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## **Population and environment in Brazil**

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### **Abstract**

Brazil is a continent-sized country, with a great diversity of ecosystems, unequally transformed by the processes of occupation and territorial formation. In the southern half of the country, the natural environment has been replaced by a humanized natural environment due to the pushing back of settlement frontiers, which, for five centuries, has transformed Brazil's land use. In recent decades the rhythm of change has been faster: on one hand, the population has increased, and migrated to the cities; on the other hand, the cultivation of major crops (coffee, sugar, soybean, cotton, etc.) has moved northwards and westwards, reaching northern regions such as Mato Grosso and Pará, threatening the rainforest in the Amazon Basin.

### **Brazil, a continent**

Brazil is a continent-size country; it extends from north of the Equator to south of the Tropic of Capricorn and from the 36<sup>th</sup> meridian to the 72<sup>nd</sup> west of Greenwich. Defining this immense space by its geographical coordinates, precise but abstract, does not give a realistic idea of the size of the country. The only way to feel it is to cross it by land. The distances amount to thousands of kilometers, and travelers can read them on the road signs installed by DNER (Federal Road Department) at the edge of the federal roads (*Figure 1*). A car driver, or more often a truck-driver, who travels to the city posted on the sign knows that one can expect to spend hours, even days, on the road to reach it.

It was by no means always obvious that Brazil was to become the giant it is today: the slice of South America allocated to Portugal by the Treaty of Tordesillas (which

delimited Spanish and Portuguese possessions in 1494) was marked by a meridian passing by the mouths of the Amazon. Two and half centuries later, the current boundaries, are nearly everywhere three thousand kilometers further west. Strong nationalist sentiments forged during this conquest made it possible to overcome social and regional cleavages and create the huge country (*Figure 2*).

Paradoxically, Brazil mainly owes this immense territorial extension to the pressure of foreign competitors. These forced Portugal to take seriously an unwillingly engaged conquest, then to complete and consolidate it. Without the competitors, the country may not have achieved the same destiny, but this competitive pressure does not explain everything. The leading factor in the extension and unification of the Brazilian territory is, rather, the coincidence of deliberate political action by the Portuguese Crown (and later by the Brazilian governments) and of the impressive pioneering spirit of Brazil's inhabitants. This continental space was indeed conquered, built, and consolidated step by step (*Théry and de Mello 2003*).

**Figure 1. Road distances**

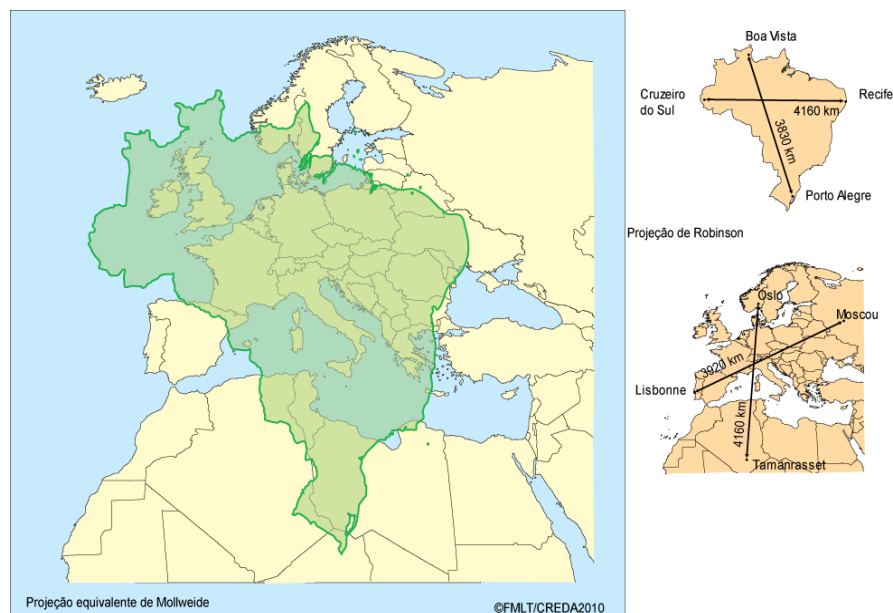


The largest photo was taken in Santarém (Pará). Secondary photos were taken on the road from Brasília towards the north (top left), at the Brazil-Venezuela border (top

right), in Acre State (middle left and between Brasília and Goiânia (bottom left).  
(Photographs by Herve Théry)

The territory we see today bears the mark of this history; it has been able, with a few adjustments, to accommodate the evolution of a country whose population has increased tenfold in the last century (from 17 million inhabitants in 1900 to nearly 170 in 2000). New municipalities (*municípios*) were constantly created in the newly conquered regions (and some are still being created), new states were founded (and some Brazilians would create yet more) but overall the structure built in the first centuries of Brazil's life still holds.

**Figure 2. Brazil's size compared to Europe**



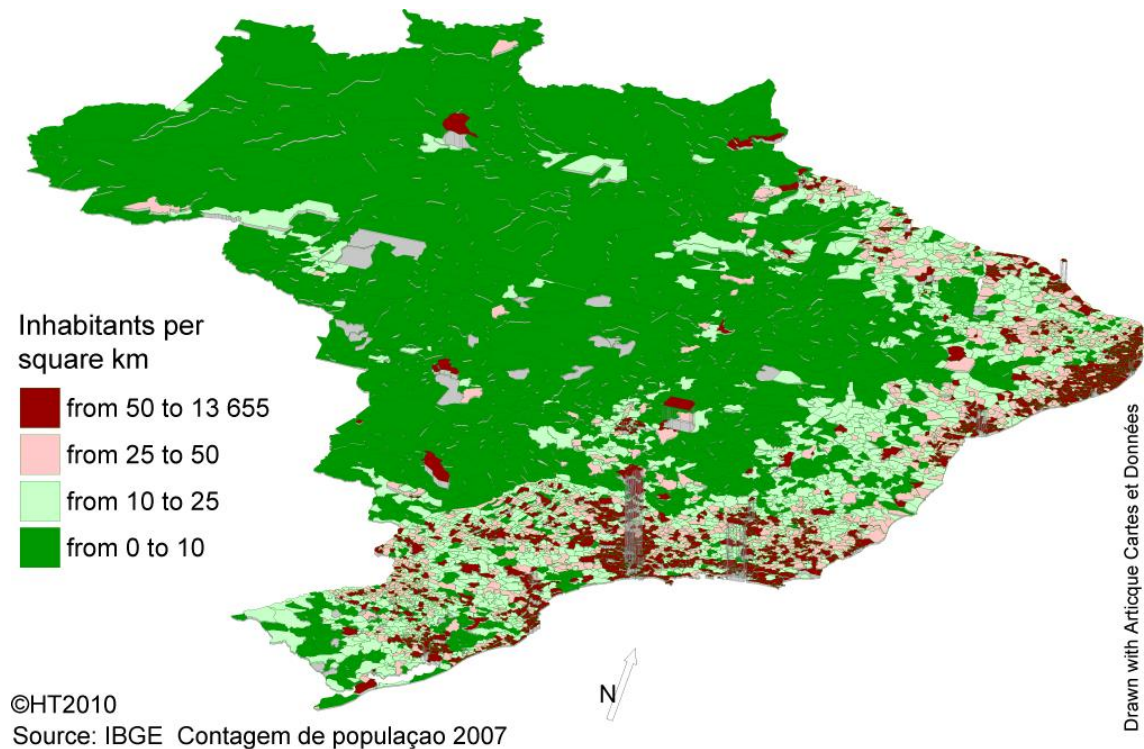
### **Population densities and their evolution**

The Brazilian population is unevenly distributed on the territory; there is still a sharp contrast between coastal and inland regions, which still reflects the effects of the colonization process and settlement of the territory. The former are highly populated, while the latter are only marginally occupied (*Figure 3*).

Even areas of population concentration are irregular: in populous states like Rio Grande do Sul, Santa Catarina, Minas Gerais, Bahia, Pernambuco, Paraíba and Rio Grande do

Norte, there remain many interspersed, thinly populated areas. Only Sao Paulo, Paraná, Rio de Janeiro, Sergipe, Alagoas, Paraíba and Ceará have a continuously occupied territory. In the rest of the country, the population distribution is closely correlated with the transport networks — waterways, railroads (built to export the products of the inland regions) and now regional feeder roads

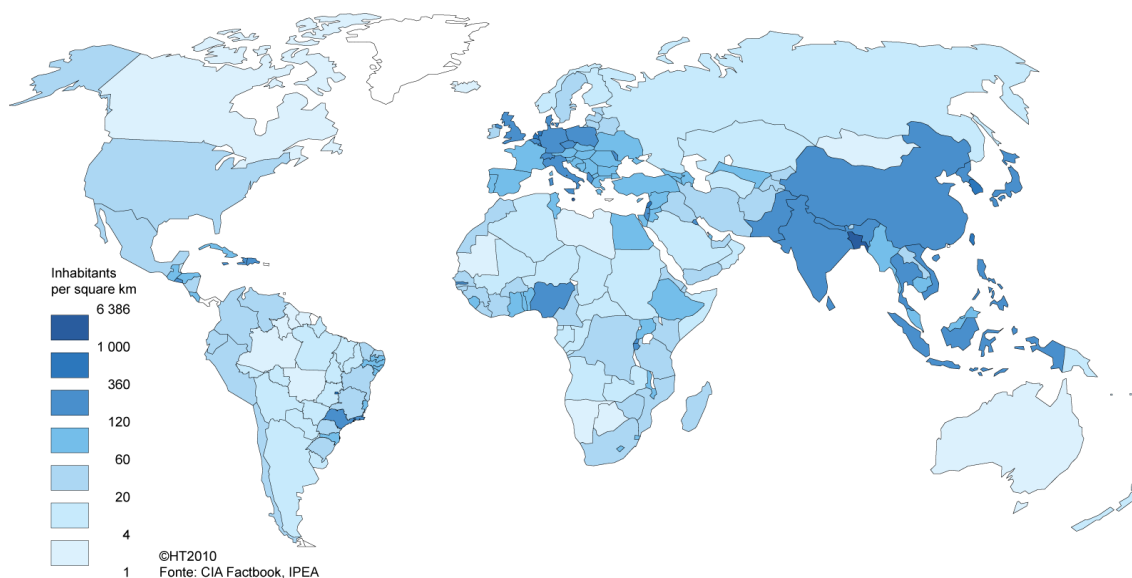
**Figure 3. Population density**



The distribution of the population shows therefore a clear east-west opposition, the result of the process of occupation and colonization starting from the coast (*Figure 3*). So in the parts closest to the sea, Nordeste, Sudeste and South, the densities exceed 50 inhabitants per square kilometer, and can rise to over 10,000 in the state capitals. In contrast, in most of the Amazon and in large areas of the Midwest, densities are very low, between 0.13 and 10 inhabitants per square kilometer. They are only higher in the state capitals and some *municípios*, where they are between 11 and 24 inhabitants per square kilometer. In fact, Amazon densities, calculated for the whole municipality, have little meaning, as a great part of them is composed of forests, but the high densities of the coast and the contrast with the interior regions remains one of the strong features of the country.

The coastal area is not homogeneously occupied: nearly empty north of the Amazon, there is a clear contrast between two highly populated regions, on both sides of a sparsely occupied center (southern Bahia State and Espírito Santo State). In the Nordeste, the contrast between the coastal zone and the interior is repeated. In the Sudeste and South, however, the density remains high in many regions close to the western borders of the country. It is the only place where Brazil has some “depth”, as shown on the density map between the latitudes of Vitoria and São Paulo, and between the sea and the edge of Mato Grosso, Brazil’s agricultural, industrial and urban heartland.

**Figure 4. Population densities by countries and Brazilian States**

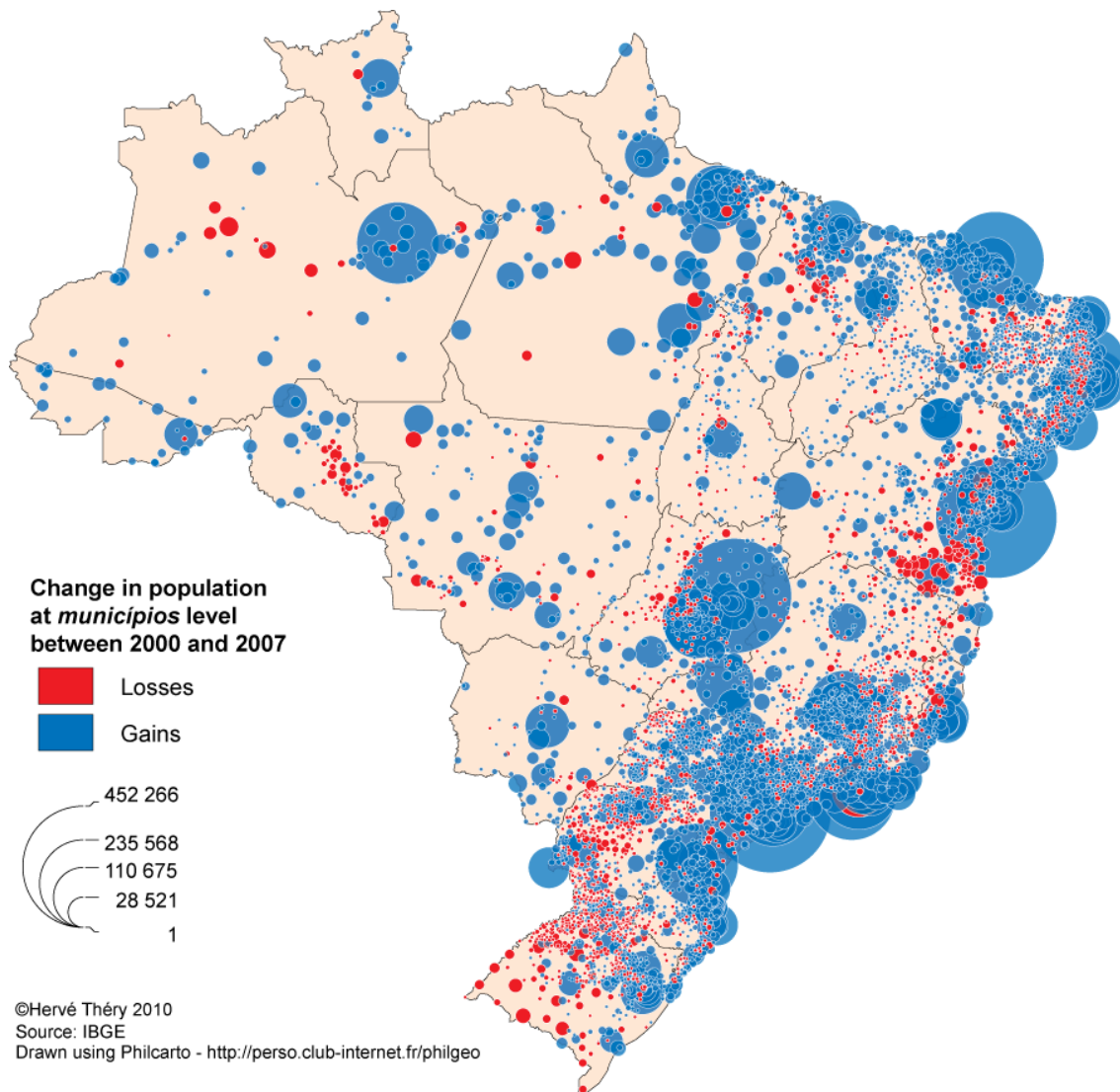


The population densities contrast so much inside Brazil that its states are, from this point of view, similar to countries with extremely different situations (*Figure 4*). The Federal District of Brasília (421 inhabitants per km<sup>2</sup>) is similar to the Netherlands (395) or to Israel (368). São Paulo (160) is a little more densely populated than Poland (123), Nigeria (139) and China (137). Pernambuco (85) is at the same level as Spain (80) or Turkey (89), and Minas Gerais (32) as United States (31) or South Africa (36). Among the least densely populated states, Goiás (16) is similar to Argentina (14) and Algeria (13), Pará (5) to Kazakhstan (5.5), and Amazonas (2) to Canada (3.2) and Libya (3.3).

How does this distribution of the population change, and how do these changes affect the environment? The IBGE (Instituto Brasileiro de Geografia e Estatística) has recently published the results of the Population Count of 2007 (*Diário Oficial da União* of October 5, 2007). According to these data, Brazil currently has 183.9 million inhabitants. In the seven years after the 2000 census, Brazil's population grew by more than 14 million inhabitants, the equivalent of Bahia State, Brazil's fourth most populated state. All major regions grew, but without changes in the hierarchy: the Sudeste is still the most populous area, with 77.8 million, followed by the Nordeste (51.5), South (26.7), North (14.5) and Midwest (13.2). Among the states, Sao Paulo leads with 39.8 million inhabitants, followed by Minas Gerais (19.2), Rio de Janeiro (15.4), Bahia (14 ) and Rio Grande do Sul (10.5). The least populated is Roraima (395.7 thousand inhabitants), followed by Amapá (587.3 thousand) and Acre (655.3 thousand).

*Figure 5* shows the regions that gained (blue circles) or lost population (red circles). The former are obviously much more numerous, owing to the country's population increases, which also increased the dominance of the coastal regions and major cities. Loss of population affected some regions, such as Rio Grande do Sul, southern Bahia, north of Paraná and — most surprisingly — the center of Rondônia and Amazonas, till recently pioneer regions which attracted migrants from other areas. The creation of new municipalities in 2001 may explain some cases, especially in Rio Grande do Sul, but in the other cases there was a real decline in population, a novelty in the demographic history of the country. How can we explain those contrasted movements? One of the main explanations is to be found in the shifting distribution of agricultural regions.

**Figure 5. Population gained and lost between 2000 and 2007**



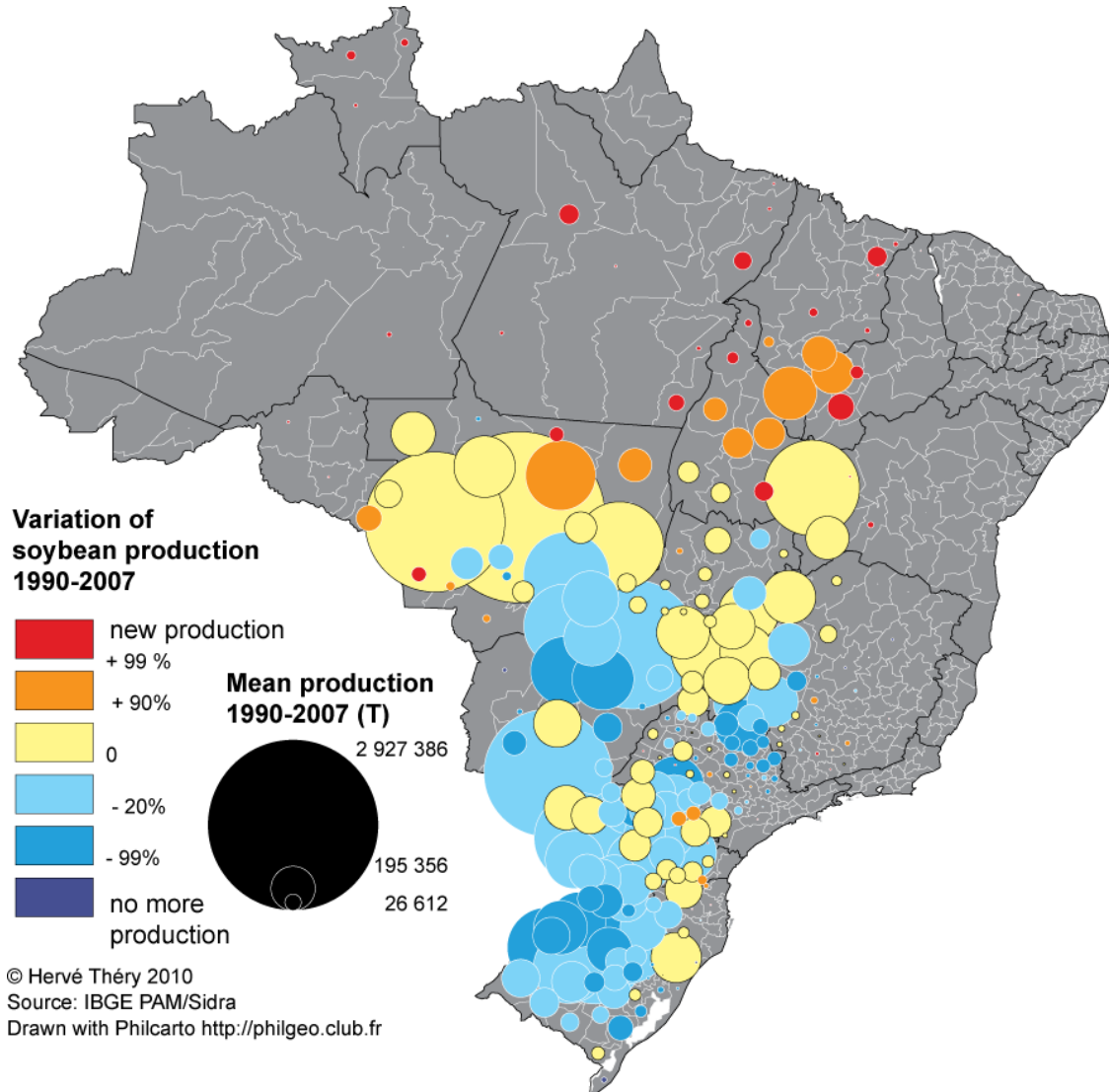
### **The agricultural frontiers**

One of the most striking aspects of the resilience of the Brazilian agriculture is its ability to change almost overnight the spatial distribution of production: the shift, over hundreds of kilometers, of the coffee, rice, sugar and cotton “belts”, are an example of the mobility of Brazil’s agricultural map, perpetually challenged by migrations and the demands of global markets (*Grégoire and Théry 2007*). The best example is without contest the case of soybeans. Brazil did not produce soybeans until the 1970s, and it is now the world's second soybean seed producer, the largest exporter of soybean meal, and one of the leaders for the oil. This increase was achieved through the cultivation of the *cerrado* savannas in Mato Grosso, Goiás and west of Bahia, while in the “old”



regions (those with production in the 1970s) soybean was displaced by other products (Figure 6) (Théry 2004).

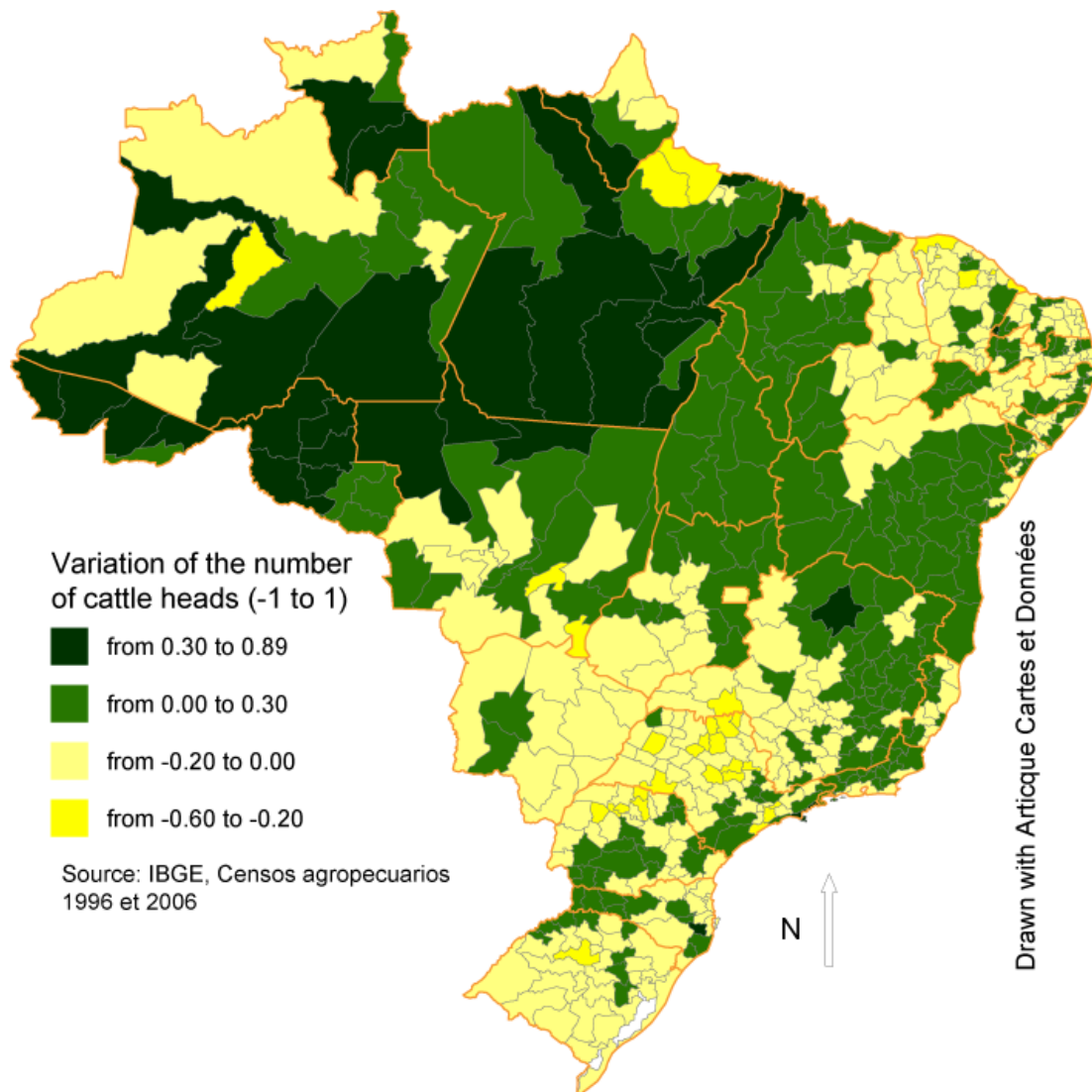
**Figure 6. Regional change in soybean production**



Meanwhile, the frosts in 1975 destroyed the coffee plantations of Paraná, and triggered the migration of coffee production to Minas Gerais State (which became the leading producer), Espírito Santo, Bahia and Rondônia. Rice (outside of Rio Grande do Sul, where it is produced for commercial purposes), which is associated with the pioneer frontier, has followed the same pattern as soybean production. Rice production has therefore been increasing along the arc of deforestation and declining behind it, where it has been replaced by other crops, or more frequently by grass for cattle. Cotton has followed roughly the same pattern as soybeans, and in this case Mato Grosso has also become the largest domestic producer (Théry and Bertrand 2006).

We are witnessing the rise of real pioneer settlement regions in Brazil, unparalleled in the contemporary world (except for certain parts of Indonesia or Malaysia), which recall those of the United States in the 19th century or, closer in time and space, those based on coffee in the states of São Paulo and Paraná in the 1930s and 1940s, masterfully analyzed by *Pierre Monbeig* (1952).

**Figure 7. Spatial variation in the number of cattle**

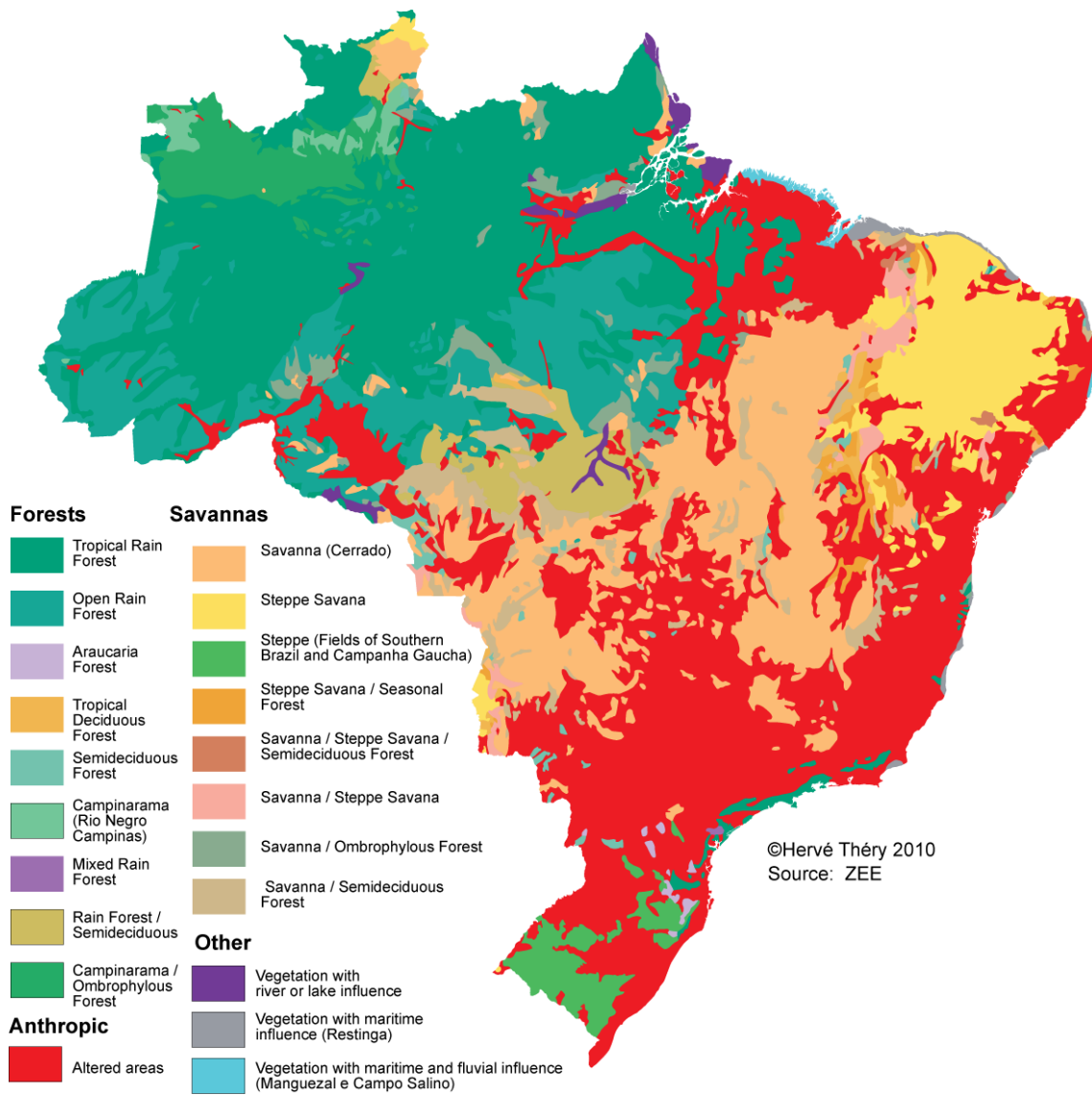


Cattle's breeding deserves special attention because of its economic importance and especially because of its effects on land use. Since the arrival of the Portuguese, this agricultural sector has been one of the main vectors in the dynamics of Brazilian rural areas, from the suburban zones out to the forefront of the pioneer settlement frontiers.

Northward expansion of cattle raising made it possible to constitute immense herds in the new areas, and to nourish those in the older areas. As a result, there are today more cattle than human beings in the country, although the Brazilians also annually consume the equivalent nearly 30 million animals (one per annum for each six people). In addition, benefitting in particular from the European difficulties related to the “mad cow” crisis, Brazil became in 2003 the world's leading exporter of beef.

In the ten years between the 2006 census from and the precedent, the growth of the livestock (*Figure 7*) occurred in the whole of the North (except for the island of Marajó) whereas the few declining areas are concentrated mainly in the Southeast (particularly the state of São Paulo). The dark green areas on the map, indicating the strongest positive variations, clearly underline the arc of deforestation which runs from Maranhão to Acre and even in areas located (more worrying still) in front of that arc, including the state of Amazonas, which has not yet been affected by deforestation.

**Figure 8. The transformation of Brazil's ecosystems**



### **The impact on the environment**

The expansion of cattle breeding is one of the main causes of the fast deforestation impacting the country. *Figure 8* shows the extent of the transformations that have occurred during the forty last years. The “anthropized zones” ( in their vast majority, cleared) between 1960 and 1997 show the continuity, but also the acceleration of the processes of occupation that started with the arrival of the Portuguese on the littoral, five centuries ago (Dean 1997). The deforestations of the current era affect primarily the *cerrados* savannas and Amazonia, incorporated by the pioneers fronts into the agro-pastoral complex. This conquest of the frontier has been encouraged, or even caused, by instituting public policies (credit, infrastructure, etc.) which started the surge of the migrants and transformation of the landscapes.

The most heavily impacted zone forms an immense triangle, whose base is located in the west of Paraná and extends to the Northwest to Rondônia and the Northeast to Maranhão and southern Pará, leaving aside (for the moment?) the Pantanal swamps. The conquest of northern Mato Grosso was incomplete at the end of the 20<sup>th</sup> century but has appreciably progressed since then, and can be expected to continue in southwest Pará and southern Amazonas. The movement launched under the Presidency of Juscelino Kubsticheck, the promoter of “march towards the West”, consumed a major ecosystem at each decade, the *cerrados* in the 1970s, the transition between *cerrados* and forest in the 1980s and in the 1990s it has clearly progressed into those.

This process is followed by the Brazilian scientists of the INPE (National Institute of Space Studies), with more precision, in spite of the vastness of the territory concerned, than in many countries, where measurements of deforestation are made at 5 to 10 years intervals. In Amazonia it is measured annually, using 229 satellite images which cover the areas of primary forest, that is to say four of the five million square kilometers of Amazonia (*Figure 9, Table 1*). About 745,000 square kilometers (or 74,5 million ha, that is to say, 135% of the surface of France) have been cleared in Amazonia through 2009 according to the INPE, and with a very clear acceleration during recent decades. Furthermore, INPE cannot see, on the satellite images it analyzes, the selective cuts which result in a loss of the biodiversity and an aggravation of the fire hazard.

**Table 1. Total and annual clearing of forest in Amazonia**

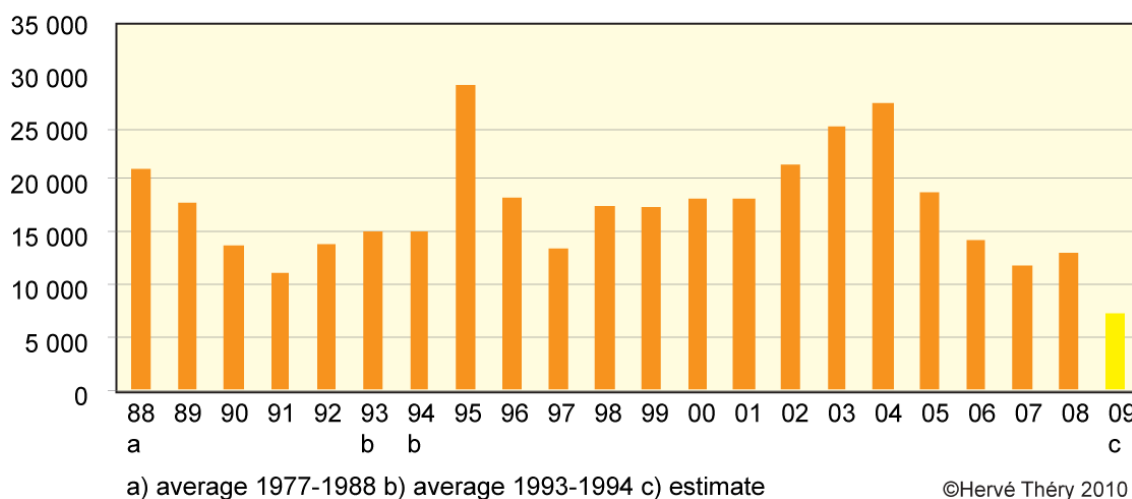
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009*
Clearing (km <sup>2</sup> )	18 226	18 165	21 523	25 396	27 772	19 014	14 196	11 633	12 911	7 008
Change from prior year (%)	5,60	-0,33	18,49	17,99	9,36	-31,54	-25,34	-18,05	10,99	-45,72
Total (millions ha)	587	605	627	652	680	699	713	725	738	745

\* Estimate. Source : INPE/Prodes,

[http://www.obt.inpe.br/prodes/prodes\\_1988\\_2008.htm](http://www.obt.inpe.br/prodes/prodes_1988_2008.htm)

**Figure 9. Annual deforestation in Amazonia**

Annual deforestation in Amazonia (km<sup>2</sup>/year)

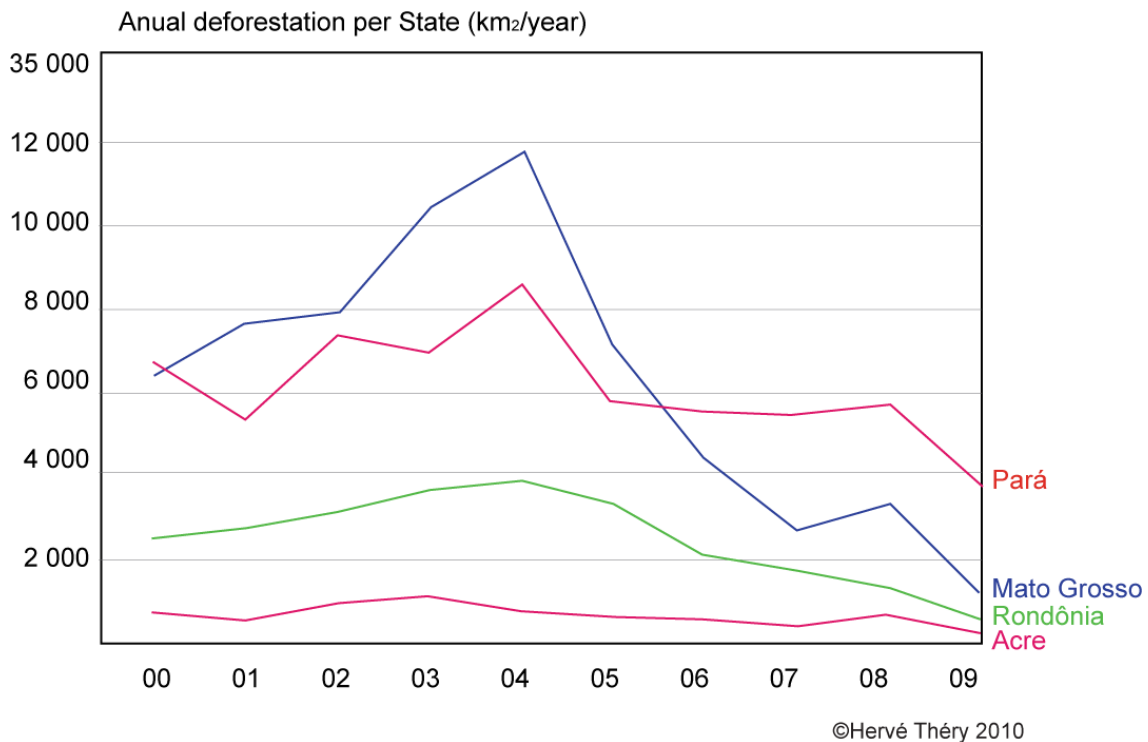


Source: Prodes/INPE

The federal government recently announced<sup>1</sup> the lowest rate of deforestation since measurements began in 1988. According to the figures of the Project for Monitoring Deforestation of the Amazon (PRODES) of the National Institute for Space Research (INPE) the total deforestation in 2009, was 7 000 km<sup>2</sup>. The rate is 45% lower than in 2007 (nearly 12,000 km<sup>2</sup>). The size of the deforested area should not be underestimated, because it is higher than the total extent of the Federal District, (5,800 km<sup>2</sup>). Among the trends of deforestation, Pará and Mato Grosso are the leading logging states, especially with the advancement of the agricultural frontier along the axis of the BR-163 road (*Figure 10*).

<sup>1</sup> <http://www.oeco.com.br/reportagens/37-reportagens/22886-o-mais-baixo-desmatamento-da-historia>, consulted 14/2/2010

**Figure 10, Annual deforestation in the main Amazonian states**



Source Prodes:INPE

This is the main challenge faced by the authorities in charge of the Brazilian public policies: how to reconcile the policies favoring an expanded settlement and agricultural area and increased in the production in Amazonia while safeguarding the environment? Significant efforts have been made to reduce the extent and impacts of the deforestation, by NGOs, by IBAMA (National Institute for the Environment and Renewable Resources), by the Department of the Environment and by scientists. All of them have tried to make the productive sectors aware of the dangers of wasting of natural resources and to convince them that there exist less predatory alternatives. As it is not an option, since the end of the military regime, to impose decisions coming from “the top down”, dialog with the various local groups became the rule, under penalty of failure. New actors entered the play, like the NGOs, the Indians, the communities of descendants of fugitive slaves (*quilombolas*) or the people in traditional communities who live along the banks of the rivers (*ribeirinhos*).

One of the mains themes of these debates (which could in fact become a solution, at least a partial one) is the ecological and economic zoning of the area (*zoneamento ecológico-econômico*), which should be one of principal tools for town and country

planning, with a clear definition of the zones to be preserved and those which can be exploited. But the divergences on methodology (which sometimes mask opposition to the very principle of zoning) slowed down or blocked in many cases agreement on land use planning mechanisms and their adoption and implementation. But in fact a kind of zoning has already been made, if one takes into account the zones already protected as parks, reserves and the indigenous lands.

On the whole, in most of Brazil, except in part of the Amazon forests, the natural environment has been replaced by a humanized natural environment. New transformations are to be expected, in northern Amazonia (still largely intact but increasingly integrated into the remainder of the country), as new roads (like the exit route towards the Caribbean, via Venezuela), and in the South, where new trade and transport activities related to the integration of Brazil in Mercosul upset established conditions. Obviously, debates on the use of the natural resources and on the condition of the environment in Brazil are not likely to die out in the near future.

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### UPDATED NOTES 3/11/11:

1. The scale used for Fig. 7 is unclear, as is, therefore, some of the related text. How is the scale determined? Should any text be changed in the paper? Done in the text. The legend should be changed to Variation in the number of cattle, from 30% to 89%, from 0% to 30%, from -20% to 0%, from -60% to 20%. Casey could you please do this change?
2. Shouldn't we add figure and table sources to the references list? If this is the case, I would need more information for some of the figures in order to inset references within the reference list. I don't think so, all of them already have references
3. Should references in non-English be translated and included in parentheses on the reference list? At least one other paper in the issue has done this. If so, can Herve (or someone) provide me or Casey a translation so that it can be put into the reference? Done
4. Figures 6 & 7: Note my suggested changes in the titles, which I think should be reflected in a title of the figure within the neat line (if a title appears there). Casey can you please change the title of figure 6 to **Regional change in soybean production**
5. Table 1: Note my suggested title changes within the table. Done
6. In figures 9 & 10, I think that any titles within the neat line should be in English. Done, you had an old version
7. Figure 10: I believe that the scale on the left of the chart should read "ha/year". Unfortunately not, it's km<sup>2</sup>/year
8. Note that I have renumbered several figures, and they differ a bit from Herve's last edition owing to an apparent numbering problem within it. Done.