presented for Maranhão excludes the population of municipalities outside the Legal Amazon. For the year 2004 (municipal data unavailable), we estimated the population of Maranhão utilizing data referring to the total population of Maranhão and a population growth rate similar to prior years. Source of data for this section: Ipea 2006a, IBGE 1991, 2000a and 2004, UNDP 2003.

[7] Specialists caution that the criteria utilized by IBGE may underestimate the rural population in Brazil (Veiga 2002).

[8] In the 1970s, the military government of President Médici established PIN, a project whose principal actions included strong incentives for migration by means of colonization projects, financial incentives for agriculture and cattle ranching projects, large mining projects, and investments in infrastructure.

[9] The male and female Amazonian populations are equivalent (IBGE 2000a). Sixty-eight percent of the population is indigenous, black, or mixed, and 32% are white (UNDP 2003). Thirty-seven percent of the Brazilian indigenous population is concentrated in this region, that is, 270,200 people (IBGE 2000a).

[10] Rondônia and Mato Grosso claim 32% and 26% of their populations, respectively, originating from the south and southeast of Brazil. The States of Roraima and Amapá have, respectively, 32% and 29% of their total population originating from other Amazonian states. In 2000, the primary intra-regional immigrants came from Maranhão (43%) and Pará (40%).

[11] **Data:** The indicators of violence in the countryside (conflicts, slave labor and rural murders) come from CPT (www.cptnac.com.br). The CPT is an entity of Human Rights Defense which operates in the areas of research and rural extension. The CPT registers and publishes annual data (registration and denunciation) on the diverse conflicts in the countryside involving laborers. The data referring to conflicts, invasions of indigenous lands, and murders come from Cimi (www.cimi.org.br), a non-governmental organization linked to CNBB. Cimi sporadically publishes a report on violence against Brazilian indigenous peoples. Finally, data on homicides (cases and rates) come from Datasus (database of the Single Health System). However, these data are available on the Ipea website. Until 1995, the information came from CID9, and from 1996 onward from CID10. Homicide is defined as the act of killing a person either voluntarily or involutarily.

Analyses: All of these data are made available by the municipalities. Legal Amazon refers to the sum of all municipalities (Indicators 1 to 3) and the total (of the Amazon or the occupation zones) as a function of its respective population (Indicator 4 and Table 4). The maps were created using ArcGis 9.0 software. The homicide map classes were determined by natural breakdowns of data. We caution that in some indicators the increase in the number of cases may be related to greater sampling intensity.

[12] Conflicts over land are acts of resistance and confrontation for possession, use, and ownership of land and for access to natural resources (CPT 2006a). The conflicts over land involve title holders, land-reform settlers, descendants from fugitive slave settlements (*quilombos*), colonists (*parceleiros*), small-scale renters and owners, occupants, landless individuals, rubber extractors, coconut-babassu breakers, nut gatherers, etc. In addition to conflicts over land, conflicts in indigenous lands are frequent in the region. Cimi (2005) reported 11 conflicts in the region in 2005 (20% of Brazil). The majority of these (73%) were in Roraima and were related to the ratification of Raposa Serra do Sol Indigenous Land. The invasions of indigenous lands by illegal small landholders (posseiros), gold miners (garimpeiros), ranchers, and loggers have also increased in recent years. Between 2003 and 2005, 27 invasions were reported in the region (73% of the Brazilian total); 37% of them in Mato Grosso (Cimi 2005). Finally, between 2003 and 2005, 30 indigenous people were murdered in the Amazon (25% of Brazil as a whole), of which almost half were killed in either Pará or Roraima (Cimi 2005). Other common forms of violence against indigenous people include environmental damage to their territories, such as deforestation and water contamination (CIMI 2005).

[13] These numbers are underestimated since, in the case of some conflicts, information on the areas and families involved was not registered (CPT 2007).

[14] Land occupations refer to acts of groups of landless families that enter rural property that is said to be unproductive (CPT 2006a). The principal social movements disputing for land and operating in the Amazon are the MST, Contag, and Via Campesina, in addition to state associations, leagues, and movements on a smaller scale.

[15] Pearson Correlation ($p < 0.001$ and $R^2 = 25\%$) between municipal data on deforestation in 2004 (Inpe 2005) and rural murders in 2003 and 2004 (CPT) calculated using BioEstat 4.0 software.

[16] They are: 1st São Félix do Xingu (PA), 2nd Novo Progresso (PA), 3rd Porto Velho (RO), 4th Altamira (PA), 5th Colniza (MT), 6th Tapurah (MT), 7th Novo Repartimento (PA), 8th Nova Maringa (MT), 9th Querência (MT) and 10th Cumaru do Norte (PA).

[17] Rural violence over land disputes also occurs in deforested regions because occupation with free access resulted in high land concentration.

[18] According to ILO (2005), slave labor refers to degrading work with privation of liberty that may stem from debt servitude, retention of documents, geographic isolation, or use of armed guards. The term *slave labor* refers to legal terminology for a condition analogous to slavery. We must caution that the sampling intensity influences the number of slave labor cases. Furthermore, slave labor cases in remote forested regions can occur without being reported due to difficults of access to MTE teams.

[19] To learn more about the National Plan for the Eradication of Slave Labor visit: http://www.oitbrasil.org.br/trabalho_forcado/brasil/iniciativas/plano_nacional.pdf

[20] In 2007, the MTE released an updated "Lista suja" ("Dirty List") containing a total of 190 names, of which 154 were in the Legal Amazon. More details are available at: http://www.mte.gov.br/trab_escravo/lista_17_07.pdf

[21] See more details at the Instituto Ethos (Ethos Institute): www.ethos.org.br/_Rainbow/Documents/PactoNacionalMinuta02_05.pdf

[22] Pearson Correlation ($p < 0.001$; $R^2 = 21\%$) between municipal deforestation data for 2004 (Inpe 2005) and the 2004 homicide rate (Datasus) calculated using BioEstat 4.0 software.

[23] **Methods: GDP.** The GDP is calculated by IBGE based on aggregate economic activities of industry, agriculture, cattle ranching, and services added to taxes and *dummy financier* (the difference between interest received and interest paid). GDP data are generated and made available by IBGE. The Ipea adjusts these data for inflation based on the Brazilian real (currency) for the year 2000, by means of the Implicit Deflator of national GDP, and makes these data available on its site at: www.ipeadata.gov.br . The data from IBGE and Ipea do not coincide due to this inflation-deflation adjustment. The inflation-adjusted data in reals were converted to dollars according to the 2000 exchange rate, equivalent to US$ 1 = R$ 1.83 (Ipea 2006i). Maps of GDP and *Per Capita* GDP were created using ArcGis 9.0 software, and the class of values was defined manually. The Gini Index presented for the Legal Amazon is the arithmetic mean of the State values.

Exportation. Export data (presented complementarily in this section) are collected and released by MDIC (http://aliceweb.desenvolvimento.gov.br/). The values are expressed in US$ FOB, that is, they include all values up to the shipping of the product; transport to the importing country is not included. The exported products are divided into 19 sections according to nomenclature common throughout the Mercosul countries.

EAP and Employment. Data referring to EAP are collected by IBGE and released by IBGE and Ipea (Ipea 2006h, IBGE 2007). The EAP is composed of individuals active for more than 10 years and unemployed individuals. The EAP of the Amazon is the sum of the population in the Amazonian states, that is economically active for more than 10 years, divided by the total population in this age bracket (IBGE 2007). Formal employment data are collected and released by MTE via RAIS. The RAIS manages labor activities in the country, providing data for elaboration of statistics related to the job market, and contributing to meeting the needs of workers, such as legislation, FGTS, Provisional Collection and Benefits, and PIS/Pasep, among others.

[24] The service sector includes, among other branches: commerce, food and lodging, transport and storage, communication, real estate activity, financial intermediaries, public administration, health, and private education. Industrial GDP incorporates four types of industries: (i) the mineral extraction industry (coal, petroleum, gas, metallic or non-metallic ores); (ii) transformation industry (food, textiles, wood products, chemicals, metallurgy, etc.); (iii) civil construction industry; and (iv) public utility services industry or Siup (energy, gas and water). The agriculture and cattle ranching GDP consists of forest exploitation, silviculture, farming and ranching activities. More information on national classifications is at: http://www.cnae.ibge.gov.br. To calculate the relative percentage of each sector of the economy (service, industry and agriculture and cattle ranching), we excluded the value referring to the *dummy financier*.

[25] Export businesses in Brazil receive discounts on IPI, PIS, and Cofins, in addition to a 0% aliquot of IOF on operations of credit, exchange, and insurance.

[26] The city of Manaus, the principal free port of Brazil, claims the fourth largest economy in Brazil, behind only São Paulo (SP), Rio de Janeiro (RJ) and Brasília (DF). A free port is a territory offering tax benefits. The free port of Manaus was instated to stimulate the economy of the western Amazon and promote productive integration into the country.

[27] The Gini index ranges from 0, where no disparities exist, to 1, signifying maximum disparity.

[28] We caution that the EAP may be underestimated due to the difficulty of access to this type of data collection in some remote areas of the Amazon, where traditional and extractivist populations reside.

[29] EAP is composed of individuals with more than 10 years of activity (employed in the formal or informal market) and inactive ones (unemployed), in addition to unpaid or self-employed workers.

[30] Formal jobs include employees with statutory, specially-protected (celetistas), temporary, and separated status. We caution that the large increase of this indicator may have resulted from initially fair indicators.

[31] To estimate informal employment in the Amazon in 2004 we subtract from the total economically active population (11.3 million people) the inactive population (768,000 people), the formally employed population (2.4 million people), and the population between 10 and 14 years of age (422,000 people). However, we caution that the economic activities of the population in this age group are illegal and certainly informal.

[32] In 2004, 4% of the EAP were between 10 and 14 years of age.

[33] Mean Timber Production in municipalities of Amazonan frontiers in 2004 (Source: Lentini *et al.*, 2005).

	Wood Producing Municipalities	Wood Consumption in Logs (thousands of m³)	Total Direct Employment	Gross Income (US$ thousands)
Non-forested zone	8%	16.77	73.93	1,441.83
Deforested zone	33%	41.98	215.72	3,930.95
Zone under pressure	69%	140.07	752.12	14,523.89
Forested zone	24%	34.40	189.55	3,398.46
Amazon Average	**21%**	**31.64**	**160.74**	**2,991.20**

[34] Municipalities with less than 50% forest cover were excluded.

[35] Means were compared by analyses of variance (ANOVA) using BioEstat 4.0 software. Different letters signify statistical difference according to the Tukey Test ($P < 0.05$). Results of ANOVAS:

	Municipal GDP in 2004 (US$ millions)	*Per capita* GDP in 2004 (US$ thousands)
	mean (s.d.)	mean (s.d.)
Non-forested	28.7 (58.5) a	3.2 (5.4) a
Deforested	46.1 (99.6) a	2.3 (2.1) a
Under pressure	93.6 (107.4) b	6.3 (5.2) b
Forested	40.7 (92.8) a	2.2 (1.9) a
F	5.8551	9,2390
p	0.0009	< 0.0001
Error (QM)	66.4 e+08	16.9 e+06

We caution that there are differences between the States inside zones (differences not tested). For example, the mean economic indicators of the non-forested zone were reduced by the municipalities of Maranhão.

[36] **Data.** The HDI is a standardized measure of evaluation that serves to compare life conditions among different regions and countries. In Brazil, the HDI is calculated by UNDP, Ipea and FJP from household census data obtained by IBGE. Starting in 1991, a new methodology for calculating HDI was adopted in Brazil to enable international comparison. HDI data for municipalities and States are available in the Atlas of Human Development in Brazil (http://www.pnud.org.br/atlas/). UNDP annually publishes its Human Development Report, which employs data on human development from throughout the world. The report and further details on its calculation methodology are available at the site: www.pnud.org.br. The most recent HDI available for Brazil on the statewide and municipal scale is from 2000. To calculate the HDI, education is measured by a combination of literacy rates of the population above age 15 and school attendance rates at three instruction levels (elementary, middle and high school). Longevity is evaluated according to life expectancy at birth. Income is calculated by the purchasing power of the population based on *per capita* GDP, adjusted to the local cost of living with employment by PPP methodology (parity of purchasing power).

Analyses. The mean HDI (total, income, education, and longevity) of the Legal Amazon was calculated by using the mean weighted for State populations (IBGE 2000a). Life expectancy was calculated in the same manner.

[37] This observed decline could be the result of including rural and indigenous populations in data collection.

[38] Indicators for education and health in the south and southeast (such as access to health services, physicians for inhabitants, and public expenditures, among others) are superior to other regions of the country. Additionally, sanitation indicators (access to water and sewer services) are better in these regions and infant mortality is lower. All these indicators reflect greater life expectancy of the population of these regions, and can be transferred indirectly with migration. In addition, the more highly educated population originating from these regions favors better personal hygiene and eating practices, which also can be reflected in the health of the population.

[39] We caution that the mean HDI in the non-forested Amazon was reduced by municipalities present in this zone in Maranhão (worst HDI in Brazil) (Figure 1), since a great proportion of this zone occurs in States with favorable HDI, such as Mato Grosso and Tocantins.

[40] **Deforestation and HDI.** The relation between deforestation and the HDI of Amazon municipalities was obtained by means of regression analyses (Zar 1979) using BioEstat 4.0 software. For this we excluded non-forested municipalities (that is, original forest cover less than 50%) and the State capitals (considered outliers by having favorable HDIs). In total, 407 municipalities of the Legal Amazon were evaluated (3.8 million square kilometers, or 74% of the total area of the region). In the first analysis, absolute municipal deforestation (km²) in 2000 was considered the independent variable and municipal HDI in 2000 the dependent variable. In the second, relative municipal deforestation (%) was considered the independent variable and HDI the dependent variable. Absolute deforestation fit better with a rising linear curve, while relative deforestation conformed better to a quadratic curve. Results of the regression analyses:

Variables	*Curve*	*p*	*R^2 adjusted*	*F*	*Error (QM)*
Absolute deforestation (km²) * HDI	Linear ascendent	<0.0001	0.154	73.44	0.262
Relative deforestation (%) * HDI	Quadratic convex	<0.0001	0.1216	28.25	0.104

[41] Municipalities with less than 50% forest cover were excluded.

[42] Mean weighted for population.

[43] Means were compared by analyses of variance (ANOVA) using BioEstat 4.0 software. Different letters signify statistical difference according to the Tukey Test ($P < 0.05$). Results from ANOVAS:

	HDI	**HDI Education**	**HDI Longevity**	**HDI Income**
	mean (s.d.)	mean (s.d.)	mean (s.d.)	mean (s.d.)
Non-forested	0.654 (0.07) a	0.759 (0.08) a	0.649 (0.07) a	0.554 (0.09) a
Deforested	0.659 (0.06) a	0.749 (0.07) a	0.670 (0.06) b	0.559 (0.08) a
Under pressure	0.713 (0.05) b	0.760 (0.06) a	0.735 (0.04) c	0.645 (0.07) b
Forested	0.648 (0.07) a	0.724 (0.11) b	0.681 (0.05) b	0.538 (0.09) a
F	6.2679	6.5961	18.4995	10.6304
p	0.0006	0.0004	< 0.0001	< 0.0001
Error (QM)	0.005	0.007	0.004	0.007

We caution that there are differences between the States inside zones (differences not tested).

[44] Means were compared by analyses of variance (ANOVA) using BioEstat 4.0 software. Different letters signify statistical difference according to the Tukey Test ($P < 0.05$). Results of ANOVAS can be seen in notes 35 and 43.

[45] Indicators of infrastructure and access to public services can indicate benefits in deforested areas.

[46] Such as, for example, the maintenance of carbon stocks, protection of waters and soils, maintenance of water cycle, etc.

[47] Idea proposed by the Sociedade Brasileira para o Progresso da Ciência (SBPC, the Brazilian Society for Progress in Science) in its 59th meeting, held in Belém (PA) in 2007, in which Professor Bertha Becker (UFRJ) convened specialists from different areas of knowledge in "GT Amazon: For an innovative regional development plan".

ANNEX

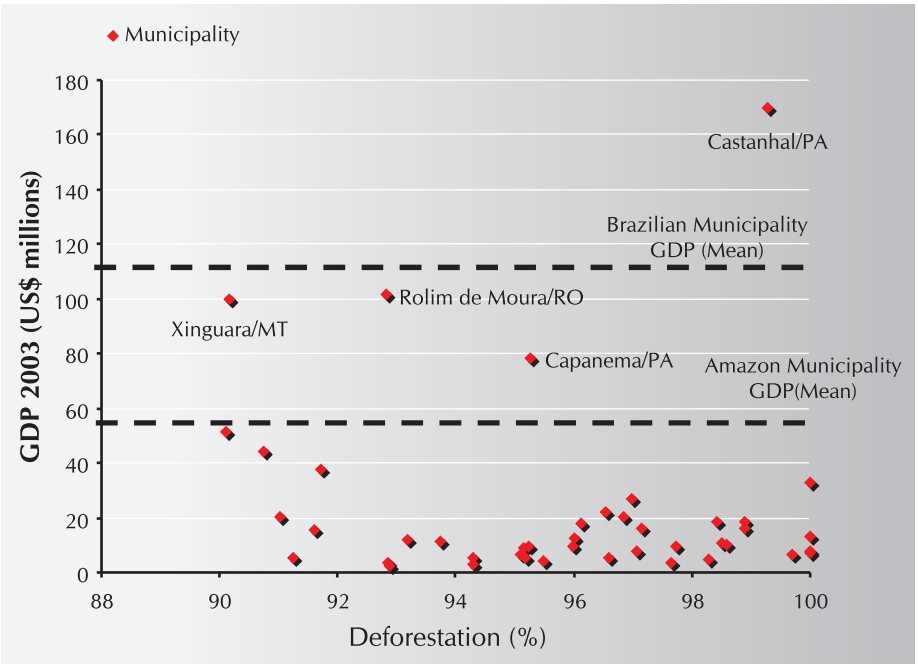

Figure 1. GDP in the 43 most deforested Amazon municipalities (Inpe 2005, Ipea 2006e).

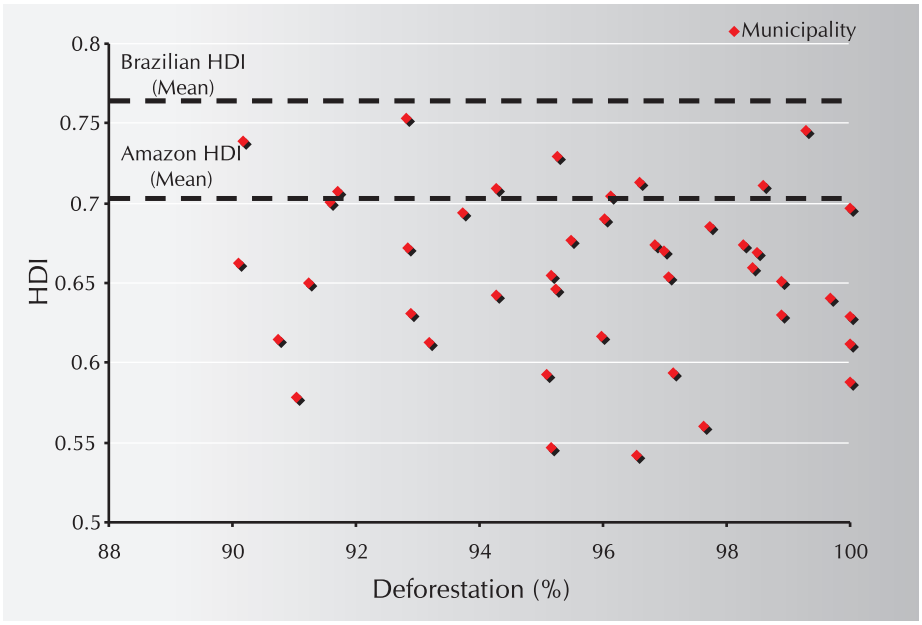

Figure 2. HDI in the 43 most deforested Amazon municipalities (Inpe 2005, UNDP 2003).

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