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Comparison of two summer crop mapping methods in the state of Paraná in 2008

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Abstract

The accuracy of crop mapping is still very dependent on the quality of processing remote sensing data, so the objective of this paper is to compare the accuracy of two different methodologies for mapping summer crops in the State of Paraná, Brazil. EVI (Enhanced Vegetation Index) images were used for this purpose, following these methodologies: classic mask generation by the difference in EVI this methodology were used in some studies such as (Schroeder et al. 1999; Labus et al. 2002; Jakubauskas et al, 2002;Fontana et al, 2007), and the RGB method, as used by Johann et al (2011).The quality of the methods was measured using higher spatial resolution images (LANDSAT and AWIFS / IRS) as a reference to calculate the Kappa Index (KI) (Congalton, 1991), Overall Accuracy(EG), omission (EO) and commission (EI) errors. With 400 random samples for each mask, an error matrix was drawn up. The results for the classic methodology presented values of: KI=0.78, EO=11% and EI=11%, while the RGB methodology presented a KI=0.895, EO=6.1% EI=5.9%. KI was 12.8% higher for the RGB methodology as EO and EI were 4.9% and 5.1% lower, respectively. The RGB method presented a greater accuracy potential than the conventional method.

Keywords: Mapping, Crops, Paraná, EVI, Kappa Index

1. Introduction

In 2010, the state of Paraná became the largest grain producer of the country, accounting for 21% of national production. The summer crops were responsible for 27 million of 30 million tons produced in the harvest season, thus showing their importance. Analyzing and monitoring these crops contribute to strategic actions to estimate harvesting and production. Current methods of forecasting crops are based on surveys with farmers and the use of historical data which may be subjective and imprecise.

The current political and economic scenario regarding agriculture requires flexibility and quality on the decision making for data acquisition. The estimation of cultivated area is extremely important for planning the crop season.

There are two methodologies that are most widely used. The first entails classifying areas using maximum and minimum EVI values. The second methodology involves creating one composite of all minimum EVI images of the crop season and another composite for all the maximums. A contrast image of these composites is then reclassified using threshold values. Since the RGB method consists of creating a new RGB image with the same composed images of the previous method (maximum composite was placed in the R channel and the minimum composite in G and B channels).

2. Proceedings

The study area comprises the entire State of Parana in southern Brazil, situated between the latitude22°29'Sand 26°43'Sand longitude48°and 54°38'2'W. For mapping and estimating planted area of soybean and corn in summer, in the State of Paraná, the MODIS images were used, product MOD13Q1 the "Tile" h13v11 (NASA, 2009). This product contains the compositions of 16 days images of EVI with a spatial resolution of 250m.

After extraction of the product for all EVI 23 images of the crop season 2007/08 (Scene 214/2007 to 225/2008), these were cropped, collected and analyzed. However, for this study only the scenes from 241 (08/29/06) to 113 (04/23/07) were used, generating the multi-temporal spectral profile of EVI as shown in Figure 1.

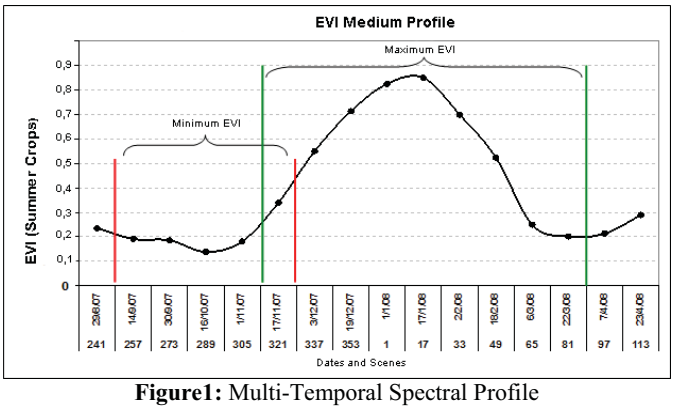

Figure1: Multi-Temporal Spectral Profile

2.1. Difference of EVI Values Mapping Method

This method is described by (Fontana et. al. 2007, Schroeder et al. 1999; Labus et al. 2002; Jakubauskas et al, 2002; Rudorff et al. 2005; Yi et al, 2007). It entails processing the EVI images, generating the following:

• *Seasonal Image*: 16 bands (each 16-day composite image from 29 August to 23 April was associated with a band), representing the seasonal variability of the Vegetation Index (VI) during the cropping season;

• *Maximum Image*: Composition of 9 bands (images 321 to 081),represents the vegetative peak during the cropping season;

• *Minimum Image*: Composition of 5 bands (images 257 to 321), represents the lowest vegetative growing condition in the cropping season;

• *Difference Image*: one band (variance between Maximum and Minimum images), used to formulate the cropping mask.
• *Integrated Image*: one band (integration from the beginning to the end of the crop season), summarizes all the cumulative VI behavior during the cropping season.

The next step in processing is the definition of the cropping mask. In order to do these thresholds from minimum and maximum values must be defined. Figure 2 shows the points "B"(minimum value) and "A" (maximum value) respectively. Analyzing the images, the values 0,55 and 1 were chosen.

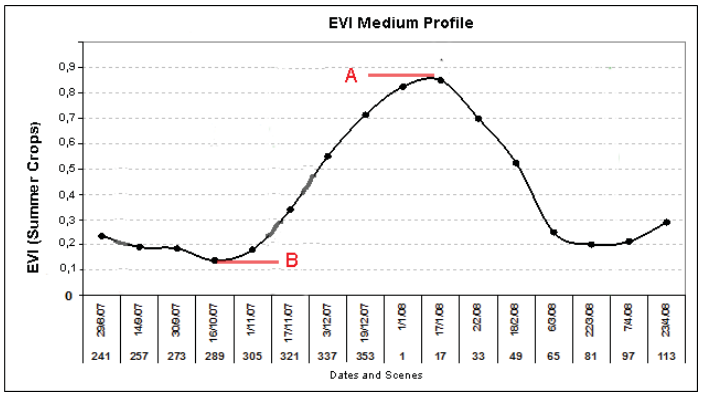

Figure 2: Maximum and Minimum Threshold Values

2.2. RGB Mapping Method

This method uses multiple dates to map cropland areas (masks). The procedure consists of using multiple images to generate the "Minimum EVI Image" and "Maximum EVI Image", thus making a composite of these images.

For composition of these images, as illustrated in Figure 1, scenes 257 (29/08/07) to 321 (17/11/07) were used to generate the "Minimum EVI Image" and scenes 321 (17/11 / 07) to 81 (03/22/08) to generate the "Maximum EVI Image". This ensured coverage of the minimum and maximum was considered for considering crop from different regions of the state, taking in account that date of planting and types of cultivars are not uniform. Using the program ENVI, the "Maximum EVI Image" was used in the R channel, while the "Minimum EVI Image" was used in the G and B channels of the color composite. Assisted by a system of extracting image data developed by (Esquerdo, 2007) in IDL, this RGB composition was manipulated with thresholds values that extracted cropping areas by grayscale values (NC). Threshold values were then generated for CN (0-255) ensuring only values which represent summer crops, this means that CN values restricting maximum and minimum EVI values are able to make this separation.

2.3. Evaluation of Results

The verification and evaluation of results were based on the Overall Accuracy (EG) and the Kappa Index(KI) (Congalton, 1991), both are generated by the comparison of the mask with reference images from thesensorsLandsat5-TM and IRS-AWFiS.

The method of using the Kappa statistics favors the visualization of the results of thematic classification and expresses the relationship between the errors associated with the classification system, the commission (EI) and omission (EO)(CARD, 1982). Highest values of commission error means that the mask

covered more area than the reality while highest values of omission error means that the mapped area is smaller than reality.

3. Results and Discussion

3.1. Crop Maps

Based on the two methodologies of mapping cropland areas, crop maps were compiled. Both maps were created with same date range and vegetation index. The comparison was carried out in order to check the accuracy of the methodologies.

Figure 3 shows the map created by "Difference of EVI Values Mapping Method", and Figure 4 shows the map created by the "RGB Mapping Method".

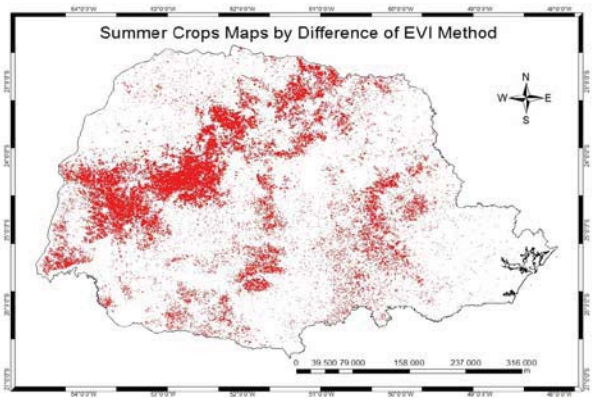

Figure 3: Summer Crops Map by Difference of EVI Method

It is possible by means of visual analysis, to infer that Figure 3 mapped less area than Figure 4. The total area of Figure 3 is covered by Figure 4 and more area is mapped, that means both methods are covering production areas.

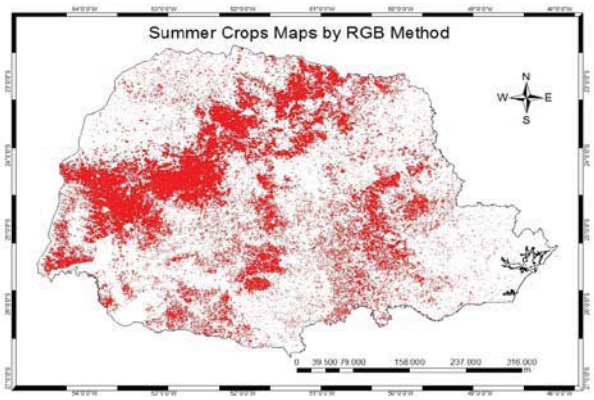

Figure 4: Summer Crops Map using the RGB Method

3.2. Evaluation of the Maps

To evaluate the accuracy of the maps, 400 random points were chosen for each map, 200 inside the mask and 200 outside the mask, to do the comparison between

the maps and high resolution images. The results of this comparison are shown in Tables 1 and 2. To do the analysis, not only the KI values are studied, but the commission and omission errors. EI and EO are the best way to compare mapping methods because they can show overestimating and underestimating on evaluation.

Table 1: Error Matrix for Summer Crops Map by Difference of EVI Method

	REFERENCE (Landsat+AWiFS)			
CLASSIFIED (Mask)	Summer Crops	No Summer Crops	Total	Commission Error
Summer Crops	**178**	22	200	11,0%
N_SCrops	22	**178**	200	11,0%
Total	200	200	**400**	
Omission Error	11,0%	11,0%		
Overall Accuracy: 89,00%				
Kappa Index: **0,7800**				

Table 2: Error Matrix for Summer Crops Map using the RGB Method

	REFERENCE (Landsat+AWiFS)			
CLASSIFIED (Mask)	Summer Crops	No Summer Crops	Total	Commission Error
Summer Crops	**191**	12	203	5,9%
N_SCrops	9	**188**	197	4,6%
Total	200	200	**400**	
Omission Error	4,5%	6,1%		
Overall Accuracy: 94,72%				
Kappa Index: **0,8945**				

Kappa Index (KI) (Congalton, 1991), omission (EO) and commission (EI) errors were calculated from the Error Matrix.

The results presented a KI=0.78, EO=11% and EI=11% for the classic methodology, while the RGB methodology have presented KI=0.895, EO=6.1% EI=5.9%. KI was 12.8% higher for the RGB methodology as EO and EI were 4.9% and 5.1% lower, respectively.

The RGB method has presented a greater accuracy potential than the conventional method. The response for that is in the proper methodology which in using several scenes to build the map, contemplating many dates allowed to consider different planting dates.

4. Conclusions

The RGB Mapping Methodology has presented a higher potential for mapping summer crops than the Difference of EVI Values Mapping Method for the state of Paraná – Brazil. That method showed better results in KI, EI and EO, presenting a greater accuracy than the alternative.

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