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DEFORESTATION PLANNING FOR CATTLE GRAZING
IN AMAZON BASIN USING LANDSAT DATA

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1. INTRODUCTION

The Amazon tropical forest constitutes approximately 40% of Brazil's land mass and is a region of low population density, small number of urban areas and an under-development network of transportation. In an effort to stimulate the region's growth, the Brazilian Government has concentrated on a program of economic incentive to provide for the rational development of its natural resources.

Since 1972 the Brazilian Space Research Institute has been receiving multispectral remote sensing information from the LANDSAT orbital platform. Through the availability of repetitive observations (every 18 days), the LANDSAT system has become extremely important to the study of the process of settlement in areas of tropical forests.

The objective of the present research was to develop a methodology for the application of LANDSAT data to study the process of settlement and deforestation in a tropical rainforest of Brazil.

2. MATERIALS AND METHODS

The study area selected for this research is located in Mato Grosso State between the Xingu and Araguaia River Basins (Lat. S $11^{\circ}00' - 12^{\circ}30'$; Long. W $50^{\circ}30' - 53^{\circ}00'$). This particular forested area is of notable importance, as it has been rapidly cleared for the implantation of cattle grazing.

The study was conducted using LANDSAT system products. The necessary information for the development of this study was extracted from two LANDSAT MSS frames for two different periods. An interactive multispectral Image Analysis System (Image-100) was used to perform automatic interpretation.

Visual interpretation was performed on channels 5 and 7, black and white imagery, at the scale of 1:1,000,000. The most prominent features analysed were: drainage network, vegetative coverage and land use.

Channel 7 was used to map the primary streams, while secondary and less ordered streams in areas of sparse vegetation were mapped in channel 5 (Valerio Filho et al, 1976; Koffler, 1976). The drainage map was produced at a scale of 1:1,000,000. The hydrologic characteristics of the region were analysed qualitatively. The purpose of this study was to subdivide the study area into zones of superficial drainage patterns and stream distributions which would facilitate locating favorable areas for cattle grazing.

A visual analysis of channel 5 provided for the separation of homogeneous vegetation areas, as this band displayed large differences in spectral responses among different vegetation types. Tonality differences

in channel 7 provided for identification of vegetation in periodically inundated areas, riparian vegetation, as well as areas in which the vegetation distribution is associated with varying soil humidity.

A classification system was established, to survey land use patterns, for two different periods: July, 1973 and August, 1976. To inventory land use features, channels 5 and 7 were used at scale of 1:1,000,000 and 1:250,000. Areas of improved pasture were estimated, using a 1 x 1 mm dot grid overlay. Visual analysis of channel 5 clearly showed transportation system, urban areas, location of ranch facilities and airstrip.

A field itinerary was then designed to include as many representative sample areas as possible. This was completed in two separate phases: a low altitude flight and a field reconnaissance by car, afterwards; final boundaries and a classification system were defined for vegetation cover types and land use according to the data collected from the field work.

During the field trip (Tardin et al, 1976) it was observed that several deforested areas initiated a natural regrowth without the presence of seeded grasses. This observation led to the separation of unimproved and improved rangeland, which were also distinguished in channel 5 of LANDSAT imagery and assigned to Image-100 system (G.E., 1975) for classification.

3. RESULTS AND DISCUSSION

3.1 Drainage Network

The drainage network is a feature easily identified using LANDSAT imagery. It was consequently used as a base data for the construction of overlays. It was also utilized to separate homogeneous zones, based on superficial drainage patterns, with the objective of locating pasture areas.

The distribution and configuration of the river systems were found to be one of the most important factors in locating pasture areas, considering the necessity of a constant supply of water for cattle (Petrone, 1970; Keller, 1970). The criterion for deciding which zones were most favorable for pasture establishment were: size of the streams, intervals among the streams, streams distribution and headwater regions.

The qualitative analysis of the drainage network patterns permitted the identification of four zones.

The high potential zone for the localization of pastures was characterized by medium-sized streams, regularly distributed and regularly spaced. The zone of low utilization was characterized by small and intermittent streams, poorly distributed streams and headwater regions.

3.2 Vegetative Coverage

The vegetation survey was conducted with the objective of identifying areas with vegetative coverage favorable to deforestation and pasture land establishment.

The use of dry season imagery revealed the associations between plant formation and water availability. Through image analysis the following vegetation types were identified: Dense Forest, Open Forest, Gallery Forest, Cerrado (Brazilian Savanna), Campos (Grassland), "Humid" Campos, "Humid" Campos - Cerrado and Floodplain Vegetation.

The criterion for choosing the type of vegetation most favorable for the implantation of pasture were: a) dense forest and gallery forest should be preserved, and b) the inundated areas were unfavorable for the establishment of pasture.

The areas considered for potential implantation were divided into three categories: High (Cerrado and Campos), Medium (Open Forest) and Low (Dense Forest, Gallery Forest, Humid Campos, Humid Campos - Cerrado and Floodplain Vegetation).

3.3 Land Use

The following land use classes were identified:

- 1) Cattle Ranching (Improved Pasture and Rangeland).
- 2) Constructed Areas (Ranch Complex and Urban Areas).
- 3) Occasionally occupied areas (Forest and Foodplain).
- 4) Transportation System (Road Systems and Airstrip).

A comparison between the land uses of 1973 and 1976 clearly demonstrates a large scale deforestation of the area, for pasture establishment and, consequently, an intensification of the construction of new roads and ranch complexes.

In the study area, deforested areas totalling 155,898 hectares (45 areas) in 1973 were augmented to 270,680 hectares (72 areas) in 1976, with a 74% increase. It was also observed that 27 new areas were cleared amounting 44,266 hectares, 11 remained stable while 14 increased more than 100% in size.

3.4 Automatic Interpretation

During the dry season the spectral response of grasses in pasture areas is affected by soil reflectance which showed light tones in channel 5. In contrasting dark tones of natural vegetation regrowth readily revealed areas that have been mismanaged, an analysis of pasture quality indicated the intense utilization after deforestation. These areas were automatically classified into: "pasture area predominantly grass", and "pasture area with predominantly arboreal regrowth".

For the sixteen sample areas (135,000 hectares of deforested areas) 87,202 hectares were under utilization during the period of study. Three pastured areas showed a regrowth more than 50% while improved pasture areas had a mean of 60% grass coverage.

4. CONCLUSIONS

The results obtained through this research showed that LANDSAT data can be utilized to develop monitoring programs in the tropical forest areas of Brazil.

This research did not show the total potential of LANDSAT system, but tried to open up new research aspects for the utilization of LANDSAT data in natural resource control.

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