DEFORESTATION DETECTION IN CERRADO BIOME OF MATO GROSSO STATE, BRAZIL, USING MULTISENSOR IMAGES

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1. INTRODUCTION

In the last decades, Brazil has become a global agricultural power and the Cerrado biome has been playing an important role in the Brazilian agriculture growth. Approximately 40% of its original vegetation cover was removed due to activities such as farming and agriculture [1] [2].

For better analysis of the anthropogenic disturbance dynamics of Cerrado biome, it is increasingly necessary to develop and adopt an efficient method of assessment and monitoring through detection of temporal changes in order to provide adequate classification of land use and land cover (LULC) changes and to implement an operational systematic monitoring system to the Cerrado biome, since only a few attempts to monitor the degradation of this biome have been made [3] [4].

Nevertheless, there is an increasing demand for this monitoring and it could be implemented similarly to the Brazilian Amazon biome through PRODES (Amazon Deforestation Monitoring Project) [5] and DETER (Near Real Time Deforestation Detection System) [6]. The execution of a systematic monitoring system for Cerrado biome region can be accomplished using MODIS images, as this sensor has high potential for studies on the seasonal dynamics of physiognomies of the Cerrado [7]. Similar to DETER methodology, some works have shown the ability of MODIS data to monitor and detect LULC changes in the Cerrado biome [8].

Mato Grosso State occupies a prominent position in national agricultural production, mainly due to the soybean plantation. The expansion of agriculture activities is a result of the occupation of Central Brazil encouraged by the Federal Government.

In this context, the main objective of this work is to apply the PRODES and DETER like methodologies to map and detect deforestation in the Cerrado biome of Mato Grosso State, Brazil, using Landsat and MODIS data, respectively.

2. DESCRIPTION OF THE STUDY SITE

The study site (Figure 1) corresponds to an area (46,815 km²) in Mato Grosso State, limited by the geographical coordinates W 56º00’ to W 53º10’ and S 13º45’ to S 15°08’, comprising all the main Cerrado formations: forestlands, shrublands and grasslands.

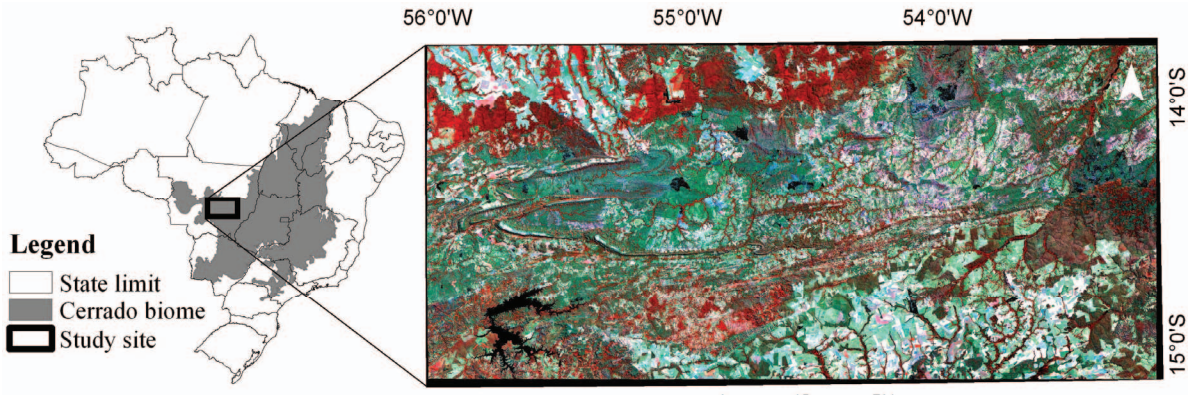

Figure 1 – Location of the study site, color mposite 4(R), 5 (G), 3 (B) TM/Landsat-5, acquired in July 2008.

Cerrado biome occupies an area of approximately 206 million hectares, located in the central portion of Brazil. The vegetation cover has a gradient between trees and shrubs, bushes and sub-shrubs and between sub-shrubs and herbaceous structures. The Cerrado biome has different physiognomies that include forestlands, shrublands and grasslands. In forestlands, tree species are dominant, mainly with continuous canopy. Shrublands are represented by trees and bushes spread out on a grassy layer. Grasslands indicate the areas with herbaceous species and some shrubs, with no trees [9].

3. MATERIALS AND METHOD

The database of the study site was elaborated to store the relevant data to perform this research. For this, SPRING 4.3 [10] was used. Firstly we applied the methodology similar to the PRODES project in order to compute all deforested areas in 1980, 1990, 2001 and 2008 in the study site. The Landsat MSS, TM and ETM+ sensors data were used. The TM and ETM+ images were resampled to 80m corresponding to MSS spatial resolution. Secondly, we applied the methodology similar to the DETER project in order to detect the deforested areas in near real time. For this, daily MODIS, cloud-free, images were collected from September 1st 2008 to August 31st 2009.

Both methodologies use the same classification procedures: application of a Linear Spectral Mixing Model (LSMM) [11] to generate vegetation, soil and shade fraction images, image segmentation of these fraction images followed by an unsupervised classification by region and, finally, an image edition of the classification is performed [12].

In the PRODES methodology, the deforestation survey from a year *i*, a mask covers all deforested areas classified in the August image of year *i*-1. Then, the total area of intact forest were deducted from the events of deforestation between the beginning of August of year i-1 until the end of July of year *i*. It is worth considering that degradations in regeneration were not counted. After the selection of cloud-free images, preference was given to images acquired closest to the reference date, i.e. the beginning of August of the year *i*.

In the DETER methodology, fraction images derived from MODIS data were considered. As well known most of biomass burning at the Cerrado biome is mainly caused by human disturbance [13], then shade fraction is used to map burns scars and it can be monitored until it becomes a new pasture or agricultural areas. The soil fraction is useful for detecting areas that were deforested without biomass burning. The vegetation fraction image similar to vegetation indices (e.g. NDVI) detects better degraded areas, mainly in forest formations of the cerrado biome (Figure 2).

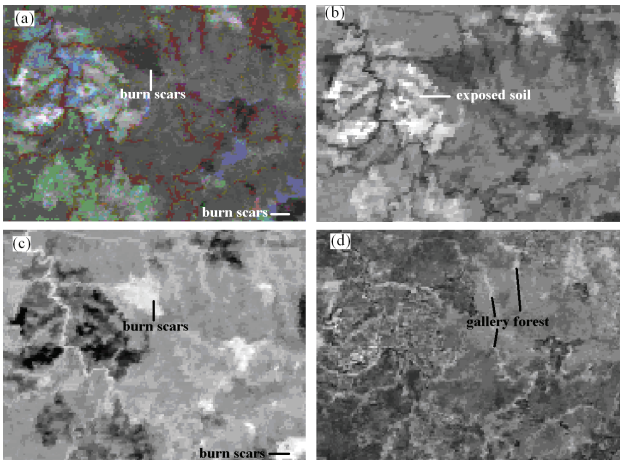

Figure 2 - a) MODIS R (2, near infrared), G (6, mid infrared), B (1, red) image showing burn scars in black; b) shade; c) soil; and d) vegetation fraction images derived by LSMM.

4. RESULTS AND DISCUSSION

The estimate and the map of deforested areas obtained from Landsat images are showed in Table 1 and in Figure 3.

Table 1 – Deforested areas in the study site estimated through interpretation of Landsat images.

Year	Deforested area (km²)	Increase (%)
1980	5,84	-
1990	7,66	31.1
2000	15,28	99.5
2008	17,78	16.5

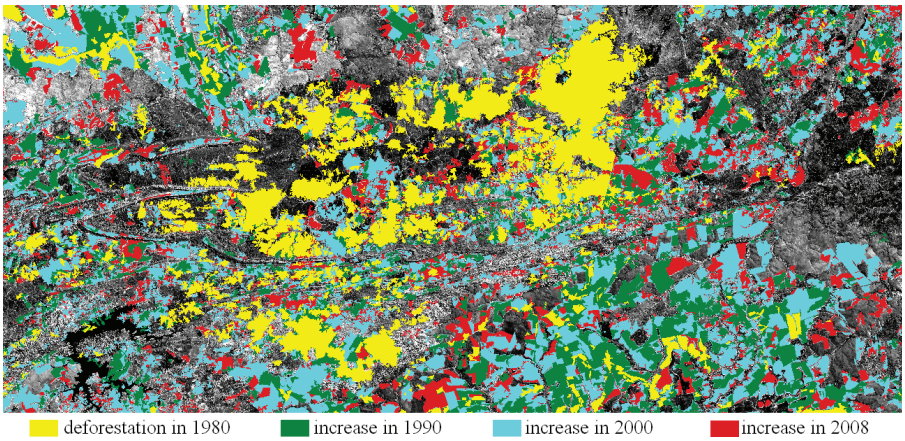

Figure 3 – Landsat/TM4 band with deforestation map of the study site for 1980, 1990, 2000 and 2008.

The deforested areas were higher in the 1990 to 2000 time period with an increase of 99.5% and a considerable reduction was observed in the last period (2000 to 2008) with 16.5% of increase in deforested

areas. The annual mean of deforestation was 987.61 km². The information about the deforested areas is important due to the fact that this biome has become a recent location for agriculture expansion, with consequent changes in LULC. These changes are linked to climate and are inputs for modeling greenhouse gas emissions. It is also known that changes in LULC modify the original CO_2 flux to the atmosphere, with new areas of sink or of source of terrestrial carbon.

For DETER methodology, it is important to use the non-Cerrado mask (old deforestation up to 2008), preventing that the same area is accounted as deforestation in the 2009 MODIS time series. The results of this analysis will be included in the full paper.

5. CONCLUSIONS

This work presented a methodology for a systematic monitoring system for the Cerrado biome. The methodology, despite all the vegetation cover change dynamic, has shown promise for the operational detection. The PRODES methodology estimates the annual deforestation in the study site, using medium spatial resolution images. The DETER like methodology points to the near real time detection of new disturbed areas (burning and/or deforestation), using a moderate spatial resolution images. These deforestation information are critical for the federal government on public policies of natural resources conservation.

6. REFERENCES

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