ESTIMATING PASTURE PRODUCTIVITY IN THE BRAZILIAN SAVANNA BIOME BASED ON MODERATE RESOLUTION SATELLITE DATA

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1. INTRODUCTION

Brazil has the largest commercial beef cattle herd in the world (over 190 million head in 2006) [1], with cultivated pastures occupying about 150 million hectares of its territory [2]. On a biome basis, the most extensive pasture occupation is found in the Cerrado ($\sim$ 546,251 km^2, amounting to about 26.8% of the total biome area and 36.8% of the total pasture area in Brazil), the Brazilian savanna biome, located mostly in central Brazil and comprising a complex mosaic of physiognomic categories, ranging from grassland to forest formations (figure 1).

In relation to the Cerrado´s cultivated pastures, it is estimated that at least 50% are already severely degraded [3], as indicated by the dominance of invading species, common occurrence of termite hills, loss of soil fertility, and decrease in biomass, leading to substantial losses in soil carbon [4, 5]. On the contrary, increases in soil carbon, up to 17%, are observed as pasture productivity recovers [6].

Primary productivity can be considered as a proxy for identifying and mapping degraded areas [7] and it can be estimated from orbital data [8, 9]. In terms of Cerrado´s cultivated pastures, primary productivity varies mainly according to species and management practices, yielding distinct spectral responses along a full hydrological cycle. In this context, we present some preliminary results regarding our attempt to map, at the biome scale, the Cerrado´s pasture conditions based on the time-domain analysis of the MODIS vegetation indices.

2. EXPERIMENTAL DESIGN

In this study, the area of cultivated pastures was selected from the PROBIO map[1], whose land use and land cover classes were obtained from Landsat ETM+ dataset (2002 overpasses) [10]. Net primary productivity (NPP) of each pasture polygon was estimated through the yearly response of the 250-meter resolution MODIS enhanced vegetation index (EVI) [11] on a pixel basis and for the year of 2008, as follows:

$$\text{Productivity\_Image}_{2008} = (\textstyle\sum \text{EVI}_{01\_23})$$

Major trends in the EVI-derived pasture productivity values were preliminarily evaluated on a comparative basis with land surface temperature values extracted from wet- and dry-season MOD11A2 images, according to three "k-means" classes representing the whole EVI-based pasture productivity image (class 1: ~173,606 km^2; class 2: ~249,902 km^2; and class 3: ~122,743 km^2). The main steps concerning data organization and the generation and analysis of the pasture productivity image are depicted in the flowchart shown in figure 2.
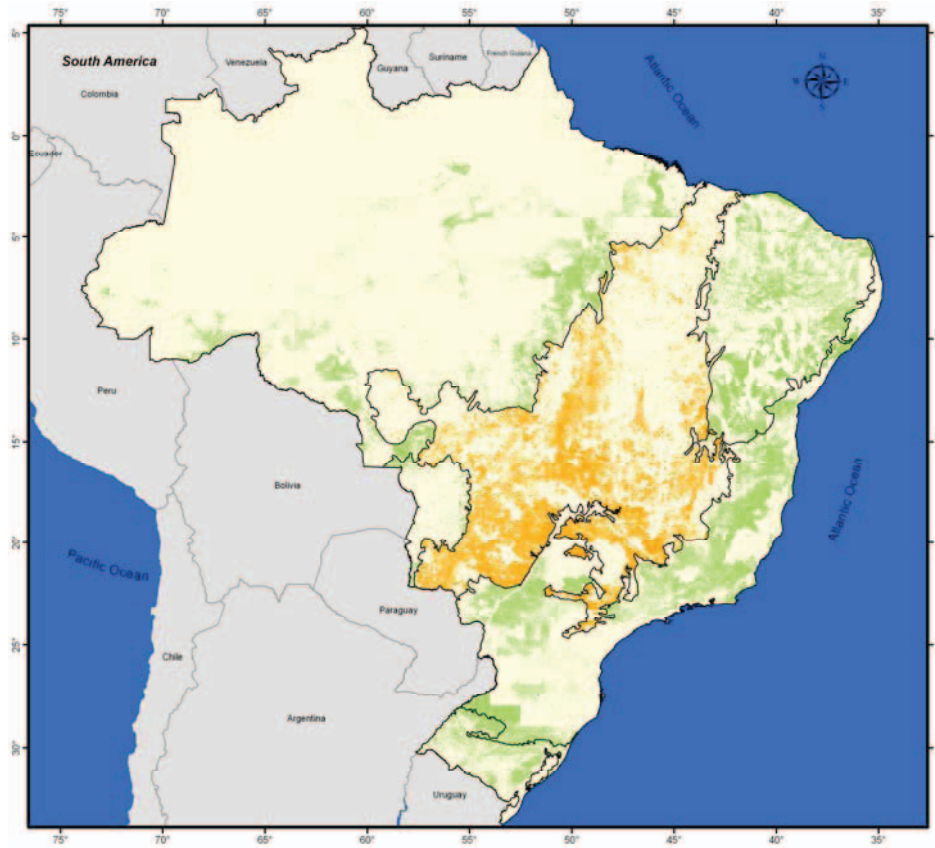

Figure 1 - Area distribution of cultivated pastures in Brazil (Cerrado pasture is highlighted in orange)
source: PROBIO / MMA

3. RESULTS

As seen in figure 3, highest pasture productivity values are mostly found in the southern portions of the Cerrado biome, characterized by the dominance of more fertile soils and adequate topographies. Interestingly, temperatures, for both the wet and dry seasons, tend to increase from the biomass rich class 3 (for dry season, mean temperature = 33 ^{o}C, standard deviation = 5 ^{o}C) to the lowest EVI response class 1 (for dry season, mean temperature = 38 ^{o}C, standard deviation = 3 ^{o}C). It seems that smaller productivity yields lower evapotranspiration and, therefore, greater sensible heat fluxes.

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[1] PROBIO Project "Conservation and Sustainable Use of Brazilian Biological Diversity" [2]
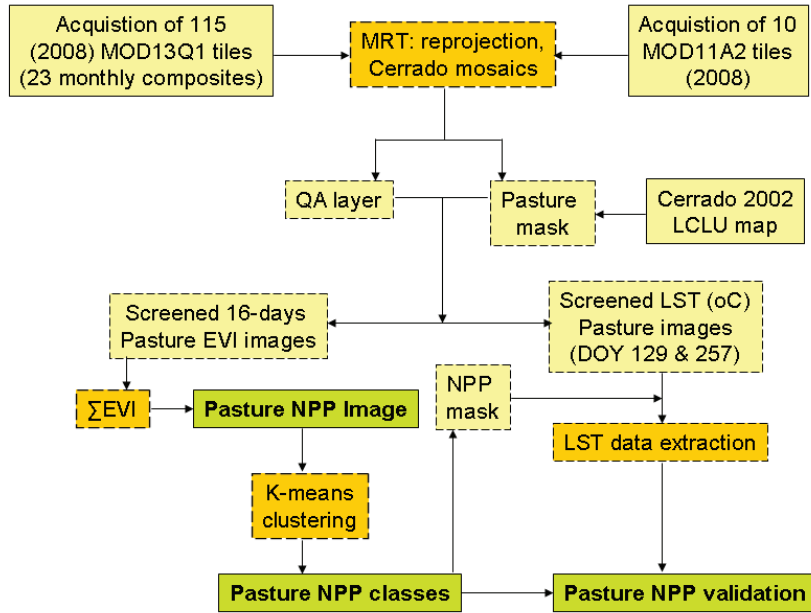
Figure 2 - Flowchart depicting the generation and preliminary evaluation / validation of the Cerrado pasture productivity image.
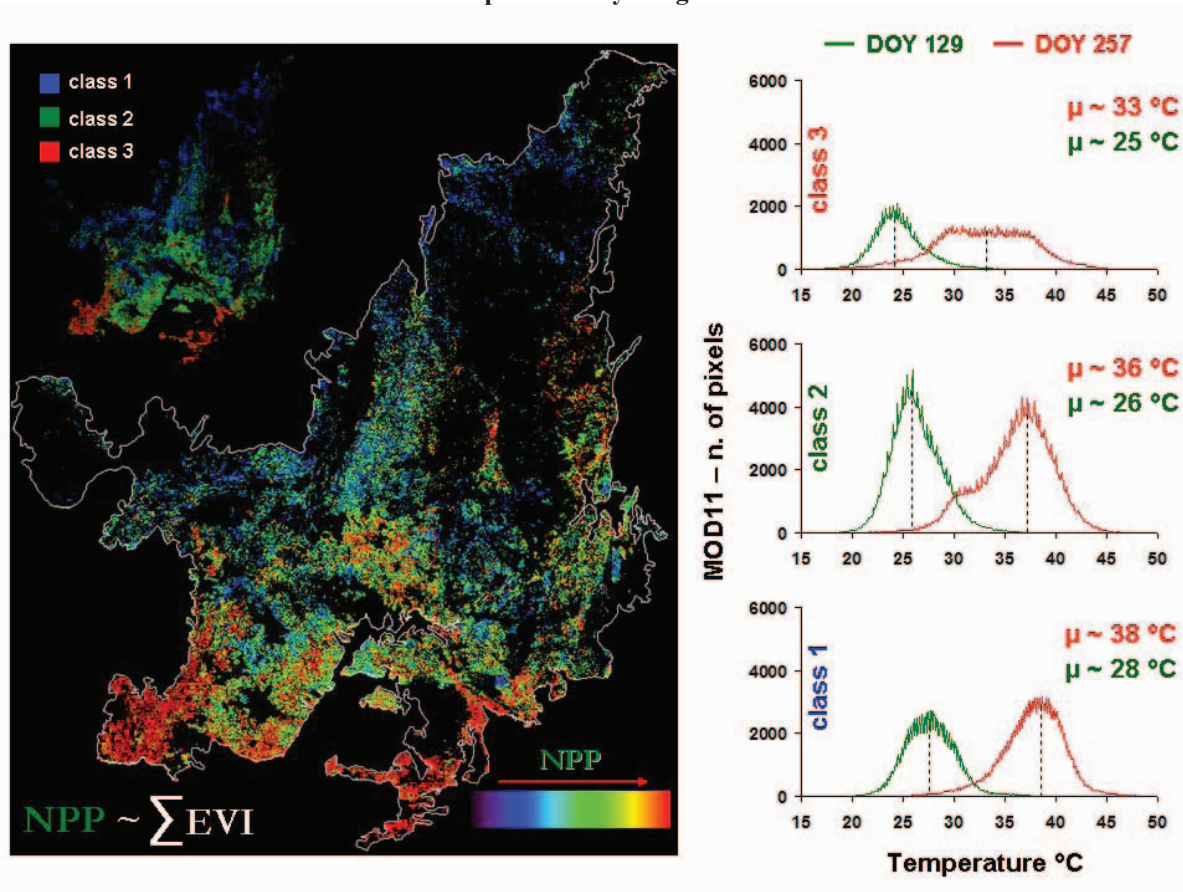

Figure 3 – EVI-based pasture productivity image and associated wet and dry season LST distribution values according to the major net primary productivity (NPP) classes (upper left corner). μ = mean temperature.

4. CONCLUDING REMARKS

Cultivated pastures are the dominant land use unit in Brazil. In the Cerrado, with about 44% of the Brazilian cattle herd, pasture is still the major driving force behind the ongoing clearings. For the 2002 – 2008 period, preliminary assessments estimate an increase of about 48,000 km^2 in grazing area. Therefore, pasture quality assessments, based on biomass / productivity estimations are instrumental in promoting more efficient and sustainable herd occupation, and, most important of all, more appropriate land use destination. In addition to higher revenues related to better management practices, improved quality pastures may hold significant environmental value, in support to REDD-like economic mechanisms (REDD = Reducing Emissions from Deforestations and Forest Degradation). In fact, we may even think, in the near future, in a REDD derivation, focused on Reducing Emissions from Pasture Degradation (REPd).

5. REFERENCES

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