Population Distribution and Environmental Change in Brazil's Center-West Region.

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Introduction

The major land use change underway in Brazil's Center-West[1] (2,129,010.7 km^2, representing 24.9% of the country's area – somewhat less than half the Amazon region), is the substitution of tropical humid forest on the region's northern reaches (Amazon) and (especially) of the savanna-like *cerrado*. With a 2000 population of 14,144,534, the region has undergone rapid development over the last three decades. In this period, the region has moved from (1) a sparsely populated area of subsistence agriculture to (2) a major migration destination for land-seeking migrants from other regions to (3) dynamic export-oriented monoculture. This has been a rapid process, coinciding with the modernization of Brazilian agriculture; increasing mechanization and government incentives have contributed to the transformation of vast extensions of land to the production of grains (especially soybeans, but also cotton, corn and rice) and cattle-raising. Great expectations have been placed on an expanding world market for soybeans and Brazil's comparative advantage in this field.

While the Amazon forest has been recognized as an important resource to be conserved and sustainably managed[2], the *cerrado's* rich biodiversity and carbon storage (principally in root systems) have, until recently, been largely ignored. The transformation of the region into productive, high-tech agriculture has been seen as a victory of technology over nature. This view does not take account of social and demographic consequences (destabilization of traditional family agriculture and high rates of urban growth); nor of environmental consequences (the destruction of natural vegetative cover, liberation of large amounts of CO_2 into the atmosphere, erosion and impoverishment of soils from soybean monoculture). The fact that the *cerrado* and the Amazon Forest are contiguous means that "border effects" of burnings in the former affect the latter.

This paper discusses the process of economic and demographic expansion of the Center-West region of Brazil in recent decades, taking into account the relations, specific characteristics and implications in terms of the uses and the spatial pattern of occupation of the region, as well as environmental impacts. We demonstrate how the introduction of a new production model has reconfigured the earlier form of land use, from both economic and demographic perspectives. We also discuss the new characteristics of population dynamics, most especially migration. We use information derived from the Demographic Censuses of 1970, 1980, 1991 and 2000; the Population Count of 1996; the Agricultural Censuses of 1985 and 1995/96; and data from the satellite monitoring of large-scale burning.

From the perspective of population change, this process has led to growing urbanization. An extensive and highly mechanized crop such as soybeans disarticulates earlier forms of settlement, based on small farms, and results in lower labor requirements, provoking population movement toward cities. The expansion of cattle raising into large areas has similar effects. In this new economic situation, the role of cities is also modified, now generally subordinated and dependent on rural activities, with the exception of the region's largest urban agglomerations, such as state capitals and the Federal District.

The paper will first present an environmental description of the region; the economic importance of grain (especially soybean) production will be briefly discussed; the population movements which accompanied this process will be analyzed; and, finally, we present some considerations on possible alternatives. Unlike earlier processes of frontier settlement marked by migration of agriculturalists to new lands and later urbanization fed by rural-urban migration, the Center-West experience was extremely concentrated in time. The same generation of migrants who have swelled the Center-West's population in this period now seek a living in the region's cities. The Center-West was 83.5% urban in 2000. Thus, this is not a replay of similar processes in the past (in Brazil and other areas). What are the consequences for urbanization patterns, migrant adaptation, insertion into the national economy and environmental integrity of a process whose cycle of settlement/exodus, combined with environmental

[1] We consider a somewhat larger region than that defined in traditional Brazilian statistical reports. The "amplified Center-West" includes, besides Góias, Mato Grosso, Mato Grosso do Sul and the Federal District, the states of Rondônia and Tocantins. This region corresponds to an area ecologically and economically more homogeneous than traditional definition allows.

[2] R.E. Bilsborrow and D. J. Hogan (eds.), *Population and Deforestation in the Humid Tropics.* Liége, IUSSP, 1999.

transformations wreaked by high tech agriculture in virgin lands, has been so concentrated in time? This paper raises more questions than it answers but is a necessary first step in posing these questions.

The Environmental Transformation of the *Cerrado*

The Center-West includes two of Brazil's major ecosystems, the savanna-like *cerrado* and the *Pantanal*. While the *Pantanal*[3] is nationally and internationally recognized as one of the world's most important wetlands, enjoying special protected status under Brazil's constitution, the *cerrado* has been consistently under-valued. Considered as unproductive for farming until the use of modern methods since 1970, the *cerrado* has always been considered as not worth preserving. The *cerrado*, with an almost entirely tropical climate, is a complex of different forms of vegetation which have variable physiognomies and floristic compositions, forming an ecological mosaic. According to Goodland and Ferri (1979), the *cerrado* is "a mixture of low trees and a well developed herbaceous strata." (cited in SMA, 9)[4]

[3] The Pantanal is the largest wetland in South America, with 140,000 km^2 in Brazilian territory. It is home to 650 species of birds, 80 species of mammals, 260 species of fish and 50 species of reptiles. Unplanned settlement of upland regions, where most of the rivers which flow into the Pantanal have their source, has already had deleterious effects. Other threats to ecological integrity are agricultural chemicals, erosion, gold mining, construction of hydroelectric plants and tourism. Nevertheless, the Pantanal is more preserved and more protected than the *cerrado*, which is the region which most suffered from the economic transformations of the late 20th century. This paper will concentrate on this second process.

[4] The core of the *cerrado*, considered the most characteristic and continuous portions, occupies 1,500,000 km^2 in the Central Brazilian Plateau, in the states of Goiás, Tocantins, Federal District, part of Minas Gerais, Bahia, Mato Grosso, Mato Grosso do Sul and part of Maranhão, Piauí, and Rondônia. Unconnected portions, forming islands of *cerrado*, are found in Amazonas, Amapá, Roraima, Alagoas, Bahia, Ceará, Paraíba, Pernambuco, São Paulo and Paraná. This fact, in addition to biological and political differences in defining *cerrado*, has led to a range of estimations of total area.

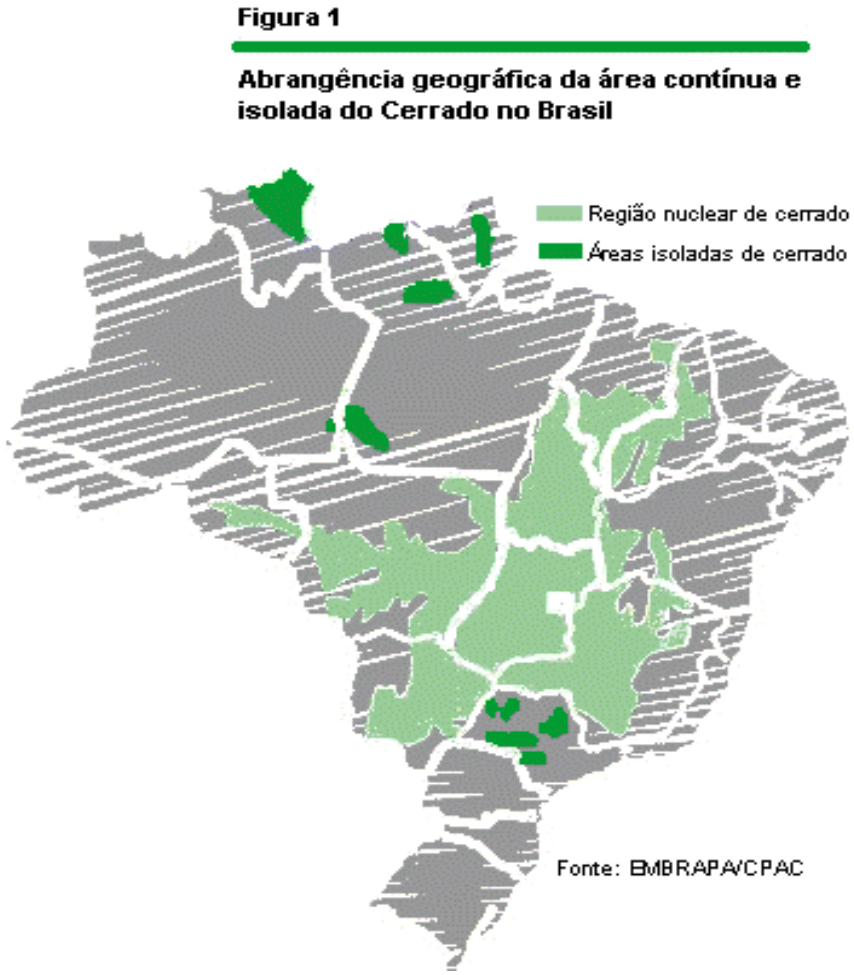

Figure 1. Nucleus of the cerrado and isolated fragments of cerrado, Brazil.

nucleus; isolated

Gold and diamond mining brought the first non-Indian populations to the region in the 18th century. When the mining cycle ended, the region remained isolated from the major population and economic centers of Brazil. This was a period dominated by subsistence agriculture and extensive grazing. With the rise of the steel industry in Minas Gerais in the nineteen forties, the natural vegetation of the *cerrado* began to be devastated to produce charcoal. The construction of Brasilia (1960) was a decisive step in ending the relative isolation of the region.

Since then, and especially since the seventies, when soil management methods were developed for the region[5], the *cerrado* has been definitively incorporated into the national economy, and is now seen by planners, investors and farmers as unoccupied and available for agroforestry, cattle raising and large-scale grain production. The intensive use of machinery and agricultural equipment, fertilizers, pesticides, herbicides and selected species have transformed the natural landscape of the region, frequently leading to the depletion of natural resources (desertification) and the contamination of food, soils and water. The original vegetation has been greatly reduced, 37% having been converted to pasture, annual crops such as soybeans, corn and rice and perennial crops such as

[5] Government policy was fundamental to this process. Embrapa, a research arm of the Ministry of Agriculture, created in the early 1970s, soon developed varieties of soybeans adapted to the climate and soils of the *cerrado*.

eucalyptus and pine plantings, as well as such urban-generated land uses as reservoirs, cities and garbage disposal. In many areas, environmental degradation has already produced decreasing productivity and greater costs. These agricultural activities were rarely introduced with any environmental concern. Local varieties of plants were ignored and instead of adapting farming to the characteristics of the region, especially to the soil, the region's characteristics were adopted to the products. (Shigeo, 1999) The result has been compacting of soils, erosion and the genetic impoverishment of the native biota.[6]

The use of fire to clear virgin land and for annual maintenance has been one of the most destructive tools in the transformation of the region. While the Amazon region has been most affected, the *cerrado* and all other ecosystems also suffer. Forest burning, in the Brazilian Amazon alone, represents 4 to 5% of the annual global flux of carbon to the atmosphere resulting from human activities[7], with negative results for climate change, human health and soil quality. Regular satellite monitoring of burnings has been carried out in the nineties and particularly detailed information is available for the most recent period.[8] As the following table shows, burnings increased in all regions in this period; for the *cerrado*, however, the number more than doubled, approaching the number of fires in the Amazon. The region increased its share of the national total from 37% to 48% between 1997 and 1999. When we examine the differences among the states of the Center-West, Mato Grosso stands out as the most serious case – due to forest clearing for lumber in the still virgin areas in the Amazon portion in the state's Northern region. But increases have been dramatic in all of the states. The increase in the number of quadrants where fires occurred, while considerable, was less dramatic than the number of total fires, suggesting a concentration of fires – although the affected areas are expanding.

Table 1 : Burnings in selected ecological systems, Brazil, 1997-1999.

Vegetation type	Area (km^2)	Number of quadrants with fires			Total number of fires		
		1997	1998	1999	1997	1998	1999
Amazon Forest	109412.54	4512	4954	5252	24939	37481	35234
Seasonal Forests	112038.05	4046	6809	6352	15404	30968	34960
Cerrado	5679.00	3982	5163	7155	11495	27667	27882
Atlantic Forest	15335.33	71	114	388	141	337	1027
Other	1459924.90	1416	7134	2874	3135	5921	13546
TOTAIS:	**1.696.710,95**	**14027**	**19285**	**22021**	**55114**	**102374**	**112649**

Source: http://www.queimadas.cnpm.embrapa.br/qmd_2000/index.htm

[6] An example of inadequate soil use is soybean production in the headwaters of the Taquari, in the North of Mato Grosso do Sul. "The plantations provoke erosion and silting of the river, which result in floods in the Pantanal. To avoid the floods on their properties, farmers dredge the river and end up blocking off its affluents. This then diminishes the oxygenation of the water and kills fish, leading to loss of biodiversity in the river." (WWF, 2001)

[7] D.C. Nepstad, A.G. Moreira and AA Alencar, *Flames in the Rain Forest: origins, impacts and alternatives to Amazonian Fire*. The Pilot Program to Conserve the Brazilian Rain Forest. Brasília, 1999, p. xiii.

[8] The principal source of information on burnings in Brazil is the Program for Monitoring, Prevention and Control of Burnings in the Ministry of Agriculture, developed by Embrapa Satellite Monitoring. This program includes research to characterize the most critical areas in terms of the occurrence of burnings in Brazil. The research considers the spatial and temporal concentration of burnings, trends in burnings and employs various spatial categories (states, municipalities, ecosystems, river basins and development corridors as proposed in the National Development Plan). Information is presented in quadrants 10 km by 10 km. These data are available at http://www.queimadas.cnpm.embrapa.br/qmd_2000/index.htm.

Table 2. Burnings in Center-West states, 1997-1999.

States	Area (km^2)	Number of quadrants with fires			Total number of fires		
		1997	1998	1999	1997	1998	1999
Tocantins	269,404.65	1,020	1,774	1,580	3,478	10,780	6,605
Rondônia	231,257.62	572	929	943	1,586	4,741	4,874
Mato Grosso do Sul	347,264.09	543	680	1,676	1,553	1,837	9,926
Mato Grosso	879,223.28	3,437	4,267	4,929	16,405	33,373	39,542
Goiás	339,727.72	824	1,684	1,525	1,929	6,677	4,523
Distrito Federal	5,645.00	11	34	20	20	104	48

Source: http://www.queimadas.cnpm.embrapa.br/qmd_2000/index.htm

This has been a rapid process: registered agricultural establishments increased their share of the Center-West region's territory from 25% (40.3 million hectares) in 1950 to 70.7% in 1980 (113,4 million hectares). On the other hand, lands actually under cultivation (pastures, annual and perennial crops and reforestation) increased from less than 0.3% in 1950 to over 24% in 1985. The case of soybeans is emblematic of this process: cultivated area increased from zero in 1950 to 5 million hectares in 1989, which represented 42% of national production. (WWF, 1995) The difference between total farmland and cultivated land shows the very significant potential which remains for agriculture expansion – and, by extension, the possibilities of preservation.

The most recent data available on land use are from the 1995-96 Agricultural Census, presented in Table 3, which compares data from the previous census in 1985.

Table 3. Land use in Central-West states, Brazil, 1985 and 1995/96.

State	Years	Land Use									
		Crops			Pasture		Woods and Forests		Unused productive lands	Unusable lands	Total
		Per-manent	Tem-porary	Tem-porary in fallow	Natural	Planted	Natural	Planted			
Rondônia	1985	3,6	5,2	1,4	3,7	14,6	67,5	0,1	1,5	2,5	6.032.647
	1995/96	2,9	2,0	0,8	3,9	29,0	57,3	0,5	2,7	1,1	8.890.440
Tocantins	1985	0,3	3,5	2,8	42,4	19,0	16,8	0,0	10,4	4,9	17.354.400
	1995/96	0,1	1,5	2,1	34,6	31,5	18,1	0,0	7,8	4,3	16.765.716
Mato Grosso do Sul	1985	0,1	6,0	0,6	31,0	39,0	13,4	1,5	1,9	6,4	31.108.811
	1995/96	0,1	4,4	0,4	19,7	50,8	18,4	0,6	1,3	4,4	30 942 772
Mato Grosso	1985	0,4	5,3	1,1	25,6	17,8	37,3	0,1	5,8	6,7	37.835.647
	1995/96	0,3	5,7	1,0	12,6	30,8	42,7	0,1	2,8	4,0	48.939.511
Góias	1985	0,2	7,1	1,7	31,7	36,3	10,8	0,2	6,3	5,6	11.985.783
	1995/96	0,2	7,7	0,9	18,7	51,9	13,7	0,3	2,0	4,5	27.472.648
Federal District	1985	2,7	24,5	2,3	25,1	20,3	6,8	7,5	4,6	6,2	313.822
	1995/96	2,1	25,0	2,0	13,9	25,5	11,3	8,2	4,8	7,4	244.930

Source: IBGE, Agricultural Censuses, 1985, 1995/96.

According to the World Wildlife Fund[9], considering the many large agricultural and transportation infrastructure projects now underway, the *cerrado*'s days are numbered. WWF's optimistic projections in 1995 were that by 2000, 45.4% of the *cerrado* would be converted to other uses. (WWF, 1995) The WWF's most recent report affirms that 40% of the original vegetation has been completely eliminated by agricultural activities and cities, while another 40% is degraded but recoverable. (WWF, 2001) A recent workshop promoted by the Environmental Ministry's *Probio* initiative, on the basis of methodology developed by Conservation International, concluded that only three localities with large extensions of relatively conserved lands remain: near the border between Piauí, Maranhão and Tocantins; near the border between Tocantins and Mato Grosso; and in the Pantanal in Mato Grosso do Sul. According to studies by the IBGE and INPE (the National Institute for Space Research), these areas represent 5% of the original extension of the *cerrado*. Worse yet, 25% of deforested areas today have no economic utility.

Environmentalist concern is related to three major questions:

1. **biological diversity:** the *cerrado* is home to an estimated 420 species of trees, 10,000 different species of plants and 800 species of birds; 40% of its woody plants and 40% of its bees are endemic. It is the world's most biologically diverse savana, home to at least 5% of the planet's flora. One of the so-called biodiversity *hotspots* of the world, the *cerrado* is one of the most threatened biomes of the planet.
2. **carbon sequestration**: although it has not yet received much attention, the capacity of the *cerrado* to store carbon is immense. While it does not have dense forest, this is compensated by its enormous size and a vegetation with deep roots, forming an "underground forest," which makes a significant global contribution as a carbon sink. (Sawyer, forthcoming)
3. **watershed protection**; the sources of the three major Brazilian and South American river basins – the Amazon, the Rio de la Plata, and the Rio São Francisco – are located in this region. Large-scale transformation of land use will have continental consequences in terms of water supply and quality. This biome also plays an important role in the support of biodiversity in general, inasmuch as its river network functions as a corridor for fauna and genetic exchange.

The rapid expansion of agriculture was accompanied by population growth in all areas of the *cerrado*. During the last 40 years, migration led to a six-fold increase in population. Contrary to expectations, however, this population growth was concentrated in cities. Earlier settlers were pushed off the land and newer land-seeking migrants were unsuccessful in the face of the low labor demands of high tech agriculture. Besides the unemployment and underemployment which resulted, urban growth further intensified several kinds of environmental impacts in cities and in their immediate hinterlands: deforestation to obtain firewood and wood for construction; increasing water demand; contamination of rivers by sewage (in the region's cities, only 38.3% of households were connected to the sewage collection system[10]) and of the soil by inadequate disposition of solid waste; air and noise pollution provoked by vehicular traffic, especially trucks transporting grains to markets; and the construction of dams for hydroelectric plants.

The Economic Transformation of the Center-West

In the 1960s the Center-West region underwent an intense process of modification of its productive base, encouraged by government actions which sought to modernize farming and cattle-raising and to integrate the region with national and international markets. Technologies were developed which permitted large-scale agriculture on the region's soils and the flat topography was ideal for grain monocultures. The Center-West became the principal agricultural frontier in the country and a process began which led to current production levels:

[9] See www.wwf.org for information on the *cerrado*, the *Pantanal* and preservation projects now underway.
[10] IBGE, PNAD (National Household Survey), 1997.

the Center-West is today responsible for more than 40% of soybean production in Brazil, 23% of corn and 20% of rice, coffee and beans. Similarly, the *cerrado* is responsible for over a third of beef and nearly 20% of pork production .

The following decades were marked by the installation of important agro-industrial firms, both Brazilian and foreign, directly linked to state programs of fiscal incentives, investments in infrastructure, subsidized credit and policies of official development agencies.

The increase of Brazilian agricultural exports in these decades, principally soybeans, occurred at the expense of serious environmental and social impacts in the *cerrado.* Land ownership became even more concentrated and agricultural employment declined. (WWF, 2001) In 1975, 13% of rural properties in Mato Grosso, for example, were between 100 and 1000 hectares, a proportion which rose to 30% in 1995/96, at the expense of smaller family farms. Between 1985 and 1995/96, agricultural jobs declined by 19% in the Center-West. In Goiás, this decline reached 23%.

Table 4. Soybean production by region and major soybean producing states in Brazil's Center-West, 1977-79 to 1998-2000, three-year averages (in thousands of tons).

Region/state	1977-79	1980-82	1983-85	1986-88	1989-91	1992-94	1995-97	1998-00
Center-West	739.3	2,128.3	4,179.5	5,859.6	7,215.0	8,568.1	9,789.7	13,530.5
Mato Grosso	161.3	235.9	1,064.5	2,349.0	3,065.8	4,217.5	5,282.7	7,398.7
M.G. do Sul	660.5	1,382.9	2,088.2	2,252.5	2,364.7	2,199.4	2,209.4	2,430.1
Goiás	137.7	484.8	963.8	1,171.8	1,683.3	2,053.0	2,219.1	3,620.8
North/Northeast	-	2.1	41.8	247.7	557.0	778.5	1,192.7	1,861.5
Sul-Sudeste	9,951.0	12,290.6	11,806.9	10,028.0	12,036.3	13,159.9	14,112.2	15,865.8
Brasil	10,690.3	14,421.0	16.028.3	16,135.3	19,808.3	22,506.6	25,094.6	31,257.8

Source: Companhia Nacional de Abastecimento (CONAB), apud Freitas, Barbosa e Franca (2000).

In 1995/96, cattle-raising occupied 60% and agriculture 6% of the region, with soybeans leading the way with 3.7%. Brazil, the second largest soybean producer in the world (31.6 million tons per year), exports half of this. In the 1999-2000 harvest, the state of Mato Grosso became the largest soybean producer in Brazil, producing 25% of 31,644 thousand tons, followed by Paraná (22.4%) and Rio Grande do Sul (15.6%). In the last twenty years, the Center-West has become the major soybean producing area in Brazil (Table 4), soaring from an annual production of 740 thousand tons in 1977-79 to 13.5 million tons in 1998-2000. Mato Grosso increased its production in this period from 161 thousand tons to 7.4 million tons.

The 1970s, a turning point for Center-West development, witnessed the "modernizing march to the West," directing intense migratory streams to the most promising areas. However, the reduction or even the elimination of financial incentives for frontier colonization, modernization of agriculture and crop substitution, among other factors, led to the slowing of migration beginning in the second half of the 1980s.

Migration to the Center-West Region, 1970-1991

The Center-West began to have significant population increases in the 1950s, when growth rates of the previous decade (3.5% per year) increased to over 5.4% per year. In the following decade, the resident population of the region grew even more rapidly, at 5.6% per

year. The average annual growth rate, while continuing very high, decreased slightly, although the states of Rondônia and Mato Grosso continued to grow at elevated rates, a situation which continued into the 1980s (Table 5).

In the 1980s the region grew at a rate of 3.26% annually. It should be noted that the abrupt decline of the growth rate of the Federal District did not reflect stagnation but the configuration of a metropolitan area, with a redirectioning of population to surrounding areas in the state of Goiás.

Table 5. Population growth, Center-West Region, Brazil, 1970-2000.

State	Population				Annual Growth Rates (%)		
	1970	1980	1991	2000	1970-1980	1980-1991	1991- 2000
Rondônia	111,064	491,069	1,132,692	1,377,792	16.0	7.9	2.2
Tocantins	516,447	743,750	919,863	1,155,251	3.7	2.0	2.6
Mato Grosso do Sul	998,211	1,393,019	1,780,373	2,075,275	3.4	2.2	1.7
Mato Grosso	598,879	1,138,691	2,027,231	2,498,150	6.6	5.4	2.4
Goiás	2,414,325	3,125,354	4,018,903	4,994,897	2.6	2.3	2.5
Federal District	537,492	1,176,925	1,601,094	2,043,169	8.15	2.84	
Total	5,176,418	8,068,818	11,480,156	14,144,534	4.54	3.26	

Source: IBGE, Demographic censuses 1970-2000; Population Count, 1996

Data on interstate migration for the seventies and eighties[11] indicate that there was a significant increase in the volumes of in-migration for almost all states in the country, with the exception of the Federal District. In the Center-West, however, there was also an important increase in out-migration, although this did not imply a reduction of population gains in the larger part of these areas, as can be seen in Table 6.

[11] In view of the differences in the census information, the data analyzed in this section are different from those in the following section. In the present case, migration was defined on the basis of information on last residence, while in the following section the migrant is defined by residence on a fixed date. Besides the time differences, then, the first referring to an inter-censal period and the second to the five years prior to the census, the definitions are conceptually distinct. Nevertheless, with due caution, they can be usefully compared. It is also worth noting that data on fixed date do not permit including children under 5 years of age, which implies that the volumes derived from this information do not include this subgroup of migrants. The justification for using different concepts is related to the information available in the 1996 Population Count (fixed date). For more details, see Cunha and Silveira (1999) and Carvalho and Rigotti (1997).

Table 6. Internal migration, Center-West Region, Brazil, 1970-1991.

States	In-migration		Out-migration		Net migration*		Average annual rates**			
							In-migration		Out-migration	
	1970-80	1981-91	1970-80	1981-91	1970-80	1981-91	1970-80	1981-91	1970-80	1981-91
Rondônia	287,874	416,207	20,988	157,951	266,886	258,256	12.33	5.58	0.90	2.12
Tocantins	92,822	159,291	87,116	144,704	5,706	14,587	1.50	1.93	1.41	1.75
Mato Grosso do Sul	298,864	271,923	204,669	237,430	94,195	34,493	2.53	1.73	1.74	1.51
Mato Grosso	328,376	543,187	121,456	244,434	206,920	298,753	3.98	3.58	1.47	1.61
Goiás	309,717	520,356	323,859	345,181	-14,142	175,175	1.13	1.47	1.18	0.97
Federal District	483,212	354,920	177,024	340,098	306,188	14,822	6.08	2.59	2.23	2.48
Total	1,800,865	2,265,884	935,112	1,469,798	865,753	796,086	2.79	2.35	1.45	1.53

Source: IBGE, Demographic censuses, 1980, 1991.

*From the demographic point of view, the differences between in-migration and out-migration cannot be considered as net migration. For convenience and because more adequate estimates are not available, the differences between in-migration and out-migration were calculated to show, even though only approximately, the result of the migratory process in the states.

**The denominator of this rate is the geometric average of the population in the period.

In this respect, the states of Rondônia, Mato Grosso do Sul, Tocantins and Goiás stand out, in that in comparison to the seventies, they registered increasing gains in the eighties. In terms of the intensity of the phenomenon, however, these gains (with the exception of Tocantins) already showed a certain deceleration. The Federal District, on the other hand, for reasons already mentioned, and Mato Grosso, as a result of the more precocious end to its frontier settlement process and of the growth of cattle-raising, were exceptions to this trend. Both states saw declines in net migration in the period.

We should not lose sight of the fact that in this period the increase of out-migration already reflected the impact of the transformations mentioned above and, to the contrary of what happened in the seventies, was composed of return migrants.

Martine (1994) predicted this reduction of the migratory attraction of the agricultural frontier after 1986 (even before these detailed data were available), in function of a series of factors, among them the end of important projects such as the *Polonorte*, of government subsidies for colonization projects and agricultural investments, the lack of adequate technological solutions, etc. Besides this, as Pacheco (1998) has observed, the eighties were marked by a substantial change in the agriculture sector of the Center-West, such as the growing importance of more dynamic crops and of modern forms of production. Soybeans and the expansion of cattle-raising have had significant impacts on the region's capacity for absorbing migrants, who no longer enjoy the possibilities which existed earlier in the region. This transformation is the basic explanation for the high degree of circulation of migrants.

As for out-migration, the Federal District experienced an increase in the number of out-migrants, a fact which reflects to a considerable extent the migratory streams to its surrounding areas located in the state of Goiás. In this case, migration is much more an intra-regional than inter-state question.

In terms of migratory streams, the Center-West had, in the seventies and eighties, important population exchanges with various states of the Northeast and of the Center-West itself, as well as Paraná, Minas Gerais and São Paulo. Migrants from Minas Gerais and Paraná had already reduced their share of migration to the region, due to their decrease in out-migration in general, stemming from their own economic development, especially in their metropolitan areas. Another important aspect is *intra-regional* migration, which, on the one hand, clearly reflects the path of expansion of the frontier to the region's North, implying important migratory streams from the states of Mato Grosso do Sul and Goiás to Mato Grosso, Rondônia and Tocantins. In this last case, the construction of the capital city of Palmas (Tocantins achieved statehood in the late eighties) was important. On the other hand, the intra-regional origin of migrants also reflects population transfers from the Federal District to the state of Goiás, to a great extent directed to the Brasília-Goiânia corridor, especially to the area known as the *Entorno* of the Federal District.

While Minas Gerais and especially Paraná reduced their out-migration to the Center-West, they received progressively more migrants **from** this region, evidence that the regional migratory process was marked by clear counter-movements which intensified in the eighties, without, however, modifying the composition of their population movements according to destination, compared to what occurred in the seventies.

It is important to consider the principal cause of the increase in out-migration and an aspect of the migratory process which gained in importance in the eighties in all of Brazil:

return migration. Data calculated for the Center-West states show that, compared to the seventies, return migration, both **from** (return to other states[12]) and **to** the region (the return of natives to Center-West states), increased considerably. The total number of persons residing in some Center-West state who returned to their state of origin in the eighties was approximately 453,000 persons versus fewer than 159,000 in the seventies; the same situation holds for migrants who returned from other regions to some state of the region, that is, just over 75,000 in the seventies and 219,000 in the following decade.

Besides this considerable increase, which is one of the most typical characteristics of Brazilian migration in the eighties, it is interesting to observe the weight of return migration in the volumes of in and out-migration for the Center-West in this period. From this perspective, we can conclude that the greater part of out-migration from the Center-West in the eighties was due to return migrants. This was not true of in-migration which was less affected by return migrants. It is worth emphasizing (Ribeiro, 1997) that this direct impact does not permit an estimation of the true effect of return migration, since it does not include family members (generally children) who were not born in the same place as the father (indirect effect). Thus, the data are a conservative indication of the importance of return migration for regional out-migration.

Summarizing internal migration for the Center-West in the twenty years considered here, there are two major factors: the first related to the process of the settlement and expansion of agricultural frontiers and the second related to the growth of urban agglomerations (analyzed below), in general led by the state capitals. Both the "path" to the frontier and the "explosion" of the largest centers, in the eighties, were decisive processes for explaining the differential behavior of demographic growth of the Center-West states.

Mato Grosso and Rondônia are the best examples of this process: they combine areas of high demographic growth, clearly related to the expansion of the agricultural frontier, with areas where growing urbanization is related to the process of concentration and development of a more complex urban dynamic.[13] However, the tendency toward the deceleration of in-migration to these states is a fact consistent with the perspectives of the slowdown of expansion and settlement of the frontiers. The empirical evidence is also clear in indicating the trajectory of the frontier toward the North of the region in the eighties.

In Goiás, as well as in Mato Grosso do Sul, where settlement – especially of the frontier – had been consolidated in the seventies, the demographic dynamics of areas such as Goiânia, the *Entorno* of Brasília and Campo Grande are the other side of the coin of the process of Center-West settlement. It is especially important to emphasize that the behavior of these areas contributed decisively to reverse the net population loss of the seventies.

The perspectives for the nineties, as shown in the data from the 1996 Population Count, are that the Center-West and all of its states are no longer so clearly areas of migratory attraction but regions of considerable population circulation, where in-migration and out-migration have large volumes, without one predominating over the other. Return migration is one of the fundamental components of this process.

[12] Included in this group are those migrants who returned to other states of the Center-West itself.

[13] Although considered separately, it is very difficult to know to what point urbanization processes, for example, of Cuiabá or Porto Velho, are not also related to the significant flow of migrants "expelled" from the frontier, a process which is not new in the region (Salim, 1992)

Thus, besides reflecting concomitant processes of redirectioning settlement to the North and of the slowing down of the pattern of frontier expansion, leading to re-migration to the more developed areas of the country, this fact reinforces an aspect of migratory movements which has been growing in Brazil, which is the low degree of stability of migrants resulting in greater circularity of migratory movements. These and other questions will be dealt with in the following section.

Migration to the Center-West, 1986-1996

Table 6 in the last section shows that the behavior of growth rates of the Center-West states in the nineties corroborates what had been predicted, especially by Martine (1994), that the region is no longer as dynamic as in the recent past. Except in the case of Tocantins, which increased its rate in this period, and Goiás and the Federal District which practically stabilized their intensities of population increase, in the remaining states the reduction is obvious and significant. Such behavior, of course, partly reflects the reduction of fertility which, as in all of Brazil, also fell significantly in the areas under consideration (Codeplan and IBGE, 1999). Nevertheless, the declining trend of in-migration to the region is the major factor.

The data suggest clearly that the eighties were a period of inflection of certain trends in the spatial distribution of population in the Center-West, particularly those related to the settlement process of the agricultural frontier. With the exception of the state of Tocantins which is still in the phase of settlement and consolidation of its territory, all of the other states significantly reduced their volumes and rates of population gains. In the case of Rondônia there was also a change in profile, no longer – as in the seventies – one of the more attractive areas, but experiencing net population loss.

The date in Table 7 show this trend clearly. When compared with Table 6, this information suggest that, effectively, there was a slowdown of the regional settlement process as of the mid-eighties, which we can see clearly if we compare the values of the volumes and intensities of these phenomena with those of the 1980-91 period. The states most directly related to the expansion of the agricultural frontier – Rondônia, Mato Grosso and Mato Grosso do Sul – experienced a visible slowing of migration, both in absolute[14] and relative terms.

[14] In this case, since the data in Table 6, besides being of a different nature, refer to a different time period, the solution used to compare volumes was to observe the average annual number of migrants. The qualifications registered earlier, as to a perfect comparison with the data in Table 6, merit repetition, especially with respect to the non-consideration of children under age five in the second table.

Table 7. Internal migration, Center-West Region, Brazil, 1986/91 and 1991/96.

States	In-migration		Out-migration		Net migration*		Average annual rates**			
							In-migration		Out-migration	
	1986/91	1991/96	1986/91	1991/96	1986/91	1991/96	1986/91	1991/96	1986/91	1991/96
Rondônia	127,061	64,928	94,462	67,428	32.599	-2.500	2.2	1.1	1.7	1.1
Tocantins	82.327	84.747	71.804	55.901	10.523	28.846	1.8	1.6	1.6	1.1
Mato Grosso do Sul	124.046	87.374	105.021	72.748	19.025	13.626	1.4	0.9	1.2	0.8
Mato Grosso	226.905	150.421	118.332	110.026	108.573	40.395	2.2	1.4	1.2	1.0
Goiás	268.063	288.648	156.665	137.313	111.398	151.335	1.3	1.3	0.8	0.6
Federal District	195.233	166.849	143.670	147.697	51.563	19.152	2.4	1.8	1.8	1.6
Total	1.023.635	842.967	689.954	592.113	333.681	250.854	1.8	1.3	1.2	0.9

Source: IBGE, Demographic census, 1991; Population Count, 1996.

*See note in Table 6.

** The denominator of this rate is the population at the end of the period

Other states such as Goiás and the Federal District – especially the latter, whose demographic growth was much less influenced by the dynamics of frontier settlement – maintained in the nineties migratory volumes and intensities similar to the eighties. In the first case, as can be seen below, a good part of this migratory dynamism is due to the growth of the so-called *Entorno* of the Federal District, an area which today constitutes a metropolitan region of the same name. In the second case, in spite of its spreading into Goiás, the Federal District remains a major migration destination for streams from various regions of the country. This has been a relatively constant phenomenon since its creation in 1960.

In the case of Rondônia, its average annual in-migration rate declined from 5.6% in the 1981-91 period to under 2.2% between 1986 and 1991, declining further in the nineties to 1.1%. This behavior also reflects the marked decline in the **volumes** of in-migration. Out-migration also declined, although to a lesser extent; the volume in the nineties fell by approximately 30% compared to the second half of the eighties, versus 50% for in-migration. It is therefore quite clear that for this state the period analyzed here registered a significant slowdown of the settlement process, reflecting not only the considerable drop in its population growth rate but principally in the progressive decline of in-migration.[15]

In the nineties family composition of migration to the region also changed, with a decline in family migration. (Cunha, 2000, 86-87) This is consistent with the decline of migration to frontier areas, which reduces the importance of families – the predominant form of migration to colonization or settlement zones.[16]

[15] For a state by state analysis of migration trends and their regional composition, see Cunha, 2000, 65-77 and Cunha and Silveira, 1999.

[16] Sydenstriker (1992), in his study of Machadinho in Rondônia, showed that although the family head often arrived first to settle his plot in a colonization project, final settlement was almost always by families. As soon as the first settler (generally male) was minimally established, the family, fragmented at the moment of the decision to move, was reunited.

Table 8. Migrant household heads by family status, Central-West states, Brazil, 1991 and 1996 (%).								
State	**Period**	**Single-person household**	**Married without children**	**Married with children**	**Extended families**	**Household head with children**	**Others**	**Total**
Rondônia	1986/91	13.1	28.5	36.1	5.1	5.7	11.7	37,246
	1991/96	16.4	17.2	32.9	9.8	5.7	18.0	18,773
Tocantins	1986/91	11.4	27.2	34.9	7.3	6.3	12.8	23,812
	1991/96	16.4	16.2	28.3	11.1	6.1	22.0	23,995
Mato Grosso do Sul	1986/91	14.0	28.6	35.7	4.5	5.4	11.8	39,765
	1991/96	20.1	18.9	30.7	8.8	5.4	16.3	28,353
Mato Grosso	1986/91	13.8	27.9	36.1	5.0	5.0	12.3	69,123
	1991/96	18.8	18.8	32.1	9.2	4.8	16.3	47,186
Goiás	1986/91	12.7	26.9	32.6	6.6	7.8	13.4	78,580
	1991/96	14.7	20.4	28.5	9.8	6.3	20.3	85,542
Federal District	1986/91	18.4	25.6	24.4	5.2	7.3	19.0	47,576
	1991/96	17.3	13.2	14.6	13.6	3.4	38.0	42,804

Source: Demographic census, 1991; Population Count, 1996. Special tabulations, Population Studies Center, State University of Campinas.

One key element in understanding migrant adaptation in the area of destination is occupational status in terms of the kind of work relations. From this point of view, the relations between the processes which structured the territory of the Center-West and migratory movements become more visible and concrete. As will be seen below, the profile of in-migration in each of the states reflected its role in the regional scenario. In this paper, as a first approximation, we analyze the census information on "condition of occupation"[17] because it gives us a synthetic view of how the migrant is inserted in the state productive structure.

The data on Center-West states reveal a very peculiar picture which clearly reflects the form of settlement of these areas and their principal elements of attraction, especially frontier expansion and the growth of urban centers. The relation between frontier expansion and the profile of migration according to this variable is clear. In precisely those states where migration was most intense – even though declining – (Rondônia, Tocantins and Mato Grosso), greater proportions of household heads were registered in the category "autonomous or self-employed in agriculture." The proportions of this type of insertion in the seventies were much higher than those in the following decade, which is consistent with the trend of the slowdown of the traditional type of settlement of the region. Although information on Tocantins is not available, this difference was very important in Rondônia and Mato Grosso (51% and 33%, versus 21% and 10%, respectively). This decline in the importance of the self-employed meant that the proportions of sharecroppers and migrant workers increased in these decades; in the nineties, these represented approximately 12%.

[17] This variable distinguishes employees, employers, self-employed, sharecroppers and domestic workers. In the case of the "employee" category, where the activity sector is not obvious, we have specified the type of activity, using the traditional division of primary, secondary and tertiary.

Table 9. Migrant household heads by occupational position, Central-West states, Brazil, 1980 and 1991 (%).

Occupational position	Rondônia		Tocantins		Mato Grosso do Sul		Mato Grosso		Goiás		Federal District	
	1980	1991	1980	1991	1980	1991	1980	1991	1980	1991	1980	1991
Migrant farmworker	3.0	2.9	-	6.1	3.0	2.3	2.7	3.4	3.5	4.3	0.1	1.5
Sharecropper-employee	0.5	3.1	-	3.1	0.7	0.4	0.4	6.4	0.4	1.6	0.0	1.3
Sharecropper-autonomous, employer or self-employed	2.3	6.7	-	2.8	2.6	0.3	2.6	2.2	2.1	0.8	0.1	0.5
Domestic worker – employee, autonomous or self-employed	-	2.1	-	1.4	-	2.4	-	2.2	-	4.6	-	7.7
Autonomous or self-employed in agriculture	51.4	21.2	-	13.5	13.2	3.8	33.3	10.2	15.1	2.1	0.6	0.4
Autonomous or self-employed in other activities	13.0	17.7	-	21.2	15.2	15.0	15.8	16.8	19.0	21.2	10.2	14.7
Employer	3.8	4.5	-	9.2	6.9	8.7	5.0	7.7	5.3	4.3	1.9	1.9

Table 9. Migrant household heads by occupational position, Central-West states, Brazil, 1980 and 1991 (%). (contd.)												
Unsalaried worker	0.9	0.9	-	0.5	0.4	0.4	0.4	0.5	0.3	0.3	0.3	0.5
Employee in industry	7.6	10.2	-	9.8	13.3	12.9	9.5	14.5	15.4	18.1	18.5	14.1
Employee in sales and services	12.4	27.6	-	24.8	25.5	34.6	15.2	24.0	26.0	35.4	66.3	53.7
Employee in poorly-defined sectors	0.5	0.5	-	0.3	0.5	0.2	0.4	0.2	0.2	0.2	0.2	0.4
Employee in farming	3.2	0.6	-	2.2	8.1	4.3	9.5	4.6	6.0	2.2	1.1	2.1
Employee in cattle-raising	1.0	1.6	-	5.1	9.5	12.3	6.0	5.3	5.6	4.0	0.5	1.0
Other agricultural employees	0.4	0.7	-	0.2	1.1	2.0	0.8	1.7	0.9	1.0	0.2	0.6

Thus, these two categories together represent almost a fourth of in-migrant family heads for these decades. Compared to the lesser weight of these categories in the other states of the country, especially the Federal District and Mato Grosso do Sul, where we know that the economic processes were different, the importance of unpaid agricultural activity in these areas is underlined. This question is even clearer when we observe the negligible weight of the categories "employed in farming" and "employed in cattle-raising." In any event, it should be noted that these data are clear in the sense of reflecting the slowdown of the settlement of the frontiers, since more than half of in-migrants in these areas in the 1986-91 period were connected to urban activities.[18]

The situation is somewhat different in the areas where frontier expansion had little impact or occurred earlier, as in Mato Grosso do Sul. In this state, besides the fact that urban activity was predominant among migrant household heads, there was also an important proportion in cattle-raising, which reflects two characteristic aspects of this state: the development of important urban centers, such as Campo Grande, Dourados and Três Lagoas and the predominance of cattle-raising activity in rural areas.

Furthermore, the significant proportion of in-migrants who were employers, found in Mato Grosso do Sul, Mato Grosso and Tocantins, reflects the expansion of extensive activities in these areas, such as cattle-raising and soybeans.

In the case of Goiás, the greater relative importance of the autonomous and self-employed categories (in this case, many with urban activities) and the clearly urban activities such as industry, sales and service, reveals the more dynamic side of the state, especially in the Goiânia-Brasília corridor. The same can be said in relation to the Federal District, although with a greater emphasis on sales and service activities and domestic workers, which in the latter case is a particularity of Brasília. This result helps to understand, for example, the characteristics of migration from Minas Gerais, Bahia and, especially, Goiás to the Federal District which showed an over-representation of women in young adult ages in the periods 1986-91 and 1991-96. (Cunha, 2000)

It is interesting to observe some of the specific aspects of these data disaggregated by migration streams. Thus, besides the general trend of the significant proportion of "autonomous or self-employed in agriculture" in all streams, especially those numerically more important, and of the greater participation in sales and services of those who went to Goiás and the Federal District, we can also see that among migrants from the Southeast and especially from the South, the proportion of employers is much greater than in the other streams. Besides this, the participation of sharecroppers and migrant workers is much more intense in the streams which originate in the Northeast, especially in those toward Rondônia and Mato Grosso, facts which also help to understand the character of migration to the Center-West and its clear differentiation in terms of the type of migration and the forms of insertion of migrants.

The data analyzed here are unequivocal as to the generalized trend in the country of the precarious productive insertion of migrants to the Center-West. The high proportions in the autonomous and self-employed in other activities (predominantly urban) reinforces this interpretation, especially when we know that a large share of these in-migrants are low income.

[18] It should be kept in mind that some of these in-migrants may have changed activity sector after arriving in the area and that the numbers analyzed here do not precisely reflect reality. This issue will be examined in further research in the region.

Urbanization in the Center-West, 1970-2000

As mentioned above, the settlement of the Center-West was concomitant with an accelerated urbanization process. The migration trends described above resulted in a remarkably rapid process of frontier settlement and city growth. Table 10 shows that all of the states of the region – even the newly created Tocantins – were already predominantly urban by 1991. With the exception of the Federal District, as a function of its specific characteristics as national capital, all of the other states went from a predominantly rural to predominantly urban situation in this thirty-year period. Urbanization levels in the region now approximate national levels.

Table 10. Percent urban, Central-West states, Brazil, 1970-2000.

State	1970	1980	1991	1996	2000
Rondônia	53.6	46.5	58.2	62.0	64.1
Tocantins	24.7	39.7	57.7	70.7	74.3
Mato Grosso do Sul	45.3	66.8	79.4	83.2	84.1
Mato Grosso	38.8	57.5	73.2	75.8	79.4
Goiás	45.9	67.6	80.8	85.8	87.9
Federal District	96.0	96.8	94.7	92.9	95.7
Total	48.1	67.8	79.2	83.2	85.6

Source: IBGE, Demographic censuses 1970-2000; Population Count, 1996.

In terms of population concentration in the state capitals, all states but Rondônia show a tendency for population concentration in these largest cities. (see Table 11) There are two distinct situations to be found when we examine the proportion of the state's **urban** population which resides in these cities (Table 12). Campo Grande and Palmas increased their share of their state's urban population, while Cuiabá, Goiânia and Porto Velho showed a decline. This is principally due to the rise and expansion of new urban areas in Mato Grosso and Goiás. Goiás was affected by the expansion of the Federal District, and much of its urban growth is part of the metropolitan area of Brasília.

Table 11. Proportion of total state population residing in capital city, Central-West states, Brazil, 1970-2000.

State	Capital city	1970	1980	1991	1996	2000
Rondônia	Porto Velho	75.7	27.3	25.3	26.6	24.3
Tocantins	Palmas	..	..	2.6	8.2	11.8
Mato Grosso do Sul	Campo Grande	14.0	20.9	29.5	31.1	31.9
Mato Grosso	Cuiabá	16.8	18.7	19.8	19.4	19.3
Goiás	Goiânia	15.7	22.9	22.9	22.2	21.8

Source: IBGE, Demographic censuses 1970-2000; Population Count, 1996.

Table 12. Proportion of state urban population residing in capital city, Central-West states, Brazil, 1970-2000.

State	Capital city	1970	1980	1991	1996	2000
Rondônia	Porto Velho	80.5	45.1	34.9	32.8	31.0
Tocantins	Palmas	..	..	3.6	11.1	15.5
Mato Grosso do Sul	Campo Grande	29.0	30.5	36.7	36.9	37.5
Mato Grosso	Cuiabá	38.0	30.2	26.6	25.2	24.0
Goiás	Goiânia	32.7	33.4	28.1	25.8	24.7

Source: IBGE, Demographic censuses 1970-2000; Population Count, 1996.

This rapid urbanization reflects both direct migration to the region's cities from other regions of Brazil and rural-urban migration from within the Center-West itself, as a result of migrants' failure to establish farms in the frontier areas.[19] In all of the Center-West states the overwhelming majority of migrants resided in urban areas by the mid-eighties (Table 13). This proportion continues to grow in the nineties, revealing the small proportions of migrants who actually managed to enter agricultural activities, and to fix their residence in rural areas.

[19] This issue is important for the larger project from which this paper is drawn and will be examined in the future.

Table 13. Proportion of in-migrants living in urban areas, Central-West states, Brazil, 1986-91 and 1991-96.

		Percent in-migrants living in urban areas		Number of in-migrants	
State	**Capital city**	1986-1991	1991-1996	1986-1991	1991-1996
Rondônia	Porto Velho	56.9	63.9	128,262	66,415
Tocantins	Palmas	71.3	84.2	82,510	85,416
Mato Grosso do Sul	Campo Grande	77.0	84.4	128,773	95,300
Mato Grosso	Cuiabá	69.5	70.7	227,644	153,218
Goiás	Goiânia	86.9	91.5	269,212	292,697
Federal District	*	*	*	198,132	171,013

*These data are unavailable.

The data analyzed here are sufficiently clear to show the relations which exist between the characteristics of the migratory movements experienced by the different Center-West states and their processes of development and organization of their productive structures. Even though it is in decline, the frontier settlement process can still be felt in the nineties. However, the new pattern of regional population distribution will be based much more on the growth and consolidation of the larger urban agglomerations, especially those centralized by the regional capitals, most especially Goiânia and Brasília. In the case of Tocantins, the natural tendency to grow as a result of achieving statehood at the end of the eighties has not resisted this slowdown, a fact already observed in the 1996 Population Count.

The trends which were already apparent in the eighties were confirmed in the nineties, pointing to a new phase for the region. With the first settlement phase completed, the region must now confront new challenges, such as maintaining population in the areas settled earlier, resolving problems of the large urban concentrations and of the urbanization process in general.

Possibilities for Sustainable Development

The picture which emerges from this analysis provokes concern both for environmental integrity and the social welfare of the region's population. The only clear gain over the last thirty years has been in the impressive grain production, now a fundamental part of Brazil's economy. The negative trends are not irreversible, however. The challenge which is posed is how, simultaneously, to stem environmental degradation and create jobs which promote sustainability. Research must be directed to identifying those areas which may still receive migration without provoking more environmental degradation; areas which can at least retain their populations; and those areas which require a redefinition of their economic possibilities.

The decline of migration may actually be negative for environmental preservation, since family farms have lower impacts than large-scale agriculture. The search for ways to permit family farms to survive is an essential ingredient in any long-run solution.

Sawyer (2001, 117-126), who has long experience in research and development activities in the region, suggests that the urbanization trends may also be positive for sustainable development. Both because cities make social services more available and because they are an alternative to frontier expansion, viable economic activities must be found for urban as well as rural areas. He makes several specific recommendations:

1. increase productivity of already occupied areas through intensification; frontier expansion will be stemmed and higher productivity will be capable of generating the necessary resources to mitigate environmental damage of more intensive practices;
2. the adoption of *integrated agro-environmental systems*, combining traditional family agriculture with the sustainable exploration of the region's biodiversity. He offers a long list of possibilities which may serve to complement incomes of family farmers;
3. articulate governmental policy initiatives related to the several distinct ecosystems of the region; tax incentives which favor sustainability; programs which support family agriculture; and environmental protection measures. Successful implementation of sustainable development will require concerted action of several different ministries and government departments.

These recommendations are not incompatible with the preservation efforts promoted by environmentalist groups. Particularly important is regularizing landholding. The chaotic situation of title to land means that in some states there is more land owned than the total territory; any attempts to monitor and control environmental policy require unambiguous identification of who owns what. The WWF also recommends the qualitative improvement of private ecological preserves and incentives for the creation of large ecological preserves (over 300,000 hectares) in the more important remnants of the *cerrado.*

There is growing support for such policies but they are far from unanimous. If it can be shown that both social and environmental ends are served by a set of integrated measures, current emphasis on the expansion of export-oriented monocultures may give way to more sustainable policies.

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