EVALUATION OF AWIFS BASED NEAR REAL TIME DETECTION SYSTEM USING LANDSAT LIKE DATA

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1. INTRODUCTION

It is estimated that in 1990 the rainforests covered and area between 11.5 and 12.4 million km² worldwide [1]. The Brazilian Legal Amazon (AML), has approximately 5 million km ², represents about 30% of the rainforests being the largest contiguous rainforest in the planet and home a vast biodiversity [2]. The AML has large biogeographic heterogeneity and had its human occupation processes resulting in a huge variety of deforestation patterns that may be associated with different actors, history and types of occupation [3-4].

To assess deforestation dynamics on the AML, Amazon Deforestation Monitoring Project (PRODES) provides detailed annual deforestation data. This project has the main objective of providing annual rates of gross deforestation [5]. PRODES delineates deforestation from Landsat and Landsat like satellites, such as CBERS and DMC, using a semi-automated interpretation approach [6].

Despite the critical importance of the PRODES project in forest monitoring and public policy design, it suffers from a relatively long delay between satellite observation and data consolidation. Hence the historical series and annual deforestation rates produced do not allow for a timely identification of areas in the initial or intermediate stages of degradation neither for the establishment of efficient preventive actions to control or reverse the deforestation process.

For this reason, the Near Real Time Deforestation Detection project (DETER) was implemented, this system has been responsible for fast and systematic deforestation survey of the AML, based on MODIS data [6-7] to map both, clear cut and forest degradation areas. However in the last decade PRODES historical series indicate a reduction of size on clear cut polygons [8] this reduction adheres to DETER a major limitation on deforestation mapping, since it is not possible to detect areas smaller than 25 ha [9-10].

Aiming to enhance the efficiency of its near real time detection system, the Regional Center of the Amazon – (INPE-CRA) began an experimental activity using AWFIS imagery based on a DETER similar methodology. The AWiFS sensor operated onboard of the Indian Remote Sensing Satellite - IRS/P6 (ResourceSat-1) stopped working on September 2013. But before that, its capability of detecting polygons smaller than 25 ha was confirmed [11] improving deforestation detection [12]. The aim of this paper is compare AWiFS dataset with the traditional PRODES data and verify its suitability as a surveillance system. The AWIFS data to be analyzed is a subset of data from June to September of 2013 and located on a portion of Para State.

2. METHODS

The mapping method used is structured as follows: a) Selection of low cloud cover AWiFS images; b) Geometrical correction based on Global Land Survey (GLS2005) orthorectified data [13]; c) Linear Spectral Mixture Model [14]; d) PRODES Mask generation. Since 1988 the AML is systematically mapped by PRODES, this historical data is aggregated to mask out areas already mapped as deforestation. This procedure avoids the overlapping of new detections with previous existing ones; e) Visual interpretation of clear cut patterns, Figure 1 below shows the method flowchart.

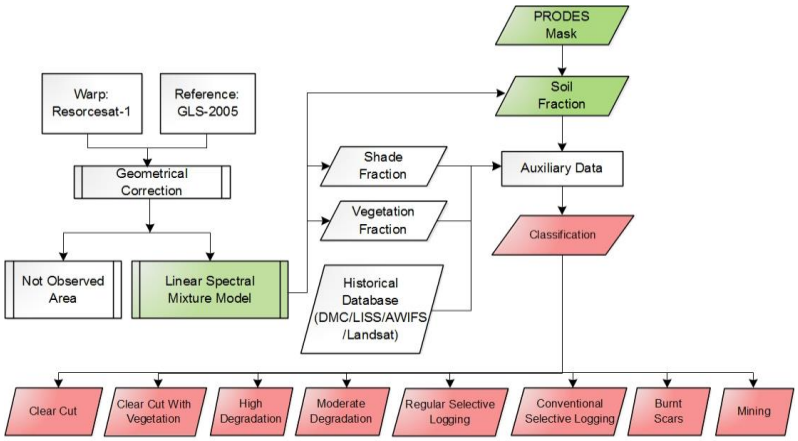

Figure 1 – Mapping method.

Eight patterns of forest degradation were identified: (1) Clear-cut, predominantly exposed soil without forest cover. (2) Clear-cut with vegetation, predominantly square areas with secondary vegetation (3) Medium degradation, predominance of forest cover with patches of bare soil, indicating presence of store yards and small canopy gaps. (4) High degradation corresponds to the presence of larger canopy gaps leading to huge soil exposure, secondary vegetation and / or large brunt areas with some remnant forest fragments. (5) Burnt scars, usually presents concentric arcs interspersed with vegetation or bare soil (windrows). (6) Regular selective logging, follows regular geometrical pattern of logging, in most cases due to the existence of a management plan, the main paths for timber transport are clearly detected, secondary paths are parallel to one another and well

distribute, as it is, the distribution of the store yards. (7) Conventional selective logging, store yards are larger than regular, both primary and secondary paths are not regularly connected generating and unusual geometric pattern. (8) Mining, areas with mineral exploration evidence associate to modification of forest cover.

Due to methodological differences between PRODES data and DETER AWIFS based, the statistical analyses of the AWiFS dataset takes into account only 3 classes out of 8 possible; Clear Cut, Clear Cut with Vegetation and Mining. This is necessary to adequate AWiFS dataset into a PRODES comparable scenario.

3. RESULTS AND DISCUSSION

In terms of polygons the number of detections made by AWIFS approach was about 1.5 times higher than PRODES, Table 1. In terms of area AWIFS based system has accounted 162226.79 ha of deforested areas, a value 8% smaller than the area calculated by PRODES. This minor differences between the systems is not only affected by different spatial resolutions, but can be related to two other main causes; 1) PRODES project established 6.25 ha as minimum detected area while AWiFS method uses 3 ha as minimum detected area. 2) PRODES main objective is to provide annual rates of gross deforestation in AML [5], and for that it uses a mosaic of images from June to September, giving priority to cloud free images near to August / September period. On the other hand AWiFS method main objective is surveillance of the AML, analyzing all incoming images of the sensor regardless of its period and discarding images only if cloud cover avoids satisfactory geometrical correction.

Table 1 – PRODES and DETER AWiFS detections analyzed by size ranges.

PRODES					**DETER AWiFS Method**				
Range (ha)	**Area (ha)**	**Num. Pol.**	**% Pol**	**% Area**	**Range (ha)**	**Area (ha)**	**Num. Pol.**	**% Pol**	**% Area**
<25	86847.41	7671	87.30	49.46	<25	71121.93	12124	91.03	43.84
>=25; <50	25446.66	767	8.73	14.49	>=25; <50	25729.52	751	5.64	15.86
>=50; <100	13800.56	212	2.41	7.86	>=50; <100	18579.00	270	2.03	11.45
>=100	49490.33	137	1.56	28.19	>=100	46796.31	173	1.30	28.85
Total	**175584.95**	**8787**	**100**	**100**	**Total**	**162226.79**	**13318**	**100**	**100**

In the last decade PRODES historical series indicate a reduction of size on clear cut polygons (Rosa et al., 2012). In 2010 detections smaller than 25 hectares represented approximately 60% of all PRODES polygons. This reduction is present in the AWIFS and PRODES 2013 data, where 91% and 87% of its detections belongs to the range < 25, (Table 1). In general the results demonstrate that AWiFS 2013 data closely follows the historically consolidated PRODES pattern, confirming the potential use of AWiFS data for AML deforestation surveillance. The results achieved are also consistent with previous analysis of Diniz et al., 2013 for MODIS dataset.

4. CONCLUSION

The trend indicated by PRODES historical data points out to the necessity of adding images of better spatial resolution to INPE's traditional near real time detection system (DETER). The performance of AWiFS imagery proved to be quite satisfactory, especially in the detection of clear cuts smaller the 25 ha, range that concentrates most of the deforestation occurrence in the Brazilian Legal Amazon [8]. This fact provides a substantial gain to this new AWiFS approach when compared to the traditional MODIS based surveillance system.

5. REFERENCES

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