Land Use and Land Cover Change Due to Sugarcane Expansion Over the Last Decade in the South-Central Region of Brazil

Rudorff, B.F.T.; Aguiar, D.A.; Adami, M.; Mello, M.P.
National Institute for Space Research (INPE), Brazil

Introduction

The possible consequences of CO_2 enhancement in the atmosphere in response to the use of fossil fuels as well as the rise of oil prices have triggered a global interest in biofuels, since they are considered less pollutant and renewable sources of energy. Studies indicate a future replacement of 5% up to 50% of the global energy supply by biofuels. However, the effective reduction of global carbon emissions from biofuels production is highly dependent on the direct and indirect land use and land cover (LULC) change. Remote sensing imagery and Geographic Information Systems (GIS) play a major rule in issues related to direct and indirect LULC change. Brazil is the largest world producer of sugarcane and is likely to continue increasing its production in response to a potential world demand of ethanol and sugar. The Brazilian South-Central region has a favorable climate and plenty of land available to produce sugarcane. This region is responsible for about 90% of the Brazilian sugarcane production. A major expansion of 3.5 Mha in the sugarcane area was observed in the South-Central region between 2005 and 2010. The present work has the objective to analyze the direct LULC change in response to sugarcane expansion in the entire South-Central region of Brazil.

Results and Conclusions

Yearly thematic maps of sugarcane for crop years 2005 to 2010 derived from Landsat images were analyzed using time series of MODIS/EVI2 data from 2000 to 2009 to evaluate the LULC transition patterns. The wavelets technique was used to reduce the noise present in the MODIS temporal image data set. A total of 1035 pure pixels of MODIS images (250 x 250m) over the sugarcane expansion area were systematically sampled. Each MODIS pixel from the time series was carefully analyzed with the aid of several Landsat-5 TM images acquired on key periods in order to correctly identify the previous land use converted to sugarcane. Adopting the year 2000 as reference year for the LULC change analysis it was observed that: 69.8% of the converted sugarcane area was previously covered with pasture land; 26.2% was previously used by annual crops; 0.6% was previously covered by native vegetation; and 3.4 % was already covered with sugarcane that was being renovated to new sugarcane crop. In order to improve the physical soil characteristics it is a common agricultural practice to change the land use from pasture to annual crop (e.g. soybean) for one to two years before introducing the sugarcane crop. It was observed that 35% of the pasture land in 2000 was first converted to annual crops and then to sugarcane. New grassland for cattle pasture is currently being incentivized, in Brazil, by increasing the herd carrying capacity rather than converting new land (forest) into pasture land as was commonly done in the past. It was also observed that the 0.6 % of native vegetation changed to sugarcane was previously converted to either annual crop (33%) or

pasture land (67%). The results clearly show that the direct LULC change for the recent and major sugarcane expansion for ethanol and sugar production in the South-Central region of Brazil is predominantly occurring on pasture and agricultural land. This is a strong indicator that ethanol production in Brazil can benefit the environment without major impact on environment and food security. Also, the temporal series of MODIS/EVI2 data 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 years.

Author publications

1. RUDORFF, B.F.T.; ADAMI, M.; AGUIAR, D.A.; MOREIRA, M.A.; MELLO, M.P.; FABIANI, L.; AMARAL, D.F.; PIRES, B.M. The Soy Moratorium in the Amazon Biome Monitored by Remote Sensing Images. Remote Sensing, v. 3, p. 185-202, 2011.

2. EPIPHANIO, R.D.V.; FORMAGGIO, A.R.; RUDORFF, B.F.T.; MAEDA, E.E.; LUIZ, A.J.B. Estimativa de áreas de soja usando superfícies espectro-temporais derivadas de imagens MODIS em Mato Grosso, Brasil. Pesquisa Agropecuária Brasileira (Online), v. 45, p. 72-80, 2010.

3. ADAMI, M.; RUDORFF, B.F.T.; BREUNIG, F.M.; PONZONI, F.J.; GALVAO, L.S.; MOREIRA, M.A.; FREITAS, J.G.; SALA, V.M.R. Effect of nitrogen and endophytic bacteria on biophysical and spectral parameters of wheat canopy. Agronomy Journal (Print), v. 102, p. 544-552, 2010.

4. RUDORFF, B.F.T.; AGUIAR, D.A.; SILVA, W.F.; SUGAWARA, L.M.; ADAMI, M.; MOREIRA, M.A. Studies on the Rapid Expansion of Sugarcane for Ethanol Production in São Paulo State (Brazil) Using Landsat Data. Remote Sensing, v. 2, p. 1057-1076, 2010.

5. MELLO, M.P.; RUDORFF, B.F.T.; VIEIRA, C.A.O.; AGUIAR, D.A. Classificação automática da colheita da cana-de-açúcar utilizando modelo linear de mistura espectral. Revista Brasileira de Cartografia (Impresso), v. 62, p. 181-188, 2010.

6. ADAMI, M.; RIZZI, R.; RUDORFF, B.F.T.; MOREIRA, M.A.; FERREIRA, C.C. Amostragem probabilística estratificada por pontos para estimar a área cultivada com soja. Pesquisa Agropecuária Brasileira (Impressa), v. 45, p. 585-592, 2010.

7. AGUIAR, D.A.; SILVA, W.F.; RUDORFF, B.F.T. Monitoramento do modo de colheita da cana-de-açúcar no estado de Sao Paulo - Brasil por meio de imagens de sensores orbitais em dois anos-safra. Revista SELPER, v. 30, p. 34-43, 2010.

8. MOREIRA, M.A.; RUDORFF, B.F.T.; BARROS, M.A.; FARIA, V.G.C.; ADAMI, M. Geotecnologias para mapear lavouras de café nos estados de Minas Gerais e São Paulo. Engenharia Agrícola (Impresso), v. 30, p. 1123-1135, 2010.

9. ROSA, V.G.C.; MOREIRA, M.A.; RUDORFF, B.F.T.; ADAMI, M. Estimativa da produtividade de café com base em um modelo agrometeorológico-espectral. Pesquisa Agropecuária Brasileira (Online), v. 95, p. 1478-1488, 2010.

10. MURA, J.C.; PARADELLA, W.R.; DUTRA, L.V.; SANTOS, J.R.; RUDORFF, B.F.T.; MIRANDA, F.P.; SILVA, M.M.Q. ; SILVA, W.F. MAPSAR Image Simulation Based on L-band Polarimetric Data from the SAR-R99B Airborne Sensor (SIVAM System). Sensors (Basel), v. 9, p. 102-117, 2009.

11. LIMA, A.; AGUIAR, D.A.; RUDORFF, B.F.T.; SHIMABUKURO, Y.E.; ADAMI, M. Dinâmica Espaço-Temporal e Caracterização Ambiental do Cultivo da Cana-de-Açúcar na Bacia Pantaneira. Geografia (Rio Claro), v. 34, p. 193-202, 2009.

12. SILVA, W.F.; RUDORFF, B.F.T.; FORMAGGIO, A.R.; PARADELLA, W.R.; MURA, J.C. Discrimination of agricultural crops in a tropical semi-arid region of Brazil based on L-band polarimetric airborne SAR data. ISPRS Journal of Photogrammetry and Remote Sensing, v. 64, p. 458-463, 2009.

13. PICOLI, M.C.A.; RUDORFF, B.F.T.; RIZZI, R.; GIAROLLA, A. Índice de vegetação do sensor MODIS na estimativa da produtividade agrícola da cana-de-açúcar. Bragantia (São Paulo, SP. Impresso), v. 8, p. 789-795, 2009.

14. AGUIAR, D.A.; RUDORFF, B.F.T.; ADAMI, M.; SHIMABUKURO, Y.E. Imagens de sensoriamento remoto no monitoramento da colheita da cana-de-açúcar. Engenharia Agrícola (Impresso), v. 29, p. 440-451, 2009.

15. SANTOS, J.S.; PEREIRA, G.; SHIMABUKURO, Y.E.; RUDORFF, B.F.T. Identificação de áreas alagadas no Bioma Pantanal - Brasil - utilizando dados multitemporais Terra/MODIS. Geografia (Rio Claro. Impresso), v. 34, p. 745-755, 2009.