CLASSIFICATION OF THE PANTANAL WETLANDS DURING HIGH WATER BASED ON SPECTRAL MIXTURE ANALYSIS OF LANDSAT THEMATIC MAPPER DATA

CLASSIFICACÃO DA PLANÍCIE PANTANEIRA DURANTE UM PERÍODO DE CHEIAS USANDO "SPECTRAL MIXTURE ANALYSIS" EM DADOS DE LANDSAT TM

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ABSTRACT

The Pantanal region of approximately 140,000 km2 is subjected to annual and multi-annual cycles of flooding due to the hydrologic and geomorphic characteristics of the area (Adamoli 1986; Hamilton et al. in review). For example, the low gradient of the entire landscape leaves few natural barriers to high flows. Apparently, recent changes in flood patterns in areas influenced by individual drainage systems like the Taquari River, have created significant discussion regarding the nature of these changes and their relation to management of the wetland area. In order to monitor these changes and to determine their cause, it is important to have an accurate classification of the wetlands. Vila da Silva and Kux (1991) report on a moderately successful classification of a portion of the Pantanal wetlands, close to the Miranda River. They found the greatest success and consistency in classification with low-water, dry season images. High water images with significant areas of inundation were less amenable to the classification techniques (both supervised and unsupervised) that they applied.

To determine whether changes in hydrology are occurring in a landscape due to either natural or anthropogenic causes, requires methods for monitoring the patterns of flooding at high water. We have successfully applied the technique of spectral mixture analysis (Mertes et al. in press; Mertes 1994; Mertes et al. 1993) to Landsat Thematic Mapper and Multi-Spectral Scanner images recorded during high water in the wetlands of the mainstem of the Solimoes-Amazon River. For the Amazon wetlands, resulting classification categories include herbaceous, woody, and senescent vegetation and absolute sediment concentration for surface waters. We report in this contribution on the application of spectral mixture analysis to a Landsat Thematic Mapper image recorded April 6, 1988, during extensive inundation of the Pantanal landscape. A brief description of spectral mixture analysis is followed by a discussion of the significant results.

Briefly, spectral mixture analysis accounts for the pixel-by-pixel variation in the mixture composition by calculating the least-squares, best fit for each pixel along mixing lines bounded by spectra for endmembers. An endmember ideally represents a pure component of the mixtures present in the pixels of the image, e.g., soil or water. For a multispectral image the image endmembers represent the purest sample of each component on the image. Image endmembers are similar to training data selected for use in other classification procedures such as maximum likelihood (Jensen 1986), but differ in that ideally they represent one component of a landcover mixture like soil. Training data will often represent the entire mixture, e.g., forested wetland.

The result of the spectral mixture analysis is a "fraction" image for each endmember. These fraction images show on a pixel-by-pixel basis the proportion (from 0 to 1.0) that is contributed by the spectra of the corresponding endmember. For example, a pixel from clear water would have fractions of 1.0 shade, 0 sediment water, and 0 vegetation. A pixel from a moderately dense, dry forest might have fractions of 0.2 shade, due to self-shading by leaves and branches, 0.2 sediment water, due to reflectance from soil visible through the canopy, and 0.6 vegetation.
The fraction images can be viewed and interpreted individually or can be combined to provide an overall landcover classification from the processed image data.

We based our analysis on bands 3, 4, and 5 from the Landsat TM image (Path 226/Row 73) of the Pantanal region centered on the Taquari River. We chose three image endmembers from the uncalibrated image. These endmembers include, sediment laden water (sedwater) with brightness values (DN's) of 59, 23, and 3, respectively for Bands 3, 4, and 5. For vegetation (veg) we selected a pixel with DN's of 20, 77, and 59. For clear water (clearwater) we selected a pixel with DN's of 13, 8, and 3. With these endme.nbers we were able to separate sediment-laden river water from other water types and several vegetation categories, including forest (cordilheiras), natural pastures (pastagems naturais), and cultivated pastures (pastagems cultivadas). Although we can only approximate the exact inundation boundary, we can distinguish flooded from non-flooded areas.

The most important result for the hydrologic analysis, is that we were able to distinguish the approximate boundary of the incursion of sediment-laden Taquari River water into the surrounding wetlands during this flood. Across the image the Taquari River changes from a meandering, single-thread channel that averages approximately 200 m in width, to a distributary system covering tens of kilometers of wetlands with channels that range in size from a few meters to 200 m in width. In several locations there are levee breaks or other places where the river overtops its banks. We approximate that on average the direct influence of sediment-rich river water, as shown by a high concentration of sediment in the sedwater fraction image, extends less than 10 times the width of the channel. Hence, the direct influence of the river water in a given year is on the order of 2 to 4 kilometers on either side of the channel.

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