

# **SPECTRAL-TEMPORAL SERIES OF EVI/MODIS TO IDENTIFY LAND USE COVER CHANGED TO SUGARCANE**

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Biofuels might have a potential benefit to the environment if they actually mitigate greenhouse gases emissions. This issue has been widely discussed among both scientists and policy makers and there are still controversies mainly due to the direct and indirect effects of land use change that can negatively impact the environment [1]. A yearly updated thematic map of sugarcane crop area, including the annual sugarcane crop expansion, in the entire South Central Region of Brazil, has been published since 2003 by the Brazilian Space Research Institute (INPE) through the Canasat project using remote sensing images from Landsat-5, CBERS-2 and -2b, and DMC satellites (<http://www.dsr.inpe.br/canasat/eng>). The information derived by this project has been used in Brazil, not only by the private industry related to sugar and ethanol production, but also by government and non-governmental agencies related to environmental protection and food production. In Brazil, this is the region of major sugarcane cultivation and by far the most important region for recent (last five years) and future sugarcane crop expansion. Currently, Brazil cultivates 5.6 million ha of sugarcane in the South Central Region from which 3.3 million ha are used to produce ethanol. Only during the last two crop years about 2.1 million ha were added to the sugarcane cultivated area in this region. The sugarcane crop expansion is a dynamic process that has to be monitored over several years in order to detect the correct land use change. This information is useful to establish and implement public policies related to food security and to land use zoning. [2] pointed out that the direct effects of land use conversion from both grain (annual crops) and pasture to sugarcane crop, and the indirect pressure that they put on deforestation as being a negative point for biofuels production in Brazil. [3] analyzed the land use conversion from: annual crops, pasture land, forested and reforested areas, to sugarcane crop in the entire South Central Region of Brazil in 2007. They visually interpreted Landsat-5 images, acquired from 2005 on, in order to identify the prior land use in the 2007 expanded sugarcane crop area. The result was quite precise due to the careful visual interpretation of the multitemporal Landsat-5 scenes; however, this is a tedious activity and also a time consuming method. Furthermore, they used images, to identify land use

conversion to sugarcane crop, considering a single crop year to observe a dynamic process that often can take more than a single year. In this context, the present work has the objective to evaluate the use of spectral-temporal series of EVI/MODIS images to identify the land use cover change dynamic of the sugarcane crop expansion. For this study we selected an area located in the North Northwest of Paraná State (49°49'00" W to 53°47'00" W and 22°21'00" S to 24°34'00" S), which was responsible for 11.0% of the sugarcane crop expansion in the South Central Region of Brazil in 2007. The analysis was performed using EVI/MODIS compositions of 16 days from February of 2000 to August 2008. The Wavelets technique was used to reduce the noise in the image data set. According to the thematic map of the land use change, performed by [3], a total of 366 plots was converted to sugarcane crop in 2006 from which 195 (53%) were occupied with pasture land and 171 (47%) were cultivated with annual crops in 2005. Spectral-temporal series of medium EVI values (from 2000 to 2008) were obtained for each of the 366 plots. Reference spectral-temporal series for the year of 2005 were generated for annual crops and pasture land and the spectral-temporal series of each plot, prior to 2005, was analyzed using a k-mean algorithm to classify them into either annual crop or pasture land. As input parameters we used data from the period in which the greatest difference among the spectral-temporal series were observed. The classification result was evaluated using visual interpretation of Landsat images acquired in 2001 and 2002. From the evaluated plots, 91 (25%) were pasture land in 2001 that were gradually converted to annual crop until 2005. On the opposite, only three plots were annual crop in 2001 and gradually converted to pasture until 2005. Therefore, if we consider the baseline to be the year of 2001 instead of 2006 the land use change evaluation for annual crops would have 91 plots less, i.e. 80 (22%) and not 171 (47%) plots of annual crops were converted to sugarcane. In this case, [3] largely over estimated the land use changed from annual crop to sugarcane crop and that pasture is by far the major source of land used for sugarcane crop expansion to produce biomass for ethanol production. This is a strong indicator that ethanol production in Brazil can benefit the environment without major impact on environment and food security. Also, the spectral-temporal series of EVI/MODIS images are adequate to identify and correctly classify annual crops and pasture land providing an objective and relatively fast procedure to evaluate the land use changed to sugarcane crop over a wider range of crop years.

[1] Food and Agriculture Organization of the United Nations, *The state of food and agriculture*. FAO, Rome, 2008.

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