THE USE OF ALOS PALSAR IMAGERY FOR CERRADO'S LAND USE AND LAND COVER MAPPING

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1. INTRODUCTION

Synthetic aperture radar (SAR) data are promising for Cerrado's land use and land cover (LULC) mapping because they can obtain images regardless of climate season and allow physiognomy discrimination based on differences in plant water content, canopy density and structure [1]. However, interpreting SAR image is not an easy task [2]. This is especially true for highly heterogeneous Cerrado's vegetation cover. Previous studies (e.g., [3, 4]) have demonstrated the need of multipolarized SAR data to obtain improved LULC maps.

Recently, new satellites have been launched carrying out radar systems capable of acquiring images with four different polarizations: ALOS PALSAR; RADARSAT-2; ENVISAT ASAR; TerraSAR-X; and Cosmo-SkyMed. To date, there is no studies evaluating multipolarized SAR data for improved Cerrado's LULC mapping. This work addresses the potential of multipolarized ALOS PALSAR imagery to map representative LULC classes from the Brazilian tropical savanna.

2. APPROACH

The test site (~ 35 km x 65 km) corresponded to the area of Federal District of Brazil (FD) that was covered by the ALOS PALSAR image obtained in April 25th, 2007 (between 15º 32' 58" and 16º 02´ 55" of south latitude and between 47º 36' 32" and 48º 02' 01" of west longitude). The satellite data set corresponded to the HH-, HV-, and VV-polarized, ascending PALSAR data. The original 16-bit amplitude images were converted into backscattering coefficients ($\sigma°$) and georeferenced into the UTM projection system and WGS84 datum (zone: 23).

Based on previous studies [5, 6] and authors' field experiences, we selected 30 $\sigma°$ samples over the following LULC classes: consolidated urban areas; in-consolidation urban areas; Cerrado grasslands; Cerrado shrublands; croplands; indifferentiated forests; gallery forests; planted pasturelands; reforestations; and water reservoirs. The size of each sample was 64 pixels. The 30

samples were sorted according to the relative Euclidian distance calculated by the hierarchical cluster statistics [7]. The variables considered in this analysis were the average and corresponding standard deviation of 64 pixel values. HH-, HV-, and VV-polarized images were processed by the segmentation technique by growing region, available in the SPRING 4.0 image processing software [8]. Threshold and similarity values were set as 25 pixels. The segments were then exported as shapefile and visually interpreted in the computer screen with support of ArcView GIS 3.2™ software. The mapping accuracy was determined from the 86 field survey points and Tau (τ) index.

3. RESULTS & DISCUSSION

Results shown in Figure 1 indicate a clear possibility of discriminating water reservoirs from other LULC classes of study area. Water reservoirs present low $\sigma°$ values and overall smooth texture [9]. In this figure, it is also shown that, for a relative distance equal to 3, all classes were discriminated each other, except between cultivated pasturelands and Cerrado grasslands. However, the geometrical pattern of planted pasturelands is far more regular than that from the Cerrado grasslands. This criterium was used to discriminated between natural and planted grasslands in the visual interpretation step.
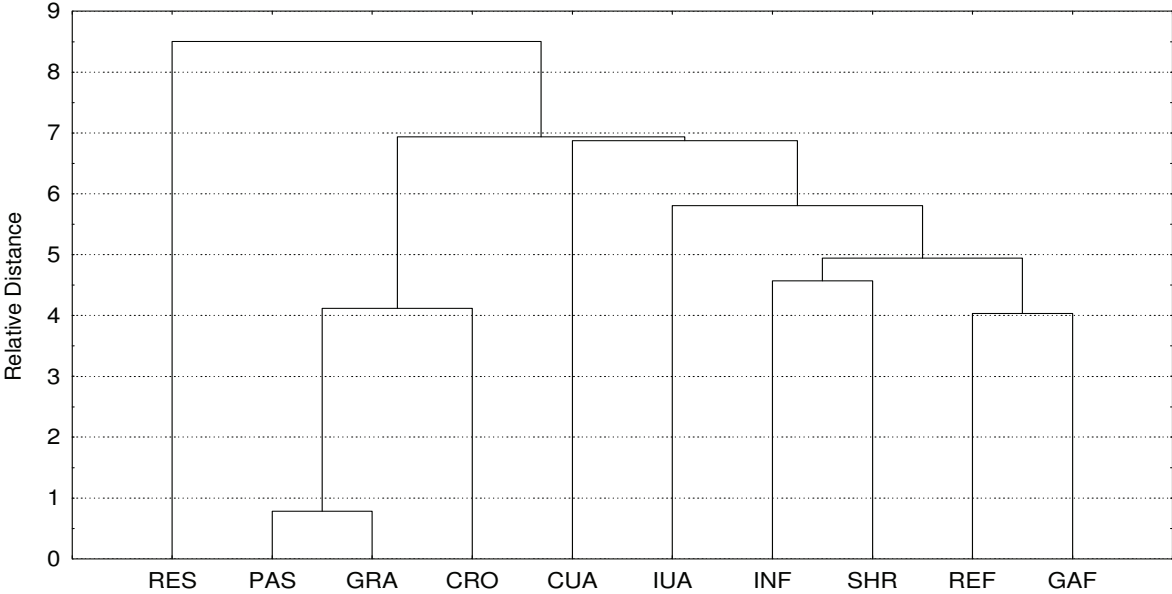

Figure 1 - Dendrogram showing the discrimination of land use and land cover classes of the study area. RES = water reservoirs; PAS = cultivated pasturelands; GRA = Cerrado grasslands; CRO = croplands; CUA = consolidated urban areas; IUA = in-consolidation urban areas; INF = indifferentiated forests; SHR = Cerrado shrublands; REF = reforestations; and GAF = gallery forests.

In Figure 2, we find the final LULC map of the study area. Natural vegetation cover (57%) was dominant in relation to the anthropic covers (41%). The most extensive LULC class was the Cerrado shrublands (22%), followed by the consolidated urban areas (16%) and by Cerrado grasslands (15%). The accuracy of map was 70%. The high spatial heterogeneity of Cerrado vegetation cover and the time delay between satellite overpass and field survey contributed to this relatively low accuracy. However, if the LULC classes are grouped into only three categories (natural vegetation, anthropic land cover and water reservoir), the τ index increases up to 84%. This study showed the potential of PALSAR images to produce improved LULC map of the study area.

5. REFERENCES

[1] Raney, R.K. Radar fundamentals: technical perspective. In: Henderson, F.M.; Lewis, A.J. (eds.). Principles and Applications of Imaging Radar. Manual of Remote Sensing. New York: John Wiley & Sons, 3rd ed., v. 2, Chap. 2, pp. 9–130, 1998.

[2] Moran, M.S.; Hymer, D.C.; Qi, J.; Kerr, Y. Comparison of ERS-2 SAR and Landsat TM imagery for monitoring agricultural crop and soil conditions. Remote Sensing of Environment, v. 79, pp. 243-252, 2002.

[3] Dobson, M.C.; Ulaby, F.T.; Pierce, L.E. Land-cover classification and estimation of terrain attributes using synthetic aperture radar. Remote Sensing of Environment, v. 51, pp. 199-214, 1995.

[4] Rignot, E.; Salas, W.A.; Skole, D.L. Mapping deforestation and secondary growth in Rondônia, Brazil, using imaging radar and Thematic Mapper data. Remote Sensing of Environment, vol. 59, pp. 167-179, 1997.

[4] Ribeiro, J.F.; Walter, B.M.T. As principais fitofisionomias do bioma Cerrado. In: Sano, S.M.; Almeida, S.P.; Ribeiro, J.F. (eds.). Cerrado. Ecologia e Flora. Brasília: Embrapa Cerrados & Embrapa Informação Tecnológica, Chap. 6, pp. 153-212, 2008.

[5] Araújo Filho, M.C.; Meneses, P.R.; Sano, E.E. Sistema de classificação de uso e cobertura da terra com base em imagens de satélite. Revista Brasileira de Cartografia, v. 59, pp. 171-179, 2007.

[6] Ferreira, M.E.; Ferreira, L.G.; Sano, E.E.; Shimabukuro, Y.E. Spectral linear mixture modelling approaches for land cover mapping of tropical savanna areas in Brazil. International Journal of Remote Sensing, v. 28, pp. 413-429, 2007.

[7] Moita Neto, J.M.; Moita, G.C. Uma introdução à análise exploratória de dados multivariados. Química Nova, v. 21, pp. 467-469, 1998.

[8] Camara, G.; Souza, R.C.M.; Freitas, U.M.; Garrido, J. SPRING: integrating remote sensing and GIS by object-oriented data modeling. Computer & Graphics, vol. 20, pp. 395-403, 1996.

[9] Lewis, A.J. Geomorphic and hydrologic applications of active microwave remote sensing. In: Henderson, F.M.; Lewis, A.J. (eds.). Principles and Applications of Imaging Radar. Manual of Remote Sensing, New York: John Wiley & Sons, 3rd ed., v. 2, Chap. 11, pp. 567-629, 1998.
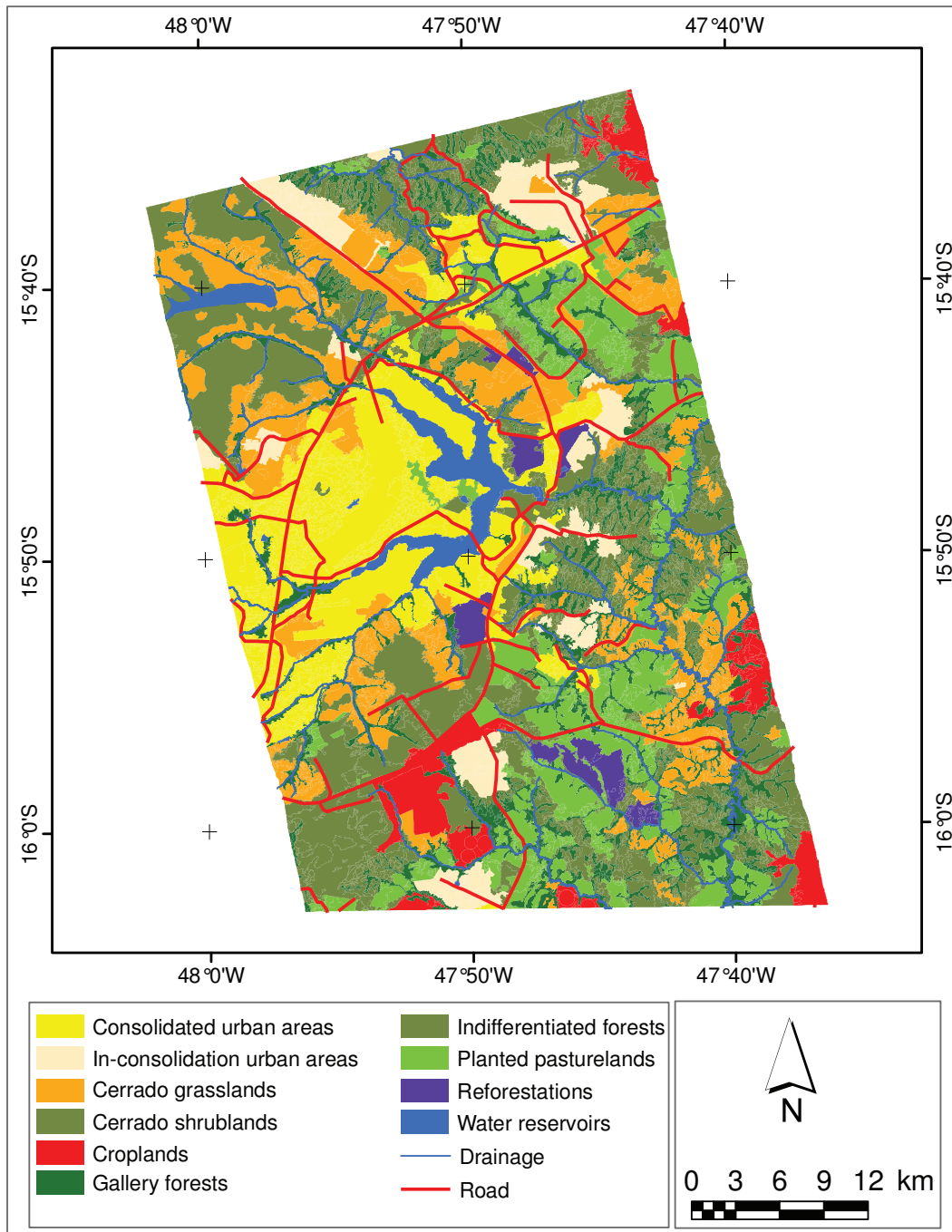
Figure 2 – Land use and land cover mapping of the study area, obtained from the ALOS PALSAR image interpretation (overpass: April, 25th, 2007, end of wet season).