CONSERVATION STATUS IN THE BRAZILIAN AMAZON FOREST-CERRADO TRANSITIONAL AREA USING REMOTE SENSING AND GIS TECHNIQUES

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INTRODUCTION

Approximately 250,000 km^2 of Amazon Forest was deforested between 1990 and 2003 (Laurance et al., 2004). The status of the Brazilian Cerrado is even more worrisome; in 1998, it was ranked as the twelfth most threatened biodiversity hotspot on the globe (Mittermeier et al. 1998). Mato Grosso State overlaps both the Amazon and Cerrado biomes and includes a vast extension of transitional or ecotonal zones at the interface between forest and Cerrado.

Recently, Mato Grosso gained international notoriety due to the rapid expansion of soybeans and other large-scale agriculture that contributed to record high rates of deforestation (Morton et al. 2006). Given its position along the arc of deforestation, a Conservation Units System (CUS) is a key priority for biodiversity conservation among the diverse biomes in the state. As this area lacks species distribution data and spans large territorial dimensions, this study analyzes the current representativeness of the existing CUS and the landscape structure. Representativeness approach indicates the amount of complementary area need for the CUS efficiency while the landscape structural metrics approach retrieves the best complementary sites design.

MATERIAL AND METHODS

The state of Mato Grosso is situated in the western-central region of Brazil, at 06° to 19° South and 50° to 62° West, and has an area of 903,358 km2 (IBGE, 2000). The main vegetation types are ombrophyllous forest, seasonal forest, cerrado savanna, and large ecotones areas. The climate is humid in the northern part of the state (maximum of two months of dry season), becoming less humid in the central and south part of the state, where the dry season is longer. Nevertheless, it is common to consider that the dry season lasts from May to September, while the wet season goes from October to April (Velloso et al., 1974).Current land cover was determined by updating a potential vegetation map to include anthropogenic areas using multi-temporal MOD13A1 MODIS sensor data from 2003-2004. Cropland areas were identified using Enhanced Vegetation Index (EVI) images acquired during the crop season (September 2003 - March 2004). Deforestation areas were mapped using the soil fraction image generated by a linear mixture model (Shimabukuro and Smith, 1991). These two classes were then incorporated into the potential vegetation map. Then the resulting map consisted on seven vegetation type classes, three transitional zones, and two land use classes.

In addition to the generated land cover map, current maps of Conservation Units (CUs) and Indigenous Lands (ILs) were used. GIS tools were then used to evaluate CUS representativeness for the existing vegetation types of the study area.

We computed four landscape metrics for each land cover classes: percentage of landscape covered by class (PLAND); Largest Patch Index (LPI); Core Area Index (CAI); and Proximity Index (PROX). The CAI metric was calculated using an edge buffer of one pixel (i.e. 250m). For PROX, we used a search radius of 5km. See McGarigal and Marks (1995) for more details about metrics formulae and results behavior.

RESULTS AND DISCUSSION

Nearly half of the initial area of all major biomes in Mato Grosso were converted to other land uses by 2004 (Cerrado = 45%; Forests = 46%; Ecotones = 46%). Of the estimated 55% of remaining natural vegetation cover, only 3% of original vegetation areas are currently included in existing CUS, and not all vegetation types are covered by the CUS.

By adding ILs as conservation sites, the area protected increased to 16% of original vegetation cover, representing all vegetation types. However, our results also indicated a failure of on-the-ground conservation and protection efforts, since 6% of CU and 9% of IL areas were in fact anthropogenic zones. In all, 750 ha of croplands were mapped within the CUs and roughly 87,000 ha within ILs.

Remaining areas of natural vegetation small and compact, but fragmentation effects vary widely among biomes. The greatest LPI index values were for Open Rainforest (6.09%) and Rainforest-Seasonal Forest Ecotone (2.11%). Mean CAI presented values between 68% and 91%. These results suggest that remaining patches have a compact shape. For natural formations, we show that PROX values were higher for open forest (PROX=22,619) and Rainforest-Seasonal Forest Ecotone (PROX=5,891) than for other biomes. Forested Savanna (PROX=107) and Savanna-Steppic Savanna (PROX=123) had the nearest neighboring patches.

CONCLUSION

Analysis of landscape structure showed varying degrees of integrity among the vegetation types, suggesting that it is a valuable tool to support the selection of conservation sites when considering factors such as habitat fragmentation and dispersal among patches. The analyses presented here will permit the development of selection criteria based on the patch size, shape, and connectivity data. In order to improve the effectiveness of the existing CUS, we suggest an increase in the total area protected by creating of new Conservation Units, since current ones do not protect a fully representative sample of vegetation types in Mato Grosso. New CUs could be established, in part, using the ecosystem types and structural metrics presented in this work. Nevertheless, such conservation measures will only be effective if they are jointly implemented with policy and enforcement actions capable of truly protecting the Conservation Units System.

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