DYNAMICS AND DISTRIBUTION OF ANTHROPIC OCCUPATION IN THE CERRADO OF MATO GROSSO IN THE PERIOD FROM 1990 TO 2008

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Abstract

The Cerrado biome occupies approximately 2 million square kilometers in the Central portion of Brazil representing 23% of our country's extension, and it is considered to be one of the hotspots in our Planet, that is, a high-priority area for conservation. However, this biome has become the object of great and accelerated demand for agriculture and cattle ranching activities since the 1970 decade, because it has favorable soils, reliefs, and climatic characteristics. Thus, this work has aimed to study the dynamics of change in spatial distribution of anthropic activities in the Cerrado of Mato Grosso in the period from 1990 to 2008, in order to understand the process of occupation that took place there, and also in order to subsidize policies for the rationalization and encouragement of environment sustainability. 28 Landsat scenes have been used for both time cuts mentioned, considering the classes of changed areas: cash crops, planted pastures, reforestation, urban areas, and mining areas. Results show that the greatest changes have occurred in the North mesoregion; and the phytophysiognomy with highest rate of suppression was the forested savanna in deep latossoil soils with a predominantly flat relief. Nonetheless, fragile environments (having steeper reliefs or more sandy soil) are also being occupied, which gives alarm for several types of risk to the sustainability of this important biome.

Key words: Brazilian Savanna. Deforestation. Anthropization. Sustainability.

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Resumo

Dinâmicas e distribuição da ocupação antrópica no cerrado de Mato Grosso no período de 1990 a 2008

O bioma Cerrado ocupa cerca de dois milhões de quilômetros quadrados na porção central do Brasil, representando 23% da extensão do país e sendo considerado um dos hotspots do Planeta, ou seja, uma área prioritária para conservação. No entanto, com solos, relevos e características climáticas favoráveis este bioma tornou-se objeto de grande e acelerada afluência para fins agrícolas e pecuários desde a década de 1970. Entre os diversos Estados que compõem este bioma, o Mato Grosso tem lugar de destaque na produção agrícola nacional, principalmente com as culturas de soja e de milho. Assim, visando compreender o processo ocupacional ocorrido, bem como subsidiar políticas de racionalização e de estímulo à sustentabilidade ambiental o presente estudo visou o entendimento da dinâmica das mudanças da distribuição espacial das atividades antrópicas no Cerrado do Mato Grosso, considerando o período entre 1990 e 2008. Foram utilizadas 28 cenas Landsat para os dois recortes temporais citados, considerando as classes de áreas alteradas: culturas agrícolas, pastagens cultivadas, reflorestamentos, áreas urbanas e áreas de mineração. Em seguida, as informações de áreas antropizadas foram cruzadas com limites de mesorregiões, solos, vegetação e unidades geomorfológicas. Os resultados demonstram que as maiores mudanças ocorreram na mesorregião Norte; a fitofisionomia com maior taxa de supressão foi a savana arborizada em solos latossólicos profundos e de relevo predominantemente plano; no entanto, ambientes frágeis (de relevos mais movimentados ou de solos mais arenosos) também estão sendo ocupados, alertando para vários tipos de riscos para a sustentabilidade deste importante bioma.

Palavras-chave: Cerrado. Desmatamento. Antropização. Sustentabilidade.

INTRODUCTION

The Cerrado biome has approximately two million square kilometers to the South and East of the Amazon Forest, and it is undergoing rapid decline due to the accelerated expansion of the modern Brazilian agriculture (BRANNSTROM et al., 2008). It constitutes the second largest Brazilian biome, only surpassed by the Amazonia. In addition to its vast extension in territory, the Cerrado stands out thanks to its great biodiversity, and it is considered to be one of the 25 *hotspots* in our Planet, that is, a high-priority area for conservation (KLINK; MACHADO, 2005). However, thanks to its favorable edaphoclimatic characteristics, this environment that was used in the past mainly for activities such as mining and timber extraction to produce charcoal has been in great demand for agricultural uses since the 1970 decade. With incentives from governmental policies and programs of direct actions, and with the help of agronomic innovations, favorable conditions have been created in this biome for agriculture expansion and for the intensive occupation of the territory (JEPSON, 2005).

Because the Cerrado is an "agricultural frontier", it has been providing relevant positive impacts upon the Brazilian economy, and thus is helping to transform the country into one of the major exporting powers worldwide as regards agriculture produce. At the same time, however, increasing environmental changes have been observed, and especially along the three last decades intensive changes have taken place in the Cerrado biome; native vegetation is the vegetation most affected by the process, with a conversion of approximately 40% of the original area by agriculture and cattle ranching activities (SANO et al., 2008).

According to Jepson (2005), cattle ranching has been the pioneering anthropic activity, and the one causing the highest rates of deforestation in the biome until some point near 1985, but in later years the pressure upon those areas started to be caused also by agricultural practices, especially with soybean, corn and cotton cultures. The advance of research in agronomic fields, new kinds of plants, and new methodologies to correct soils have all propitiated the occupation of large areas, making it possible to take agriculture and cattle ranching activities to regions where they were impracticable up to mid 1980’s due to the acidity of Cerrado soils; thus warranting economic viability for those crops in the biome.

Nonetheless, the current model of agriculture development as practiced in the biome has been causing severe damage to the environment. Concomitantly with the replacement of native vegetation, there is loss of biodiversity and alterations in the whole system, such as: increase in soil eroding processes; alterations of the hydrologic cycle such as an increase in surface flow, and consequent loss in soil fertility, followed by silting up and eutrophication of rivers (CLAY, 2004; KLINK; MACHADO, 2005). For Anderson et al. (2004), all these alterations may be even more dramatic because they end up influencing natural cycles of the Earth system, such as the climatic and biogeochemical cycles.

Having this context in view we can notice that an environmental degradation of the biome has been taking place due to the fast replacement of the vegetation cover – in a system that enjoyed environmental balance – promoted by impacting anthropic activities such as agriculture and cattle ranching. The magnitude of this degradation must be better assessed in order to subsidize future actions of accountancy and prediction of places that have suffered deforestation and alteration of their vegetation cover.

On the other hand, as pointed out by Rindfuss et al. (2004) and Steffen et al. (2004), it is essential to learn the dynamics occurring in land use in order to understand determinants of change, and in order to improve global models.

Remote sensing has been used to produce maps of land use/land cover in the Cerrado region; however, as studied by Brannstrom et al. (2008), we find that existing analyses consider extremely large areas (for example the whole biome), which causes disregard for intra-regional differences in terms of rates or of spatial patterns. Among works developed in the LULC (“land use / land cover”) segment of study, we point out one by Mantovani and Pereira (1998) intending to assess the integrity of the vegetation cover, one by Machado et al. (2004) aiming to estimate losses of natural areas, one by Jepson (2005) analysing the dangers of the fast anthropizatin of the biome, and one by Jasinski et al. (2005) assessing the expansion of mechanized agriculture. However, the rate, extension and pattern of changes that have been taking place in the Cerrados are still poorly documented, as pointed out by Brannstrom et al. (2008).

Thus, the objective of the present work has been to use remote sensing data and available data bases to verify the dynamics and spatial distribution of areas changed in function of anthropic activities in the ‘Cerrado do Mato Grosso’ biome in the period from 1990 to 2008, in relation to phytophysiognomies, types of soil, and geomorphologic units, aiming to subsidize policies for the rationalization and encouragement of environmental sustainability.

MATERIAL AND METHODS

Area of study

The area of study corresponds to the Cerrado biome contained within the limits of the State of Mato Grosso (Figure 1), with an area of 382.17 thousand km^2 located between coordinates 10° 00’ and 18° 05’ South, and 50° 45’ and 60° 15’ West. The adopted frontier for the Cerrado biome has been established by the Brazilian Institute of Geography and Statistics – IBGE (2004), and the same applies to municipal borders updated until year 2005.

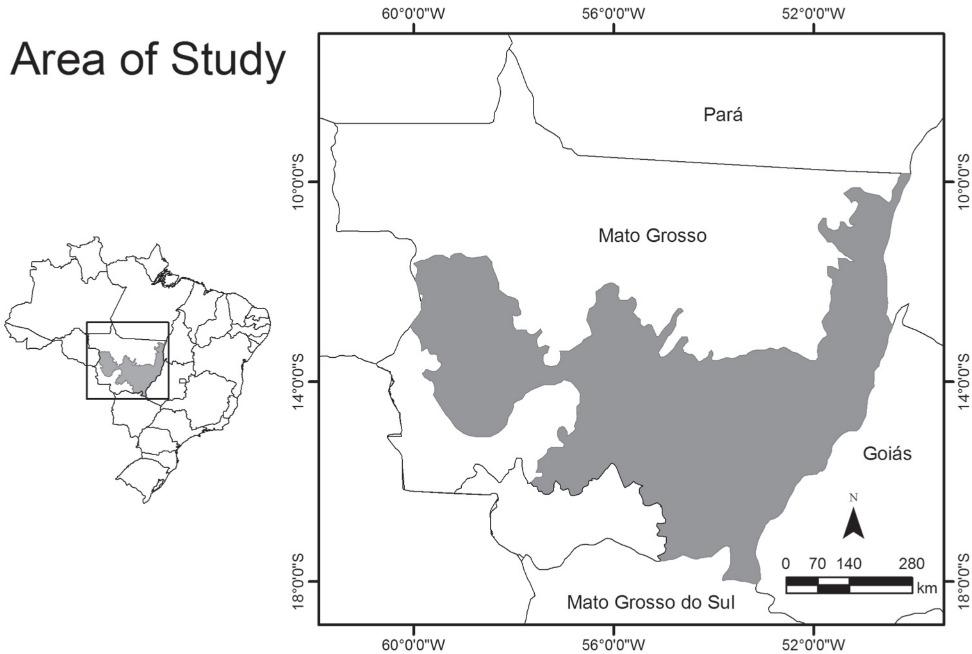

Figure 1 – Localization of the area under study: the Cerrado biome in the State of Mato Grosso

The relief of the Central-West region is formed mainly by the portion of the Brazilian shield called Maciço Goiano-Mato-grossense (Goiás-Mato Grosso Massif). It is limited to the North by Amazonian basins; to the East by the São Francisco Basin; to the West by the Andean rim; and to South-Southeast by the Paraná Sedimentary Basin. Highest altitudes are found in the South (800-1,200 m in Serra Azul, and 500-800 m in Chapada dos Parecis), while lowest altitudes are found in the northern region where the Cerrado borders the Amazon Basin, with average altitudes between 200 and 500 m (SILVA, 2009).

Considering the area of Cerrado within the limits of the State of Mato Grosso, savanna phytophysiognomies correspond to 44% of the natural vegetation cover, while forest physiognomies correspond to 21%, and field physiognomies have low representativity in the State: approximately 1% (BRASIL, 2007).

The main soil types in the area, according to SEPLAN (2001), are Latossoils corresponding to the *Haplustox* class (Soil Survey Staff, 2006), and Quartzarenic Neosoils corresponding to the *Quartzipsamment* class in the North-American soil classification system.

The overall geomorphology of the State of Mato Grosso presents several systems, such as the Denudational System represented by a relief of landforms undergoing a process of sculpturing where destructive aspects predominate with continued lowering; the Mixed Denudational System corresponding to areas where there is a combination among a number of morphogenesis of denudational origin; and the Aggradational System based on accumulation processes propitiated by geomorphological systems (SILVA, 2009).

The region is characterized by the recent opening and occupation of agriculture areas that have transformed it over the last decades in one of the main grain-producing regions, especially for soybean and corn, in addition to having large areas of pasture with extensive systems of bovine cattle ranching (KLINK; MACHADO, 2005).

Data source and methodology

Identification of modified areas in years 1990 and 2001

Images used to map year 1990 correspond to the TM (Thematic Mapper) and ETM+ (Enhanced Thematic Mapper Plus) sensors and have been taken between August 1988 and July 1994. Landsat scenes used were those from orbits 223 through 229, points 067 through 070, according to the global system of reference. Bands used were red (0.63 – 0.69 μm, B3), near infrared (0.76 – 0.90 μm, B4) and medium infrared (1.55 – 1.75 μm, B5). Images used to map year 2001 were taken from the same orbits/points, between May 2000 and September 2001. Image processing has been entirely done in Data Base (DB) in the SPRING – Georeferenced Information Processing System (Sistema de Processamento de Informações Georreferenciadas) (CÂMARA et al., 1996).

Data generated by the PROBIO – Project for the Conservation and Sustainable Use of the Brazilian Biological Diversity in 2002, when they mapped the vegetation cover of the Cerrado biome, served as base for mosaic generation. In the survey carried out by PROBIO, the following classes have been considered to describe modified areas: (i) agriculture; (ii) planted pasture; (iii) reforestation with pinus or eucalyptus; (iv) area with urban influence; and (v) area degraded by mining.

The mosaic of Landsat images has been assembled with the ENVI application, and 28 scenes from the Landsat satellite were required to cover the area under study. Both 1990 and 2001 mosaics have been imported into the DB in SPRING, and images have been coverted into the system of geographic coordinates and datum SAD/69, due to the large extension of the studied area. In the DB, areas refering to the remaining vegetation cover have been masked, thus maintaining those areas classified as modified by PROBIO.

In the segmentation, 8 was the value adopted for similarity, and 64 was the value for area, thus generating polygons with an area of at least 6.25ha. Subsequently, this segmentation was vectorized, and polygons have been classified into one of only two classes: (i) modified areas and (ii) natural areas (Figure 2). The stage of vector-based editing has been executed in the ArcGIS 9.3 application. In this way, areas that had not suffered modifications susceptible of interpretation in the date of the respective image – 1990 or 2001 – were disregarded, finally generating a mosaic of modified areas in the period 1990 through 2001. Figure 2 shows illustrations of images containing burned-over land in forested formation (4c) and in savanna formation (3d) areas.

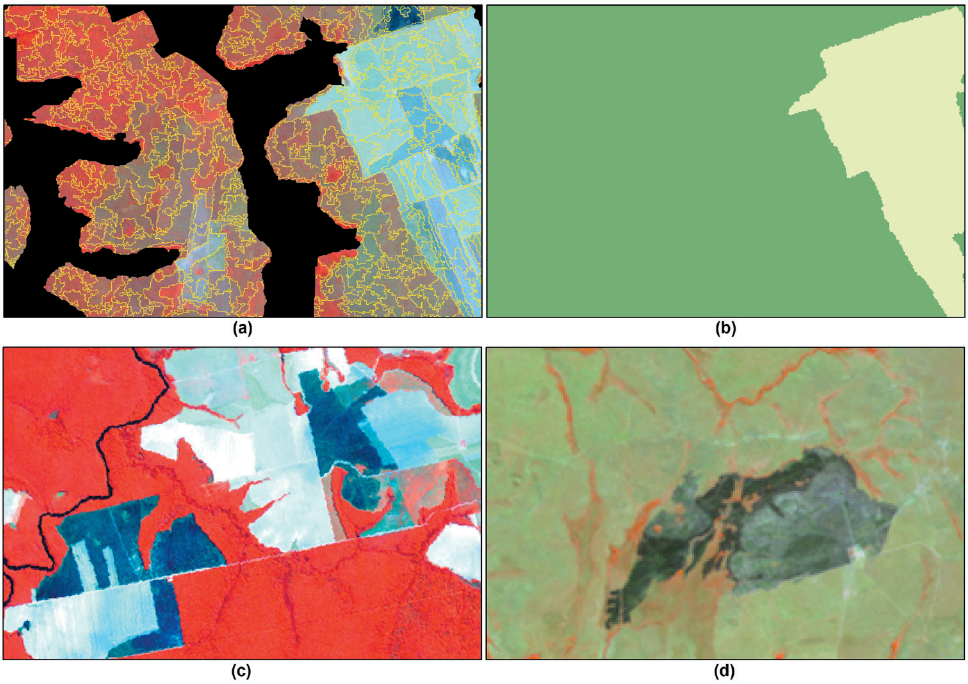

Figure 2 – Second stage of the methodology adopted in regard to Landsat images. In: a) composition R(4) G(5) B(3) TM/Landsat-5 (1990), as segmented; b) map from 1990: areas of natural vegetation cover (in green) and modified areas (in yellow); c) forested formation d) burned-over areas

Identification of modified areas in years 2002 through 2008

Data on anthropic areas in the period from 2002 to 2008 have been obtained from the "Satellite Monitoring of Deforestation in Brazilian Biomes Project– PMDBBS", (BRASIL, 2009). The main objective of the project has been to identify anthropized areas in Brazilian biomes, the Cerrado among them, through the use of images from the TM/Landsat 5 and CBERS-2B satellites, the CCD sensor, and remote sensing techniques. In the project carried out by PROBIO the following classes have been considered to describe modified or anthropized areas: (i) agriculture; (ii) planted pasture; (iii) reforestation with *pinus* or eucalyptus; (iv) area with urban influence; and (v) area degraded by mining. Areas have been first mapped through visual detection, then their physiognomies were manually entered using a basic working scale of 1:50,000 and minimum detection area of 2 ha, then generating their respective results in a 1:250,000 scale. Areas considered to be of natural vegetation were those presenting an original vegetation cover in the period when the orbital images used in the project had been acquired. Areas with native pastures were considered to have a natural vegetation cover, even if portions of the area were being used for cattle ranching; therefore they were classified as natural areas.

The PROBIO project has been validated through high-resolution CBERS-HRC images with the Kappa index and global accuracy of 92 and 97 percent respectively. The data update the increment of anthropic areas from 2002 through 2008, that is, they present information on new areas occupied by some anthropic activity up to year 2008.

The natural vegetal formations that have been delimited correspond to the main floristic regions existenting in the State of Mato Grosso, and to contacts and transitions between those formations that sometimes constitute areas of ecologic tension. Thematic maps of vegetal formations have been built using as base documents IBGE's topographic maps in scale 1:250,000, together with photointerpretation and field reconaissance. Table 1 describes cartographic data used in this work.

Table 1- Base of cartographic data used

Product	Scale	Source
|Map of Brazilian Biomes	1:5.000.000	IBGE
|Map of Vegetal Cover in the Cerrado Biome	1:250.000	MMA
|Map of Soils – State of Mato Grosso	1:250.000	PRODEAGRO-MT
|Map of Geomorphology –State of Mato Grosso	1:250.000	PRODEAGRO-MT
|Map of Potential Vegetation – State of Mato Grosso	1:250.000	PRODEAGRO-MT
|Map of Mesoregions – State of Mato Grosso	1:250.000	PRODEAGRO-MT
|Map of anthropized areas from 2002 to 2008	1:250.000	BRAZIL

Figure 3(a) illustrates the division of mesoregions in the Cerrado do Mato Grosso biome, according to IBGE (2002), and Figure 3(b) presents the map of potential vegetation in the same biome (Prodeagro, 2000a). The map of soils used was the Low Intensity Reconaissance map, published in the 1:250,000 scale (Prodeagro, 2000) (Figure 3c). The geomorphological compartmentation used is in the 1:250,000 scale (Figure 3d) (PRODEAGRO, 2000).

Having in view our objective – namely, to generate analyses regarding the dynamics of anthropization, all those maps: of mesoregions (Figure 3a), vegetation (Figure 3b), soils (Figure 3c), geomorphology (Figure 3d), and maps of modifications ocurred in the period 1990-2001 (Figure 4a) and in the period 2002-2008 (Figure 4b) have been superimposed through intersections made by the ArcGIS application. This enabled the generation of results in the form of tables through which several analyses could be developed.

The second stage of the present work consisted in a survey of agriculture across mesoregions included in the area under study. We considered municipalities the territories of which are entirely or partially inside the limits of the Cerrado biome. Cultures selected for the survey were: cotton, rice, sugarcane, corn (1st and 2nd harvests together), and soybean. Tabulated data were taken from PAM – Agriculture Production in Municipalities; information to feed this base is collected with the use of questionnaires that are filled out by IBGE's collecting agents (IBGE, 2009). All data are available at the "SIDRA – IBGE's Automatic Recovery System" site (http://www.sidra.ibge.gov.br/).

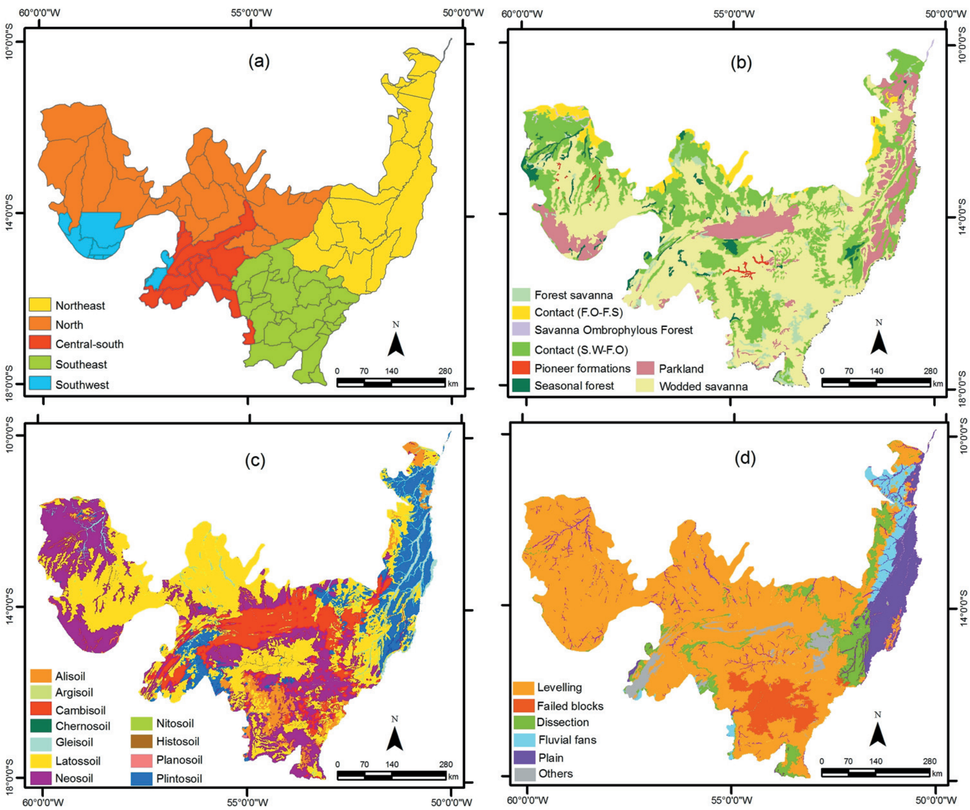

Figure 3 - (a) Division of the Cerrado of Mato Grosso biome into mesoregions. Source: IBGE (2002); (b) |Map of potential vegetation in the Cerrado of Mato Grosso biome. Source: PRODEAGRO (2000a). (c) |Map of soils of Cerrado of Mato Grosso. Source: PRODEAGRO (2000b). (d) Map of the most representative geomorphologic classes in the Cerrado of Mato Grosso

Source: PRODEAGRO (2000c).

In each mesoregion we analysed the estimate of accumulated planted area for each different culture in the time intervals considered in the present study, that is, 1990 through 2001, and 2002 through 2008. Analyses were made objectifying to learn which cultures have shown greatest growths regarding their planted area in each mesoregion, as well as to show what has been the dynamics of anthropic occupation in the Cerrado do Mato Grosso in the period under consideration.

RESULTS

Analyses of the spatial distribution of modified areas

In regard to the amount or extension of modified areas in the Cerrado of the State of Mato Grosso, we observed in the period from 1990 to 2001 an increment of 42.96 thousand km^2 (Figure 4a), while in the period from 2002 to 2008, the increment was 17.65 thousand km^2 (Figure 4b); therefore there was a significant reduction in the anthropization rate when we take both periods in comparison. However, the North mesoregion continued to present the highest rates of modification in both periods under study. Except for the Southwest and North mesoregions that have shown increases in modified areas, all other mesoregions have shown reduction in the anthropic modifications.

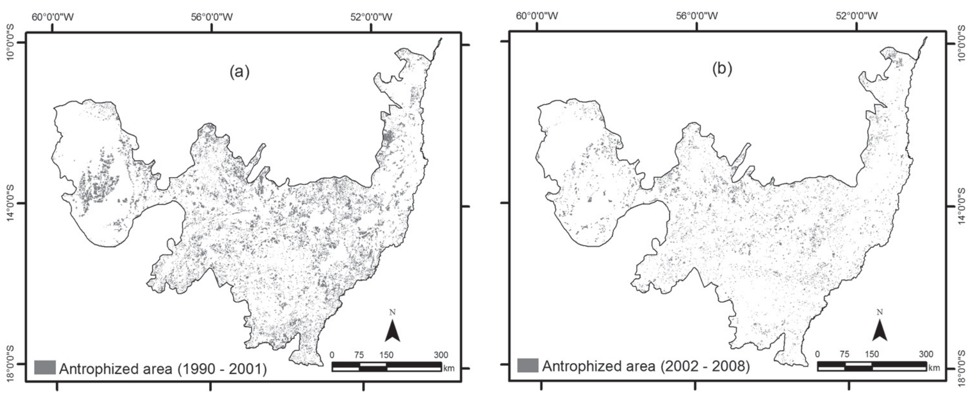

Figure 4 – Map of increments of anthropized areas in the years between 1990 and 2001 (a). Map of increments of anthropized areas in the years between 2002 and 2008 (b)

Source: BRASIL, 2009.

The North mesoregion presents the highest rate of alteration in both time intervals studied; in the period between 1990 and 2001, it presented 42.62% of modification, and 46.13% in the period between 2002 and 2008 (Figure 5a). In that mesoregion we point out the municipalities of Lucas do Rio Verde, Sapezal, Sinop, and Sorriso, all known for their large production of soybean and corn, and all can be considered to have had recent occupation. In the middle of the 90's those municipalities have taken the lead as regards agriculture yield in the State, revealing that the production shifted from Center-South to Center-North of the State.

The Latossoil class occupies 38.79% of the territory under study, and is followed by the Neosoil class with 28.36%; both together totalize more than 50% of the studied area. In figure 5(d) we can see also that the Latossoil is the main class occupied by anthropic activities, even with the reduction in the modification rate, from 51.12% in the period 1990-2001 to 45.44% in the period 2002-2008. This is closely related to the fact that such soils are residual soils in levelling surfaces known in the region as *chapadas*, which present a flat to mildly undulated topography – a characteristic that is especially beneficial for agricultural activities because it favours mechanization (REATTO et al., 2008).

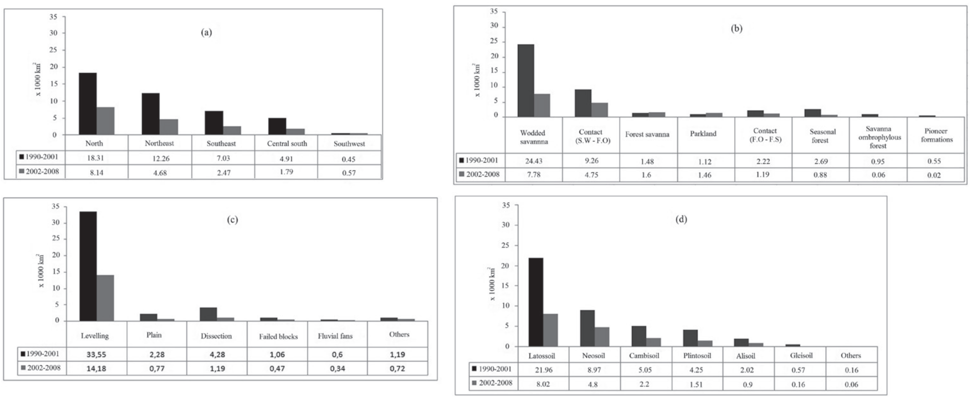

Figure 5 - (a) Estimate of modified areas in the Cerrado do Mato Grosso biome in the periods from 1990 to 2001 and from 2002 to 2008, in 1,000 km² per mesoregion; (b) classes of vegetation; (c) geomorphologic formations; and (d) classes of soil

Contrary to the reduction verified in Latossoils, occupation in the Neosoil class has shown increase, having passed from 20.88% in the period 1990-2001 to 27.20% in the period from 2002 to 2008. Those soils are conditioned to low contents of argyl and organic matter, and consequently to a low capacity of particle aggregation, thus being very susceptible to erosion and then considered to have poor aptitude for agriculture (GUERRA; BOTELHO, 2001). Due to its limitations in regard to agriculture, when the demand for new planting areas began after the 1970 decade, Neosoils ended up incorporated into the pasture system, and afterwards into the grain producing process. However, continued use of this type of soil to grow annual crops can cause rapid environmental decay, with soil loss from erosion, river silting, and decrease in natural fertility, among other problems (EMBRAPA, 1999).

In regard to the local geomorphology, the levelling system represents 70% of the area under study and is characterized by small declivities and little intensity of drainage, with very ample and open valleys (PRODEAGRO, 2000c), and it presents the highest values for modified areas in the period from 2002 to 2008: approximately 80 percent (Figure 5c). The same tendency is observed for the period from 1990 to 2002, demonstrating that the levelling system has been the one most modified by anthropic actions along the whole period under study, and showing that the tendency in both periods has been to occupy flat lands, because they are favorable for agriculture.

The remaining geomorphologic formations sum up 19.67% of occupations, and it could be interesting to highlight occupations in the Plains formation. Although anthropic occupation in this formation has shown a decrease from 5.31% (1990-2001) to 4.34% (2002-2008), occupations are associated to areas near rivers and they can be described as regions originated in degradation processes, mainly fluvial ones. Planning and handling are important for cultures in those areas, since they present great probability of being the cause of river silting, when occupied in irregular manners (SILVA et al., 2010).

In regard to classes of vegetation in the Cerrado biome, the forested savanna formation is predominant in the studied region, representing 50.4% of the territory. Considering the distribution of original vegetation that has been suppressed, the forested savanna, in addition to being present in more than half the area, is the one most affected by anthropic advancements, and has been converted by 56.86% and 43.88%, respectively in the periods from 1990 to 2001 and from 2002 to 2008 (Figure 5d). It can be partially explained by the spatial configuration of the vegetation, because there are species sufficiently ligneous to be used in charcoal kilns. Arvor (2009) has obtained results indicating that the expansion of agriculture between 2000 and 2007 explains 12 percent of the deforestation in Mato Grosso. He also concludes that 71 percent of the new soybean areas in the State have been planted in stripes of land that had been previously deforested; in other words, new areas have been opened or deforested to allow for the growth of the mentioned culture.

According to Ribeiro and Walter (2008), forested Savannas are areas under high risk of deforestation and subsequent conversion to agriculture and livestock use, because they occupy plain terrains with deep soils that are mostly related to the Red Latossoil and Red-Yellow Latossoil classes, and are favorable for mechanized agriculture.

The Contact region (Savanna-Ombrophylous Forest) covers great part of the dissected surface of hills and tabular reliefs in the Northern Mesoregion of the Cerrado do Mato Grosso, representing 26.77% of the territory under study. Although occupation is relatively recent in that region of the State (after the 70's decade), the great lumber potential of the forest, with fine hardwood such as cherry wood and mahogany, has conditioned exploration of activities directed to wood extraction in the region, thus contributing with 26.80% of conversion to anthropic activities (PRODEAGRO, 2000a).

Dynamics of the growth of cultivated areas per mesoregion in the Cerrado do Mato Grosso

In this stage of the work we tried to observe which cultures have shown to have their planted areas increased in the periods from 1990 to 2001, and from 2002 to 2008. In function of the different extension of periods considered, the first having twelve and ten second having seven years, we didn't assign priority in the analysis to cases where the percentages of growth have been negative. It is worth pointing out that "modified area" refers to areas estimated from data presented by Silva et al. (2010) and BRASIL (2009), that is, to data interpreted through satellite images; while "planted area" refers to areas estimated through the use of a methodology employed by IBGE to develop PAM.

Another aspect of great significance is the fact that between 1990 and 2008 the North mesoregion of the Cerrado do Mato Grosso has shown a growth of 950% in soybean production, thus proving the high agricultural activity in the region, and therefore this can be related to the high rate of modified areas in the period under study (IBGE, 2010).

In figure 6 we observe a great increase of the area planted with soybean cultures in the Cerrado biome along the period from 1990 to 2008. In the year 1990 few municipalities reached 125,000 ha of planted area, the average area being at the time approximately 15,000 ha. In 2008, the average extension of planted areas had jumped to 150,000 ha, with some municipalities reaching the figure of 600,000 ha. There is a large nucleus of production in the Northern region, in the municipalities of Lucas do Rio Verde, Campo Novo do Parecis, Sapezal, and Sorriso, where the soybean culture comes to represent in some cases 90 percent of the municipality's economy. According to Arvor (2009) the municipalities characteristically have levelling reliefs, and mostly have deep latossoils, which facilitates mechanization of the culture, thus favouring the establishment of large properties, and making the soybean culture an economic pillar of the State of Mato Grosso.

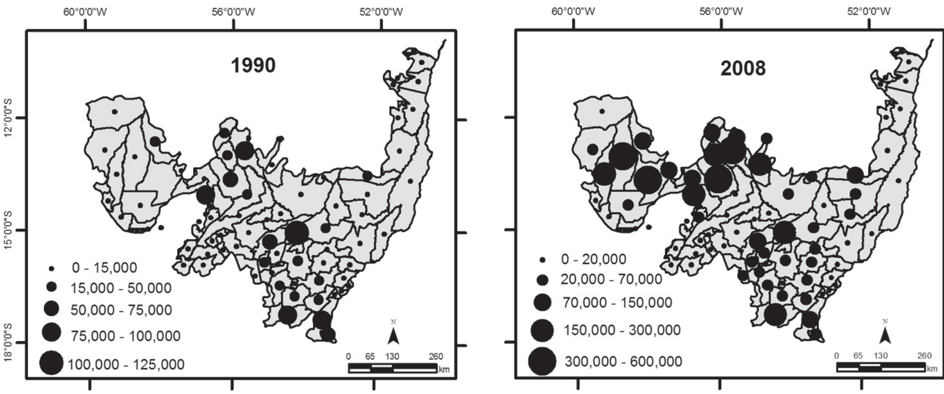

Figure 6 – Areas planted with soybean per municipality in the 1990 and 2008 harvests, in the Cerrado of Mato Grosso

In regard to rice and cotton cultures, in the seven years considered between 2002 and 2008 their production didn't even reach half of the planted area existing in the first period. On the other hand, areas planted with soybean have grown by 112.9%, going from 2,063 km² to 4,392 km² (Figure 6).

Similarly to the Central-South mesoregion, the Northeast mesoregion has also shown a decrease in the percentage corresponding to the total modified area relative to the area under study (Figure 7a). In the period from 1990 to 2001, modified areas accounted for 28.5% of the total estimatea area, and in the period from 2002 to 2008 they accounted for 26.5%. Despite the small decrease, soybean and cotton areas have shown a significant growth, with an increase of over 80 percent of planted areas. Cotton areas went from 1,157 km² to 2,280 km², while soybean areas went from 17,725 km² to 32,517 km².

In the North mesoregion cotton, sugarcane, corn and soybean cultures have shown growth in regard to the extension of planted areas (Figure 7b). Among those cultures, sugarcane presented the smallest areas, with 2,560 km² in the period between 1990 and 2001, and 3,441 km² in the period between 2002 and 2008 – a growth of 34.4%. In absolute terms regarding land extension, the soybean culture stands out, accounting for accumulated areas of 143,250 km² and 257.249 km² respectively in the periods from 1990 to 2001, and from 2002 to 2008. Cotton and corn may also be highlighted, since these cultures have shown growths in planted areas that exceeded 100%. This was the mesoregion with highest estimates of modified areas in both periods considered, accounting for 42.62% from 1990 to 2001, and for 46.13% from 2002 to 2008.

The Southeast region has shown a landscape that is similar to the one seen in the North, with significant percent increase of cotton (208.5%), sugarcane (31.1%) and corn (19.5%) cultures (Figure 7d). Soybean culture has shown a small difference between both periodsconsidered (-0.6%), but it is worth pointing out that in seven years (2002 through 2008) the soybean planted area was similar to the area considered in the 12 precedent years (1990 through 2001).

Besides the North mesoregion, the Southwest mesoregion has also shown a percent increase as regards the representativity of modified areas (3.25%) between 2002 and 2008, relative to the period from 1990 to 2001, going from 0.45% to 0.57% (Figure 7e); increases in the sugarcane (45.9%) and soybean (63.1%) areas were prominent. This has been the only mesoregion where the area occupied by soybean cultures was not predominant, although it has shown the biggest percent increase.

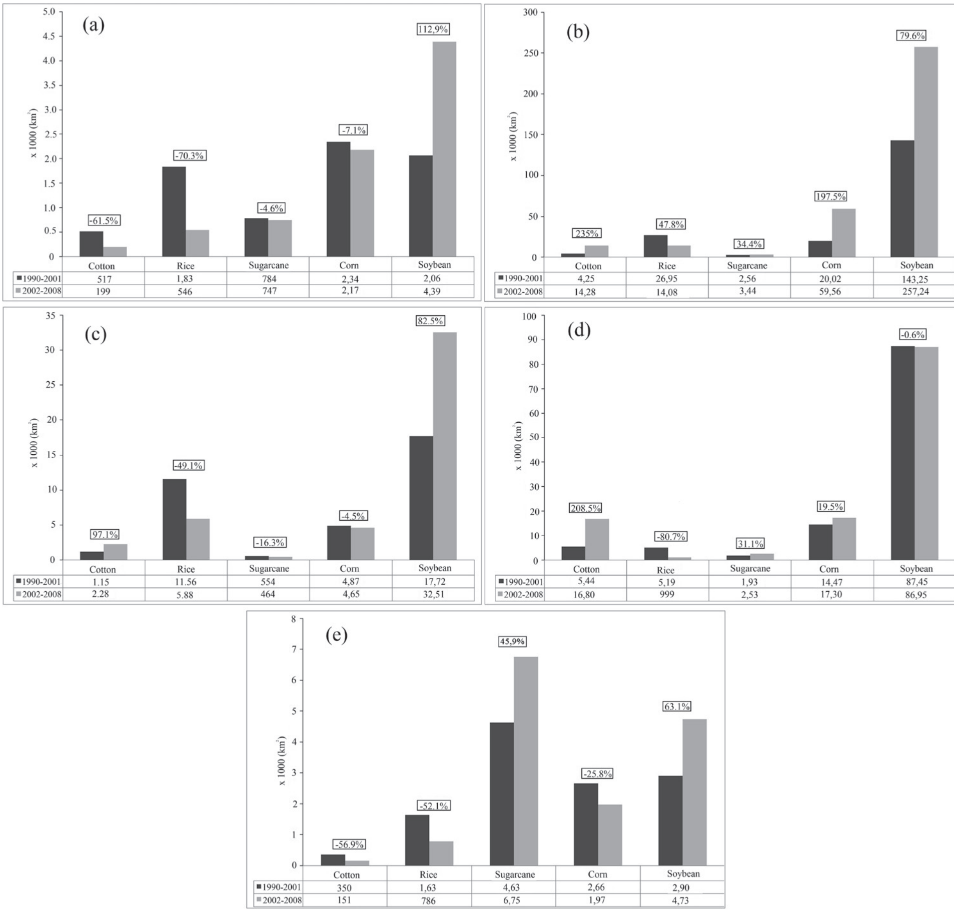

Figure 7 – Areas planted with cotton, rice, sugarcane, corn, and soybean, in the periods from 1990 to 2001 and 2002 to 2008 in the mesoregions: Center-South (a); North (b); Northeast (c); Southeast (d); and Southwest (e)

In an overall calculation, we have observed that the soybean culture has shown a percent increase in all mesoregions of the Cerrado of Mato Grosso, between the periods under consideration. It is worth highlighting that sugarcane cultures occupy predominantly areas modified in the second period (2002 a 2008), in the North, Southeast and Southwest mesoregions, while in the Central-South mesoregion the percent difference was under 5%.

CONCLUSIONS

In the present work, considering the methodology employed, it has been possible to observe that:

- the mesoregion North of the Cerrado do Mato Grosso biome has shown greater dynamics of occupation and opening of new areas, in both periods considered (1990 through 2001, and 2002 through 2008);
- occupations have shown a significant preference for deep latossoils in flat reliefs; however, soils considered to be fragile, such as neosoils and cambisols, also have shown to have significant occupations.

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