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Object-based feature extraction of Google Earth Imagery for mapping termite mounds in Bahia, Brazil

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Abstract: This study investigates the potential of object-based feature extraction from Google Earth Imagery for mapping termite mounds. Termite mounds are often hotspots of plant growth (i.e. primary productivity). Accurate and timely information about termite mounds is crucial for land management decision-making and ecosystem monitoring. To address this issue, the effectiveness of object-based feature extraction that use automated image segmentation to extract meaningful ground features from imagery was tested. The study used very high resolution multispectral Google Earth images to produce termite mounds maps in Bahia, Brazil. The results from the study indicated that an object-based approach provides a better means for ground feature extraction than a pixel based method because it provides an effective way to incorporate spatial information and expert knowledge into the feature extraction process. Also the results suggest that Google earth imagery has considerable potential in mapping termite mounds.

Keywords: Object-based image analysis; Feature extraction; Remote sensing; Google Earth; Termite mounds; Brazil

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1. Introduction

Termite mounds are often hotspots of plant growth (i.e. primary productivity). Accurate and timely information about termite mounds is crucial for land management decision-making and ecosystem monitoring. Classification based on pixel-based approaches to image analysis is limited. Typically, there are considerable difficulties dealing with high resolution imagery. Advanced and mostly knowledge based methods seem to be more promising. Object-based image analysis combines spectral information and spatial information.

In remote sensing, the process of image segmentation is defined as “completely partitioning a scene into non-overlapping regions (segments) in scene space (e.g. image space)” (Schiewe, 2002). Our understanding on the segmentation is that semantic information to interpret an image is not represented in single pixels but in meaningful image object which can match with ground one in reality. Image segmentation takes into account criteria of shape and context information besides color statistics for the classification. Basic task of segmentation algorithms is the merge of (image) elements based on homogeneity parameters or on the differentiation to neighboring regions (heterogeneity), respectively similarity (Blaschke, 2000, Schiewe et al, 2001, and Schiewe, 2002). The study aimed to define feature extraction parameters for termite mounds mapping through the use of Google Earth Imagery in Bahia, Brazil. The extracted termite mounds can be combined with inputs from field studies and provide a basis for further spatial analysis and visualization.

2. Experimental Section

2.1. Study Area and Data

The study area (Figure 1) is Bahia, Brazil and one of the 26 states of Brazil. It is located in the eastern part of the country on the Atlantic coast. The actual testing site covers 0.77 square kilometers and is at latitude of -12.47 and a longitude of -41.64. The study area is mostly covered by forest and grass. Grassy termite mounds have a diameter ranging from 5 - 20 m. The remote sensed data used was captured from Google Earth Imagery on 10th January 2013. Google Earth provides 3 visible bands. The spatial resolution in the study area is 3.6 m.

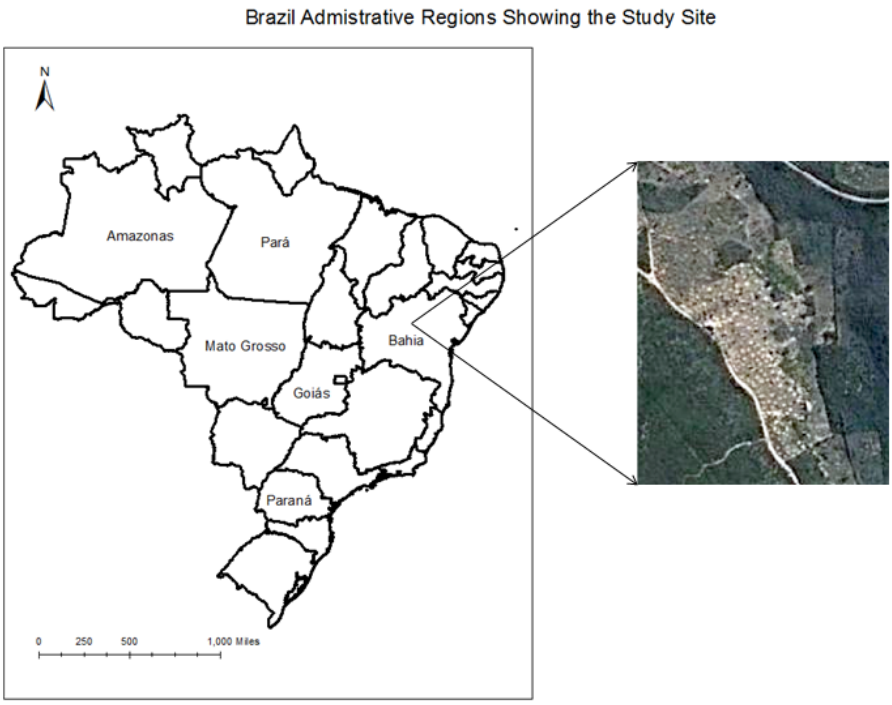

Figure 1. Study Area

2.2. Methods

For this study, Imagine Objective in Erdas 2011 version and later versions provide solutions to object-based image analysis for classification and feature extraction. In parallel some evaluation runs were carried out with ISODATA unsupervised classification for comparison purposes. Therese results are not reported here. Imagine Objective was used to define feature models employing different feature extraction methods. A feature model forms the basis for the extraction with the series of "Process nodes".

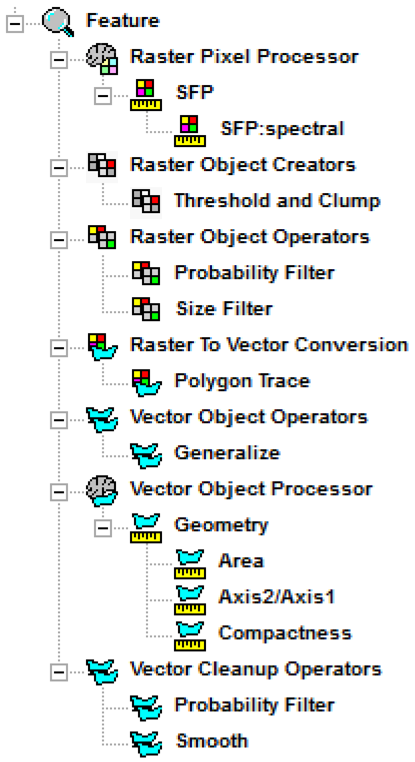

Figure 2. Feature model tree for termite mounds extraction

The following procedure describes the developed single class feature extraction for termite mounds (Figure 2): Step 1) Raster Pixel Processor: For this pixel based classification the SFP (single feature probability) was chosen, which uses a Bayes-classifier. The definition of training areas for termite mounds is important for the outcome; Step 2) Raster Object Creators: in this step, the function "Threshold and Clump" was used and assigns an average pixel probability (combined with results of step 1; Step 3) Raster Object Operators: Using "Probability Filter" and "Size Filter" allowed keeping pixel objects with high probability and a certain amount of pixels only; Step 4) Raster to Vector Conversion: with "Polygon Trace", raster objects were automatically vectorised converting objects; Step 5) Vector Object Operators: In this step, the vector objects are generalized which accelerates later processing; Step 6) Vector Objects Processor: This function processes geometric and textural features of the Vector Objects and writes the probability value for each feature to each object in an attribute table. This involves specifying area, Axis2/Axis1 and compactness cues. This was used by object classifier to measure shape and size property of the termite objects and uses the cues to assign a probability to each object in the group of vector objects. The cue algorithms quantify human visual characteristic by computing cue metrics and the object level cues.

3. Results and Discussion

In the study area, nearly 90% of the total termite mounds was identified and extracted with the feature model (figure 3) and the results from each step are presented in Figure 3. A manual comparison with the original image showed that a few clusters of the combined termite mounds were not extracted at the final step (from Figure 3, step 6).

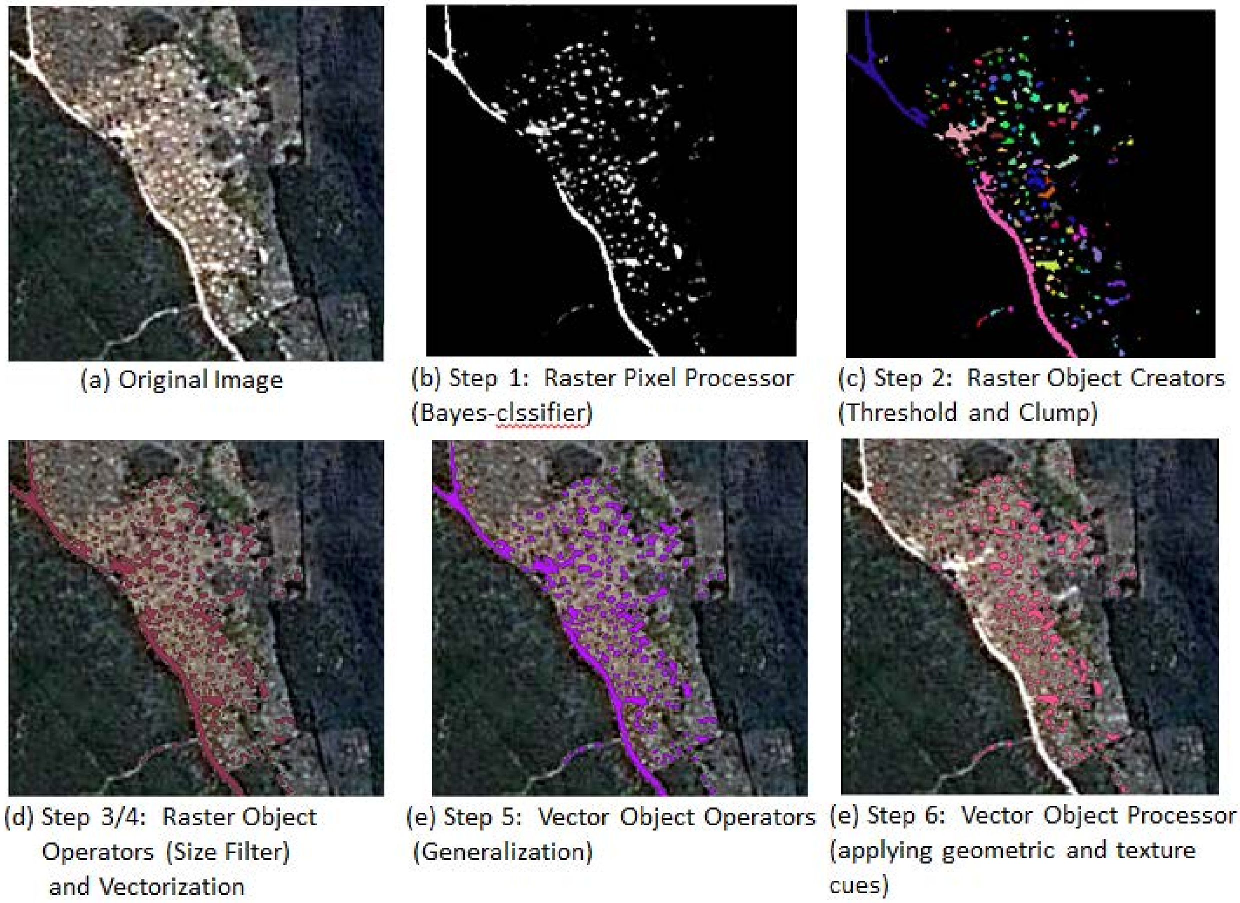

Figure 3. Step by Step termite mounds extraction feature model

It was found that large cluster of termite mounds have maximum 1122 square meters in size and 328 meters in perimeter, small cluster of termite mounds have 240 square meters in size and 72 meters in perimeter. Most termite mounds had an average compactness of about 0.7. An overall accuracy of 90% was achieved.

4. Conclusions/Outlook

The developed feature extraction model identified the termite mounds objects in the image in Bahia, Brazil with the overall 90% accuracy. The object-based feature extraction model by Imagine Objective can be applied to further study areas. In most cases, only the training process has to be adjusted. The study ensured the capability inherent with an object based image analysis using 3 visible bands-Google Earth Image.

Author Contributions

This work was performed in collaboration between the authors.

Conflicts of Interest

The authors declare no conflict of interest.

References and Notes

1. Blaschke, T.; Lang, S.; Lorup, E.; Strobl; J.; Zeil, P. Object-oriented image processing in an integrated GIS/remote sensing environment and perspectives for environmental applications. In: *Environmental Information for Planning, Politics and the Public.* ed.: Cremers, A. and Greve, K., Eds.; Metropolis, Marburg: 2000; Volume 2, pp. 555-570.

2. Mathieu, R.; Aryal, J.; Chong, A.K. Object-based classification of Ikonos imagery for mapping large-scale vegetation communities in urban areas. *Sensors* 2007, 7, 2860-2880

3. Ozdemir, I.; Norton, D.A.; Ozkan, U.Y.; Mert, A.; Senturk, O. Estimation of tree size diversity using object oriented texture analysis and aster imagery. *Sensors* 2008, 8, 4709-4724.

4. Schiewe, J. Segmentation of high-resolution remotely sensed data— concepts, applications and problems. In: *Joint ISPRS Commission IV Symposium: Geospatial Theory, Processing and Applications*, 9–12 July 2002 (on CDROM)

5. Schiewe, J.; Tufte, L.; Ehlers, M. Potential and problems of multi-scale segmentation methods in remote sensing. *GIS - Geo-Informationssysteme* 2001. 6, 34-39.

6. Sim, S. A proposed method for disaggregating census data using object-oriented image classification and GIS. International Archives of Photogrammetry, *Remote Sensing and Spatial Information Sciences*, 2005; XXXVI(Part 8/W27).