

# ANTHROPIZATION DYNAMICS OF THE CERRADO (BRAZILIAN SAVANNA) IN THE URUÇUÍ-UNA ECOLOGICAL STATION, BRAZIL, BASED ON ORBITAL IMAGES FROM 2003 TO 2005

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**Abstract-** Cerrado is one of the largest biomes in Brazil and its importance is justified for its size, and biodiversity that it contains. However, in reality, anthropogenic interferences risk the integrity of the Cerrado. Deforestation and burning for the maintenance and expansion of agriculture and pastures consume its areas even inside Conservation Units, which are protected from these practices by law. In the Uruçuí-Una Ecological Station (ESEC UU), a 203,426.91 ha area in Baixa Grande do Ribeiro city, in Piauí, a northeastern state of Brazil, it's not different. Neither it is in its buffer zone. This study detected and quantified the deforestation and burning dynamics during the dry season in 2003, 2004 and 2005 in these areas using orbital images of the sensors CCD/CBERS-2 and TM/Landsat-5. Two dates from each of the years were analyzed: one at the middle of the dry season and one at the end. Deforestation was detected in all dates and occurred mostly in the buffer zone. Both, the ESEC UU and buffer zone showed burning scars in all dates too, although sometimes it was more intense in one than in the other. The scenario described in this study reaffirms the urgent need for a stronger fiscalization in order to stop the anthropization in the ESEC UU and the creation of a management plan, absent for this unit so far.

**Keywords:** Cerrado; Brazilian savanna; deforestation; burning; Uruçuí-Una, Piauí; remote sensing; CCD/CBERS; TM/Landsat.

## 1 - Introduction

Cerrados – the Brazilian savannas – are located mainly in the central part of Brazil, representing 21% of the national territory and may attain approximately 1,8 millions of km<sup>2</sup> (COUTINHO, 1990; AGUIAR & CAMARGO, 2004). Fire is one of the most important ecological features of the cerrado, which can be started naturally or by the interference of man (FRANÇA and SETZER, 2001; FRANÇA *et al.*, 2007). In the rainy season, from October to March, lightnings occasionally start fire during rainstorms and, in this case, areas don't usually burn more than 1km<sup>2</sup> (FRANÇA *et al.*, 2007). However, man has been the principal cause of fire in the cerrado from the earliest times (COUTINHO, 1990), specially during the dry season, from April to September, when farmers burn areas for agriculture and cattle raising and the fire is spread through hundreds of kilometers of the cerrado, in this case, with no rain to stop it (COUTINHO, 1990; FRANÇA *et al.*, 2007).

Studies on this biome are important for the maintenance of the biodiversity and because it is the habitat of many endemic and migratory species that are at risk of extinction (ZAHER, 2001; MANTOVANI & PEREIRA, 1998; AGUIAR & CAMARGO, 2004). The chosen area of study is the Uruçuí-Una Ecological Station (ESEC UU), in the south of Piauí, Brazil (IBAMA, 2001). This conservation unit should provide protection to its ranges of cerrado, spring waters, rivers and fauna. But the truth is its delicate natural equilibrium is endangered because of anthropization. Burning and the deforestation of large areas outside of the station, by farmers, and inside by *posseiros* (squatters) to promote agriculture and cattle raising are the biggest dangers to the ecosystems there (ZAHER, 2001, IBAMA, 2004).

The objective of this study is to quantify the deforestation and burning dynamics during the dry season from 2003 to 2005 in the Uruçuí-Una Ecological Station and its buffer zone using orbital images of the sensors CCD/CBERS-2 and TM/Landsat-5.

## 2 - Study area

The area of study is the Uruçuí-Una Ecological Station (ESECUU) and its buffer zone. The ESECUU is a 203.426,91 ha area in Baixa Grande do Ribeiro city, in the south of Piauí, a northeastern state of Brazil (IBAMA, 2001), illustrated on Figure 1. Buffer zone is the area evolving every Conservation Unit – among these Ecological Stations. It covers the 10km extension from the borders of these Units and it's use is restricted (CONAMA, 1990).

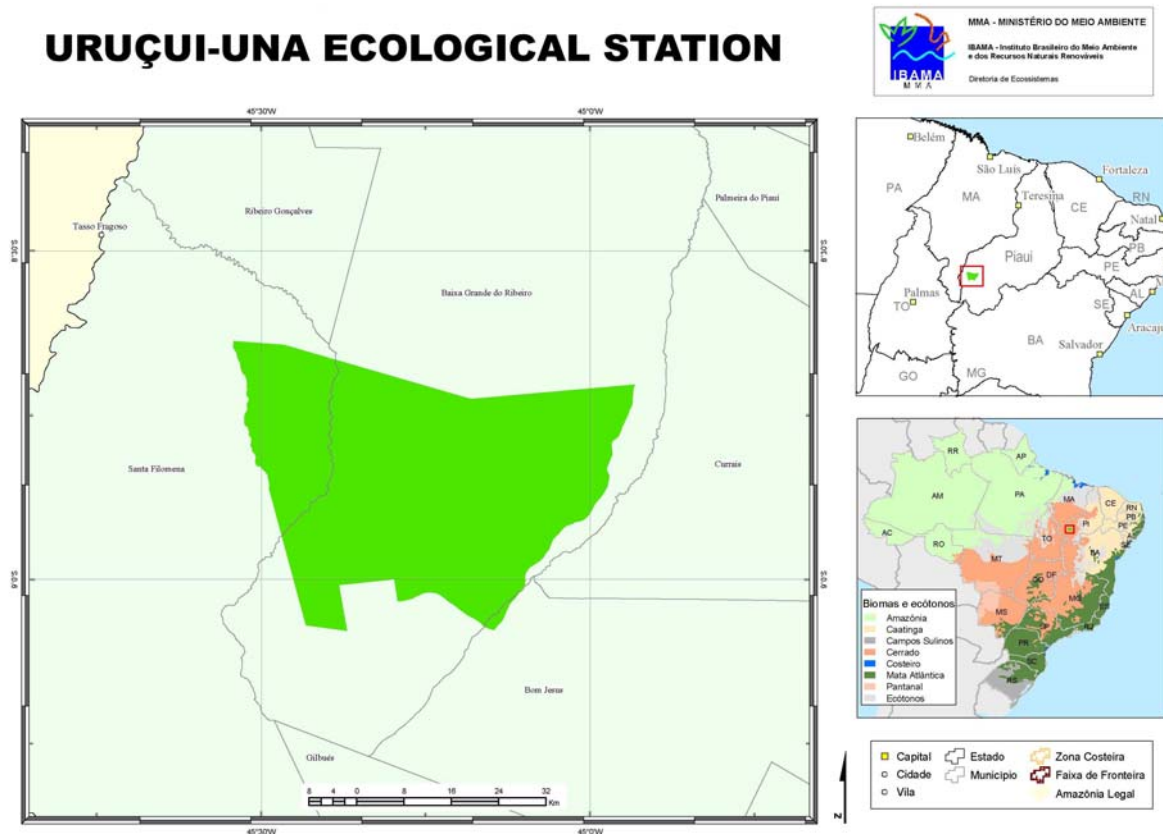


Figure 1: Study area: Uruçuí-Una Ecological Station (ESECUU), in Baixa Grande do Ribeiro city, in the south of Piauí, a northeastern state of Brazil.

## 3 - Material and Method

### 3.1 - Material

The geoprocessing software used in this study was SPRING 4.3.3 downloaded from <http://www.dpi.inpe.br/spring> (INPE, 2008) and the ESECUU limits from <http://www.ibama.gov.br/siucweb> (IBAMA, 2004).

The images used are listed in Table 1. The bands used from the orbital sensor CCD/CBERS-2 were 2 (0,52-0,59  $\mu\text{m}$ ), 3 (0,63-0,69  $\mu\text{m}$ ) and 4 (0,77-0,89  $\mu\text{m}$ ), with geometric resolution of 20 m. And from TM/Landsat-5 were bands 3 (0,63-0,76 $\mu\text{m}$ ), 4 (0,76-0,90 $\mu\text{m}$ ) and 5 (1,55-1,75 $\mu\text{m}$ ), with geometric resolution of 30 m.

Table 1 – Dates, sensors, orbits/points and color compositions used.  
MD indicates dates in the middle of the dry season and ED in the end.

Date	Sensor	Orbit/Point	Composition
27/07/2003 (MD)	TM/Landsat-5	220/66	3B4R5G
16/11/2003 (ED)	TM/Landsat-5	220/66	3B4R5G
13/07/2004 (MD)	TM/Landsat-5	220/66	3B4R5G
17/10/2004 (ED)	TM/Landsat-5	220/66	3B4R5G
20/07/2005 (MD)	CCD/CBERS-2	156/110	2G3B4R
06/10/2005 (ED)	CCD/CBERS-2	156/110	2G3B4R

### 3.2 - Method

Six color compositions were generated from orbital images of two dates from each of the years 2003, 2004 and 2005: one at the middle of the dry season and one at the end. The compositions were segmented and classified automatically by unsupervised Isepeg method. Two information plans were generated from each, one for burn and one for deforestation. They were corrected manually on the screen using raster edition (Figure 2). The polygons obtained in the information plans were measured so the areas of burning and deforestation for each of the dates could be obtained.

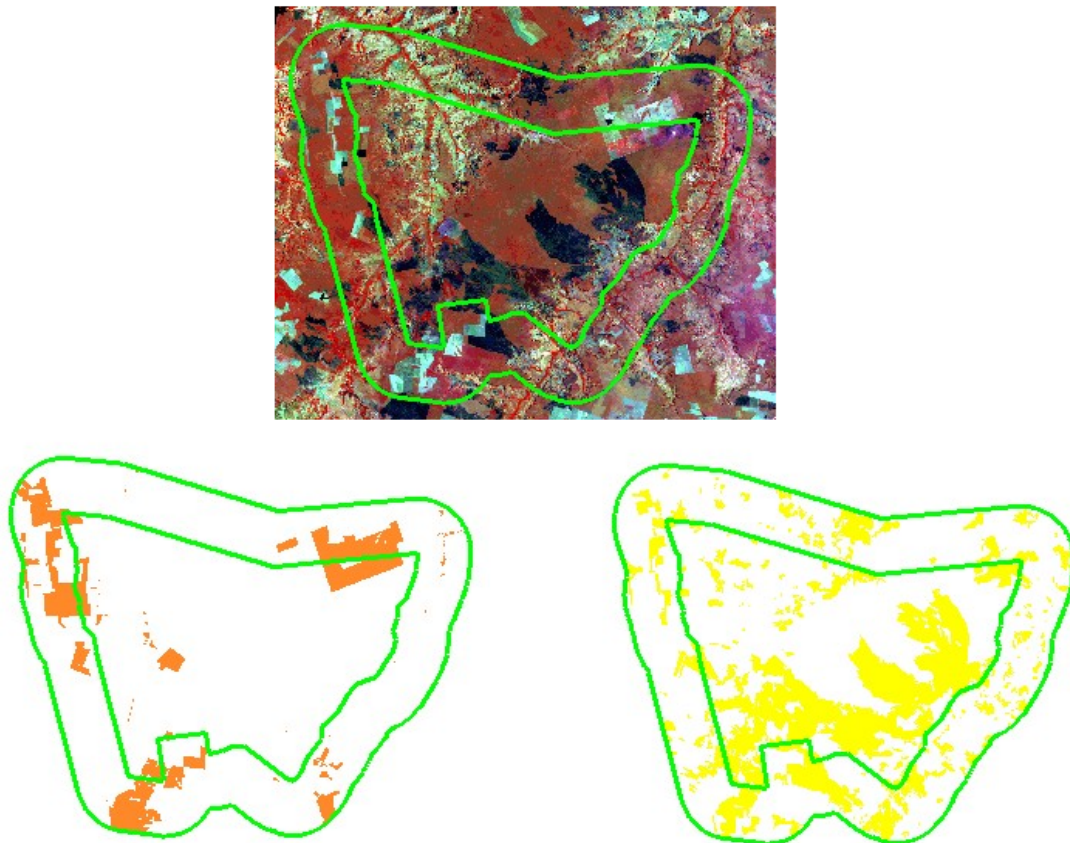


Figure 2: TM/Landsat-5 color composition 3B4R5G of 17/10/2004 (on top) and the two information plans generated, one for deforested areas (left) and one for the burned areas (right) within the delimitations of the ESECUU and buffer zone.

## Results

For all areas analyzed – ESECUU, buffer zone and ESECUU and buffer zone together – and years, the total of deforestation showed low variation (Table 2) and the burning marks were always larger in the end of the dry season comparing to the mid-season dates (Table 3). The results of burning for 2005 are probably underestimated, since part of the buffer zone area was not covered by the images in July and part of the buffer zone and ESECUU area was not covered by the images in October.

Table 2: Area and percentage deforested of the ESECUU (UU), buffer zone (BZ) and both the Station and buffer zone (UU+BZ).

Date	Deforestation					
	UU		BZ		UU+BZ	
	ha	%	ha	%	ha	%
Jul/03 (MD)	10,386.54	5.1	20,681.28	8.6	31,067.82	7.0
Nov/03 (ED)	11,282.49	5.6	22,870.62	9.6	34,153.11	7.7
Jul/04 (MD)	11,364.21	5.6	30,427.11	12.7	41,791.32	9.4
Oct/04 (ED)	11,329.20	5.6	30,822.32	12.9	42,221.52	9.5
Jul/05 (MD)	10,445.92	5.1	28,500.50	11.9	38,946.42	8.8
Oct/05 (ED)	10,643.21	5.2	30,707.60	12.8	41,350.81	9.3

Table 3: Area and percentage burned of the ESECUU (UU), buffer zone (BZ) and both the Station and buffer zone (UU+BZ). \* indicates underestimated values.

Date	Burning					
	UU		BZ		UU+BZ	
	ha	%	ha	%	ha	%
Jul/03 (MD)	3,524.58	1.7	5,874.66	2.5	9,399.24	2.1
Nov/03 (ED)	10,352.88	5.1	35,994.87	15.0	46,347.75	10.5
Jul/04 (MD)	5,846.04	2.9	5,693.76	2.4	11,539.80	2.6
Oct/04 (ED)	70,579.80	34.7	45,556.38	19.0	116,136.18	26.2
Jul/05 (MD)	6,431.24	3.2	*19,386.80	*8.1	*25,818.04	*5.8
Oct/05 (ED)	*27,242.84	*13.4	*37,671.56	*15.7	*64,914.40	*14.7

In the ESECUU, the smallest deforestation, 10,386.54 ha, was detected in July/2003 and the largest, 11,364.21 ha, in July/2004. There was a variation of 5.1% to 5.6% of the deforested area. Burning covered the smallest area of the ESECUU, 3,524.58 ha, in July/2003 and the largest, 70,579.80 ha, in October/2004, showing 1.7 % and 34.7% of the area burned, respectively (Figure 3).

The minimum deforestation in the buffer zone was 20,681.28 ha in July/2003 and maximum was 30,822.32 ha in October/2004. This is 8.6% and 12.9% of deforestation in these dates, respectively. Burning was smaller, 5,693.76 ha, in July/2004 and larger, 45,556.38 ha in October/2004, that is 2.4% and 19.0% of the buffer zone, respectively (Figure 4).

Deforestation was always a lot larger in the buffer zone than in the ESECUU. However, the biggest fire event inside the ESECUU, 70,579.80 ha, in October/2004, 34.7% of the Station burned, was larger than the biggest one detected in the buffer zone, 45,556.38 ha, 19.0% of the buffer zone, which occurred in the same date.

Deforestation in the ESECUU and the buffer zone together covered the smallest portion of this area, 31,067.82 ha (7.0%), in July/2003, and the largest, 42,221.52 ha (9.5%), in October/2004. The least burning, 9,399.24 ha (2.1%), occurred in July/2003, and the most, 116,136.18 ha (26.2%), in October/2004 (Figure 5).

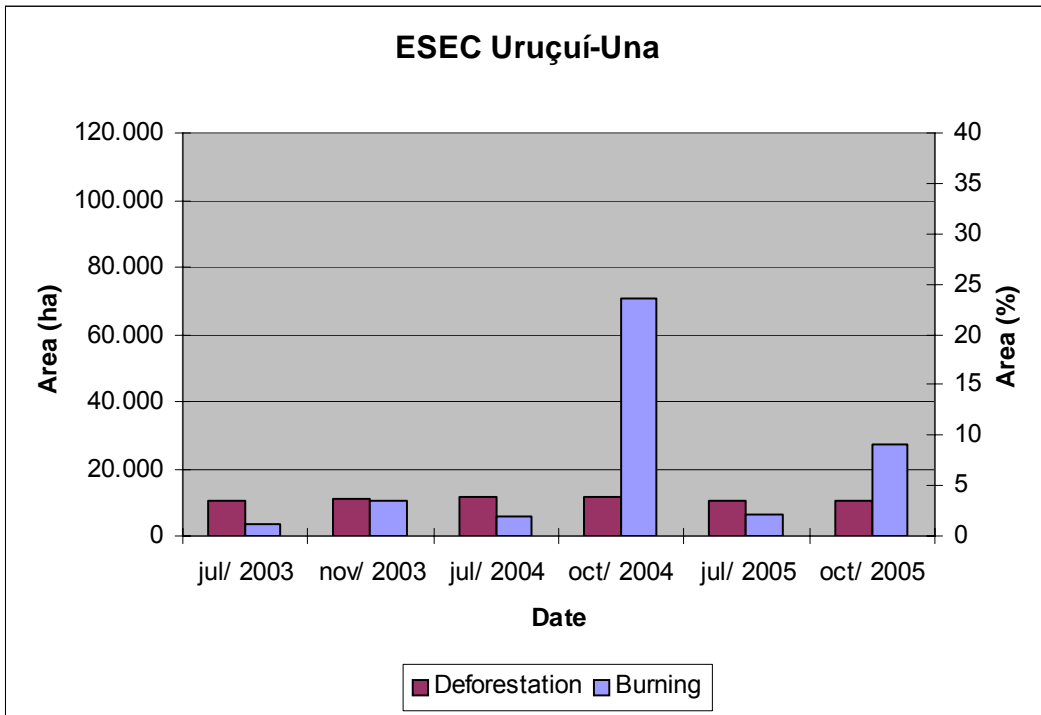


Figure 3: Area of deforestation and burning in the Uruçuí-Una Ecological Station.

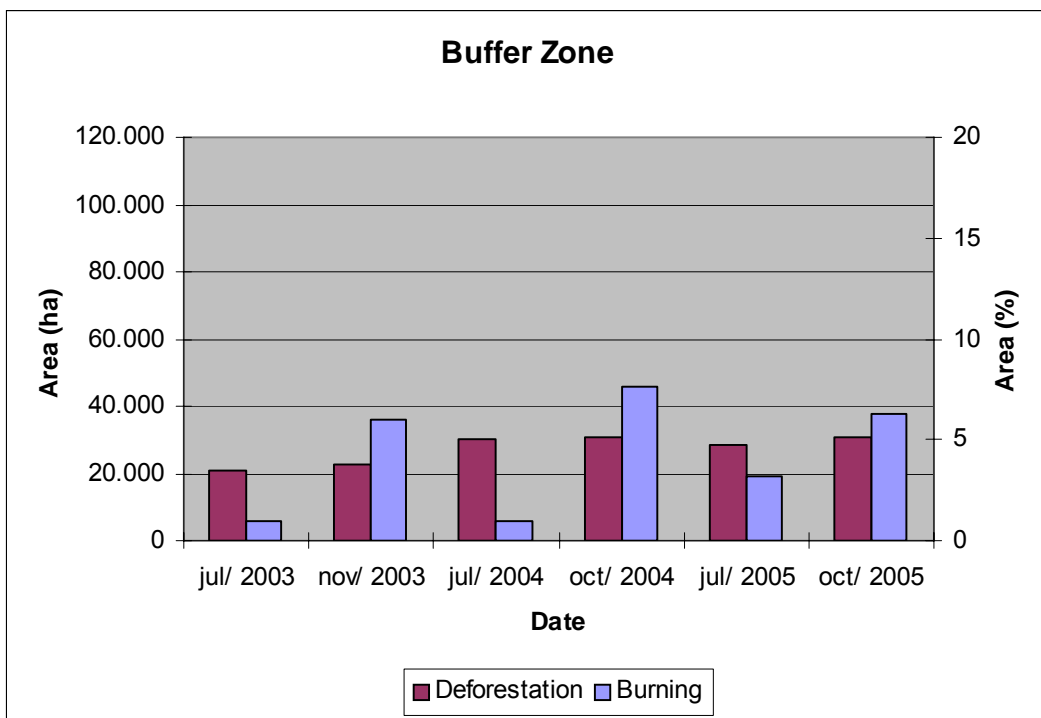


Figure 4: Area of deforestation and burning in the buffer zone of the Uruçuí-Una Ecological Station.

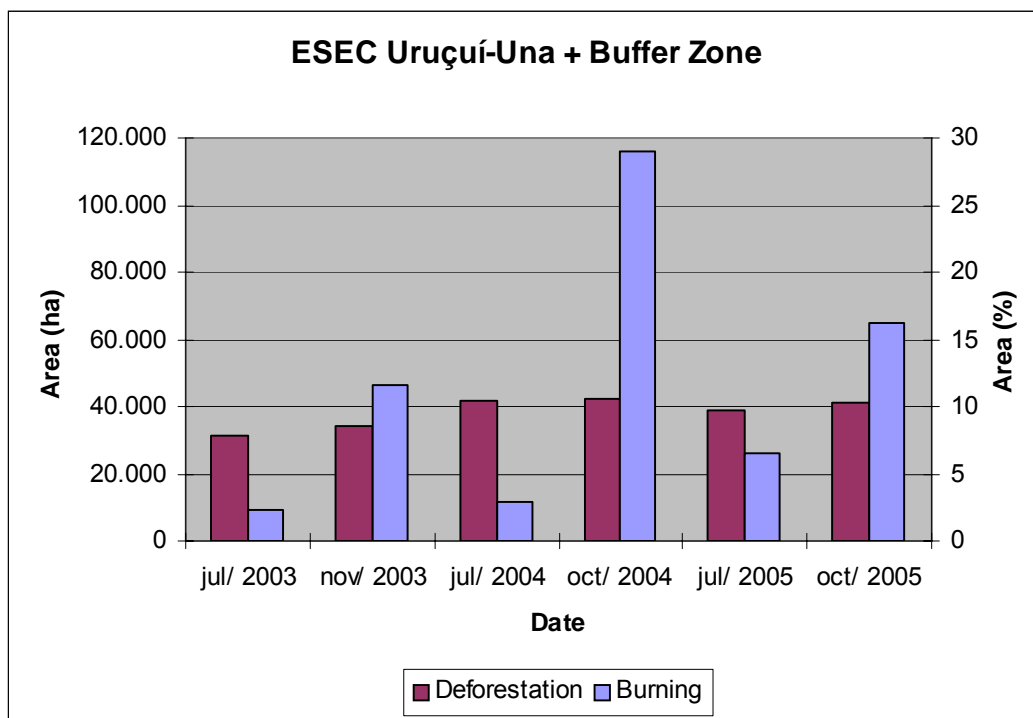


Figure 5: Area of deforestation and burning in the Uruçuí-Una Ecological Station and its buffer zone.

## Discussion

The law no. 9,985/2,000 of July 18<sup>th</sup>, 2000 (BRASIL, 2000) regulated the Conservation Units in Brazil, among them are the Ecological Stations, where alterations are only allowed for restoration of modified ecosystems, management of species to preserve the biological diversity, collecting for scientific purposes and scientific research with restricted impact. Also, Environment Brazilian Council (BRASIL, 1990), considering the urgent necessity to establish rules concerning the surroundings of the UCs in order to protect the ecosystems, had already determined as buffer zones the 10 km extension from all around the borders of the UCs, where any activity that could affect the biota must be licensed by the legal environmental agency. However, this study shows a different scenario from the one regulated by law. For all the dates analyzed deforestation and burning happens inside the ESECUU and even more in the buffer zone. Zaher (2001) also noticed the occurrence of this unregulated uses of the land when visiting the ESECUU to study vertebrates.

In Brazil, little has been done in the Conservation Units, beyond basic administration, like control of entrance and exit of visitors and infrastructure maintenance of roads, bridges, buildings, etc (FRANÇA *et al.*, 2007). The ESECUU doesn't even have a management plan (IBAMA, 2004).

According to Coutinho (1990), man has been the principal cause of fire in the Cerrado from the earliest times. França and Setzer (2001) add that hundreds of thousands of fire of anthropogenic origin have been detected each year and the frequency of these intentional, accidental or criminal burnings, in areas that are protected or not, is far greater than fires due to natural causes, and therefore rapidly transforms the original environment. ESECUU is an example of Conservation Unit that is affected by anthropization when it happens within its borders, in the buffer zone and other surrounding areas.

Pereira (1992) monitored the fire in the Cerrado and detected that most burnings occur in the second half of August. França and Setzer (2001) explain that the fire season usually starts in May and peaks by late August and early September. The present study supports such affirmations since burnings and scars were always larger in the end of the dry season (October and November) comparing to the mid-season dates. According to Coutinho (1990) in the dry season, the cattle suffer from the lack of palatable, green feed, so weight loss is accentuated and milk production diminishes. Firing the cerrado in the second half of the dry season (August-September) constitutes the cheapest management practice undertaken by the cattle ranchers since a few days or weeks after a burn-off the vegetation sprouts, good for cattle feeding. Coutinho (1990) adds that is the principal cause of fire in the cerrado regions.

The second great cause of burn-offs in the cerrado also happens in the end of the dry season when great areas are cleared to bring in new agricultural areas. Cerrado has low-cost land and provides favorable conditions for intensive cultivation of grains and the greatest expansion of agricultural frontiers has been exactly in this phytogeographic region (COUTINHO, 1990). This explains why deforestation, boosted by the demand in producing, exporting and consuming foodstuffs, crosses the barriers of the ESECUU.

Pereira (1992) and Mantovani and Pereira (1998) note that the detection of the deforestation and burning through remote sensing is fast, low cost, has synoptic coverage, good area quantification accuracy and low intensity of fieldwork. The dynamic of this study confirms affirmations of these authors, who also alert to the importance of a combination with the fieldwork. Since this is an analysis of late images, groundtruthing didn't seem to be essential. Following works that continue to study images of the region until present times will certainly be better performed with an expedition to the ESECUU.

## Conclusion

Cerrado is one of the largest biomes in Brazil and its importance is justified for its size and biodiversity that it contains. However, in reality, anthropogenic interferences risk the integrity of the cerrado. Deforestation and burning for the maintenance and expansion of agriculture and pastures consume its areas even inside Conservation Units, which are protected from these practices by law. In the Uruçuí-Una Ecological Station (ESECUU), a 203.426,91 ha area in Baixa Grande do Ribeiro city, in the south of Piauí, a northeastern state of Brazil, it's not different. Neither it is in its buffer zone. This study detected and quantified the deforestation and burning dynamics during the dry season from 2003 to 2005 in these areas. Deforestation was detected in all dates analyzed and occurred mostly in the buffer zone. Both, the ESECUU and buffer zone showed burning scars in all dates too, although sometimes it was more intense in one and sometimes in the other. The scenario described in this study reaffirms the urgent need for a stronger fiscalization to stop the anthropization in the ESECUU and the creation of a management plan, absent for this unit so far.

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