The main objective of this presentation is to describe some experiences on the application of remote sensing data (MSS or TM/LANDSAT, HRV/SPOT and AVHRR/NOAA) as a tool in assessing changes in the use of Brazilian savannas. The approach adopted in this discussion exposes the use of orbital data in order to understand the geographical distribution of the savannas, to estimate vegetation biomass, to identify and evaluate burned areas, to monitor agricultural and reforestation activities in the savanna region.
EXPERIENCES IN ASSESSING CHANGES IN THE USE OF SAVANNA ECOSYSTEMS

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ABSTRACT

The main objective of this presentation is to describe some experiences on the application of remote sensing data (MSS or TM/LANDSAT, HRV/SPOT and AVHRR/NOAA) as a tool in assessing changes in the use of Brazilian savannas. The approach adopted in this discussion exposes the use of orbital data in order to understand the geographical distribution of the savannas, to estimate vegetation biomass, to identify and evaluate burned areas, to monitor agricultural and reforestation activities in the savanna region.

1. INTRODUCTION

The Brazilian savannas region (cerrados) has shown up as the best option for the broadening of the agricultural border. This growing land use increased the demand for research on the environmental variables which affect the productive system. Consequently, a continuous data collection on vegetation is necessary to monitor the savannas region. The savannas large territorial extension (approximately 1.8 million square kilometers) and their heterogeneity of the aspects make remote sensing technology an important monitoring tool.

Several researches have shown the accuracy of satellite data for studying vegetation and land use cover, primarily on a regional approach, using MSS and TM/LANDSAT images and more recently HRV/SPOT data. There are several data collection platforms with sensors of different spatial, spectral and temporal characteristics which are very useful to this study. The AVHRR/NOAA, for example, having less spatial detail than LANDSAT or SPOT sensors, but providing daily worldwide data collection, presents a great potential for monitoring macroregional vegetation and its dynamic.

The objective of this presentation is to describe some relevant experiences using multisensors data (AVHRR/NOAA, MSS and TM/LANDSAT and HRV/SPOT) for the assessment of the changes in the use of the Brazilian savannas. The contribution of the remote sensing data for mapping, estimation of vegetation biomass and their phenological conditions, detection and evaluation of the burned areas, monitoring of agricultural and reforestation activities in the savannas region will be analyzed in the final remarks of this work.

2. REMOTE SENSING DATA IN THE KNOWLEDGE OF THE GEOGRAPHICAL DISTRIBUTION OF THE BRAZILIAN SAVANNAS

The knowledge of the geographical distribution of the savannas, based only on physiognomical concept, is not adequate to
land use planning in order to develop agricultural activities. To create a wide view of the environmental conditions of this region, cartographic maps, at the scale of 1:5,000,000 were produced based on geological, geomorphological, climate and vegetation characteristics (Azevedo and Caser, 1980). In this approach, the maps related to vegetation were obtained through visual analysis of radar and satellite images (MSS/LANDSAT). These cartographic maps contain a macroregional study, where it can be observed that the climatic parameters enhanced the identification of the Brazilian savannas limits, i.e., the "core area" and the savannas under the influence of the Amazonic, northeast region, Atlantic meridional and South Continental climates. It is advisable that studies regarding to changes in the savannas land use, even those with more recent remote sensing data, be based on this macroregional approach.

Other researches using remote sensing data (MSS/LANDSAT) were carried out at the same time, but in a local level (Santos et al., 1980). Shuttle Imaging Radar (SIR-A) data of some Brazilian savannas areas were also compared to LANDSAT data aiming at the evaluation of the photointerpretative capacity of these orbital data regarding to the structural aspects of the vegetation (Balieiro, 1990).

3. REMOTE SENSING DATA APPLIED TO THE EVALUATION OF THE SAVANNAS BIOMASS

Considering that the vegetal cover reflectance is related to the foliar biomass, thus this parameter estimation can be used as a nondestructive method to evaluate the vegetation.

Several researches, including Tucker (1979), Weiser et al. (1986), suggest a broaden discussion about the spectral bands which would be best applied in the numerical model (vegetation index) and how they are related to the biomass. Prince and Astle (1986), studying woodland savannas areas in Botswana, concluded that the percentage of vegetation cover and green herbaceous biomass can be evaluated using the vegetation index "simple ratio" (R), using data of the MSS 7 and
MSS 5 sensors of the LANDSAT. Wispelaere and Fabregues (1986), estimating the forage resources on a steppe area vegetation (Tamesna - South of Niger), correlated biomass data (dry weight) to several vegetation indices obtained by field radiometer (correlated to the bands of the HRV/SPOT) and by MSS/LANDSAT and AVHRR/NOAA.

In the specific case of the Brazilian savannas, few works were developed until now.


Santos (1988, 1989) studying the savannas in the core area, the "woodland savanna" type, made an analysis of the relationship between the foliar biomass and the vegetation indices (simple ratio and transformed vegetation index) obtained by the Thematic Mapper/LANDSAT. The linear \(y = a + bx\) and exponential models \(y = ae^{bx}\) were used to analyze this functional relationship. The results shown that the TVI model can explain about 72% of variations found in the estimated biomass with a standard deviation of 12%.

All the methodological approaches described were developed for local level. Furthermore, they will be tested on a regional basis with the objective of establishing an operational procedure of the estimation and monitoring of the Brazilian savannas.

4. REMOTE SENSING DATA APPLIED TO THE IDENTIFICATION AND ESTIMATION OF BURNED AREAS

Some studies were first developed in the 70s, identifying and estimating savannas burned areas due to the availability of the MSS/LANDSAT data. This work continued, mainly regarding the National Parks monitoring, through the TM/LANDSAT data that presented a better spatial and spectral resolution than the MSS/LANDSAT. As an example,
it can be mentioned the studies of Ponzoni et al. (1986) in the Brasília National Park (Federal District) and Shimabukuro et al. (in press) in the Emas National Park (Goiás State), whose areas represent the savannas core domain. In these two studies, multitemporal TM/LANDSAT data were used. Besides using digital analysis (principal components) to analyze the temporal data of LANDSAT, Shimabukuro et al. (in press) performed a daily checking using AVHRR/NOAA data, since the beginning till the end of the fire actions.

The biomass burning, as a practice of land occupation and as a management of agricultural and pasture activities, is a cultural event. This practice has been studied due to the possible damaging effects in the environment, as the atmospheric pollution caused by the gases released during the burning.

Several questions need to be discussed. For example:
What is the percentage of burned areas in the Brazilian savannas nowadays? Where do the burned areas occur more intensely? What is the loss of biomass caused by fire action?

A methodological proposition to the biomass burning detection and quantification occurring in the "core" area of savanna, with multisensor data (AVHRR/NOAA and TM/LANDSAT) was presented by Pereira Júnior et al. (1989), during the 4th Latin American Remote Sensing Symposium, held in Argentina.

The fire points detected on AVHRR images will be plotted using a Geographical Information System (GIS) on a digital map, which contains the geographical distribution of the savannas. This macroregional approach is very important because nationwide experiments were being analyzed in relation to gases concentration (mainly ozone and carbon monoxide) in several Brazilian regions, with their different ecosystems, including the savannas and their influence on the local and global chemistry.
5. REMOTE SENSING DATA TO MONITOR AGRICULTURE AND REFORESTATION AREAS

The major cause of the increasing crop activities over savannas region is due to federal funds delivered to the regional development programs. The success of these programs implementations reflects different capacities of integration in the national economic system. Such differences can be detected through the monitoring of crop area expansion and the analysis of spatial pattern of human activities using TM/LANDSAT and HRV/SPOT images.

The effects of the high technology level used for agricultural exploration, as well as areas of marginal development and under integrated development process, according to Gusmão's classification (1980), can be seen over large savanna areas.

Recently, TM/LANDSAT images 1:250,000 scale were used to measure deforestation areas in the Legal Amazonia. In this analysis one can verify that savannas areas are close correlated to the national agriculture activity and strongly integrated to the rural development.

The microregion of Federal District, with a high level of technology, has been frequently studied using remotely sensed data for crop management purposes as a component of a large Agriculture Information System (SIAG). As an example, TM/LANDSAT data have been analyzed in this system to identify and estimate soybean and corn areas through the sampling techniques of "direct expansion" (Moreira, 1990).

Some studies using vegetation index determined from LANDSAT and SPOT data have been investigated to classify corn and soybean with low and high biomass.

Also, orbital data acquired over savannas region have been studied to detect the irrigated areas during the dry season.
Remote sensing data are being used for mapping, inventory and monitoring of reforestation with *Eucalyptus* sp. and *Pinus* sp. in savannas areas (Hernandez Filho and Lee, 1984). Studies dealing with reforested areas under stress conditions were also carried out.

6. **FINAL REMARKS**

The related experiences in assessing changes in the savannas land use through remote sensing data prove the great potentiality of this tool. Based on the knowledge of the savannas geographic distribution and on the present availability of the remote sensing data, with their spectral, spatial and temporal characteristics and synoptic view, including the development of the new orbital sensors systems (for example SAR satellite), procedures can be established to keep a continuous monitoring and evaluation of anthropic activities in the savannas.

The great volume of available orbital data from the savannas region oblige the researchers who work in this field to look for the dynamism of the extraction and use of the information obtained through these techniques. To accomplish the monitoring operational process and real planning of the human occupation in the savannas region, a serious research of top priorities, on a regional or local approach, will be demanded.

It is important to notice that studies should be undertaken in the savannas areas under climatic influences different from that of the core area, due to the fact that these areas are under ecological hazards causing intense integration to the regional productive process.
7. REFERENCES


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