

# LOOKING INTO SMALLHOLDER COFFEE PLANTATION WITH ALOS DATA IN LAMPUNG PROVINCE, INDONESIA

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**ABSTRACT:** Coffee production in Indonesia has implications in both international and domestic economic significance. Smallholder plantation is the dominant form of coffee farming system, which can pose difficulty in accurate assessment of coffee growing areas in both spatial and temporal context. The objective of this study is to investigate the performance of information extraction about the coffee plantation using the combination of ALOS/AVNIR-2 (10 m resolution MS) and ALOS/PRISM (2.5 m resolution PAN) data in Lampung Province, the heart of the country's robusta coffee region. Improvement in spatial characteristics over conventional Landsat-type medium resolution satellite image data enhanced the performance to identify and isolate patchy coffee plantations of less than 1 ha in size. Previous efforts in mapping spatial extent of coffee plantations has been overly generalized and limited to smaller than 1:100,000 scale. Persisting cloud cover still is the major challenge in the area but detailed delineation of coffee plantations made possible defined the areas of interest for further monitoring efforts. The use of data from different sensors onboard ALOS platform indicated that smallholder coffee plantation in Lampung Province can be differentiated from surrounding seasonal crop growing areas at mapping scale of 1:50,000 that has not been readily feasible to date.

## 1. INTRODUCTION

Indonesia is the fourth largest exporter of coffee in the world today. Coffee production in Indonesia has implications in both international and domestic economic significance. Particularly of great importance is the robusta coffee production (second largest producer only after Vietnam). Lampung Province, situated in southernmost tip of Sumatra island, is the heart of the country's robusta coffee region (Figure 1). Smallholder plantation is the dominant form of coffee farming system. The size of each coffee plantation is usually less than a hectare or so to 3-4 ha at the most. Both coffee planted acreage and production collected and aggregate by BPS (Statistics Bureau) of Lampung are in tabular format. In the light of increasing world demand for robusta coffee, it is desirable to establish a quality spatial information about the distribution and condition of coffee growing area.



Figure 1. Location of Lampung Province, Indonesia.

The objective of this study is to investigate the performance of Japan's newly implemented Advanced Land Observing Satellite (ALOS)/AVNIR-2 (10 m resolution multispectral: MS) and ALOS/PRISM (2.5 m resolution panchromatic: PAN) data for extracting information about the coffee plantation in Lampung Province.

### 1.1 Previous Effort

Previous effort by Indonesian Center for Agricultural Land Resources Research and Development (ICALRD) has resulted in land use/land cover map of entire Lampung Province in digital format at a mapping scale of 1:100,000. This land use/land cover map was compiled using a series of Landsat TM image data (30 m resolution MS) acquired between 2000 and 2002

using both semi-automated supervised classification and manual interpretation techniques. Although it depicted the general land cover characteristics, overgeneralization of smallholder coffee plantation is evident due to its small scale nature.

## 1.2 Study Area

The study area is a sub-watershed of Tulang Bawang river, which almost coincides with the sub-district of Sumberjaya, located in West Lampung District of the Province. It covers a watershed, where large forest areas have been transformed over the past three decades into mosaics of smallholder coffee plantations on slopes and rice paddies in the valleys. The size of the watershed is about 45,000 ha with elevation around 700-1700 m above mean sea level. Sumberjaya soil is fairly fertile, dominated by Inceptisol, Andisol and Ultisol. Approximately 65% of Sumberjaya was reported to be covered by coffee plantation (Verbist et al., 2005) but the actual figure remains obscure. South-west part of the watershed belongs to Bukit Barisan Selatan National Park, the second largest national park in Sumatra. Figure 2 shows the location of the study area.



Figure 2. Location of the Sumberjaya study area.

## 2. DATA AND METHODS

### 2.1 Datasets

ALOS/AVNIR-2 and PRISM data of the study area acquired on October 2, 2006 were used in this study. Ground control points were collected with GPS of the site since the preexistent topographic maps were outdated (1974/75) and only at 1:50,000 scale. Locations of coffee plantations, seasonal crops (cassava, etc.), rice paddies with simple irrigation, settlement areas were recorded to be used for training set preparation. Landsat image data acquired on April 5, 2000 (Path-Row: 124-64) as well as Landsat derived land use/land cover map compiled by ICALRD were used for comparison.

### 2.2 Supervised Classification (AVNIR-2) and Manual Interpretation (PRISM)

Original ALOS data were georeferenced to UTM Zone 48 South WGS84 and clipped out with the watershed boundary (Figure 3). Using the training sets collected on the ground, we performed the supervised classification with maximum likelihood classifier. We used all 4 bands of AVNIR-2 based on the separability evaluation of the spectral signatures. Classes implemented by the ICALRD land use/land cover classification were adapted for the consistency. Smaller than 1 ha size of salt-and-pepper effects were removed with contiguity analysis. With PRISM's 2.5 m resolution, we concluded that it was better and more reliable, although could be labor-intensive, to carry out a conventional manual interpretation on the image. Coffee plantation, rice paddy, seasonal crops could easily be identified (Figure 4).

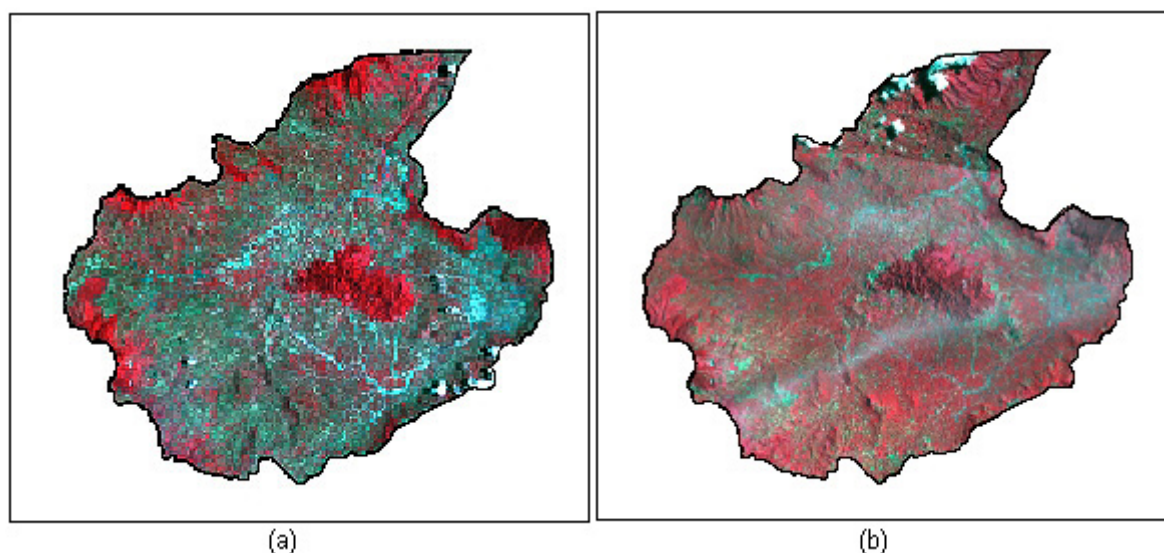


Figure 3. (a) ALOS/AVNIR-2 and (b) Landsat ETM+ data of Sumberjaya watershed.

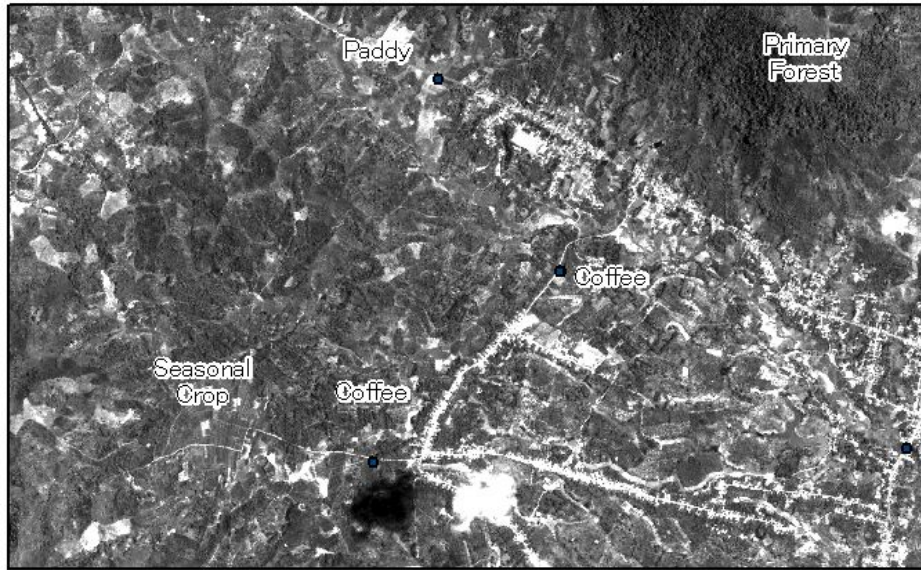


Figure 4. With PRISM (2.5 m PAN), it turned out to be better to carry out a manual interpretation on the image to get the best results.

### 3. RESULTS AND DISCUSSION

Figure 5 shows the classification results from ALOS/AVNIR-2 and previous land use/land cover map. Although there were some obvious errors present in the classification result, the use of AVNIR-2 enabled the authors to identify more detailed land information. The complex nature of landscape in Indonesia can particularly benefit from the improved resolution. Preliminary results indicated that the use of AVNIR-2 in this particular region can best suited for land use/land cover mapping at scale 1:50,000 to 1:100,000. The use of PRISM, on the other hand, has the potential for mapping at even larger scale (e.g., 1:25,000) but it would be best to fuse the detailed spatial information available in PRISM to the spectral characteristic of AVNIR-2. This way, more robust semi-automated classification procedures could be implemented.

One major drawback of ALOS data, then, would be its relatively narrow swath (70 km). Even with its flexible observation mode, persistent cloud cover in the monsoon Asia still poses difficulty in collecting quality multitemporal data. During the past one year of data distribution, there were only a few less cloudy image data captured over our study area.

### 4. CONCLUSIONS

Preliminary assessment of classification result of the smallholder coffee plantation in Lampung Province, Indonesia using newly available ALOS image data indicated significant improvement. The use of ALOS data for this particular application is expected to be best suited for land use/land cover mapping at scales 1:50,000 or even better.

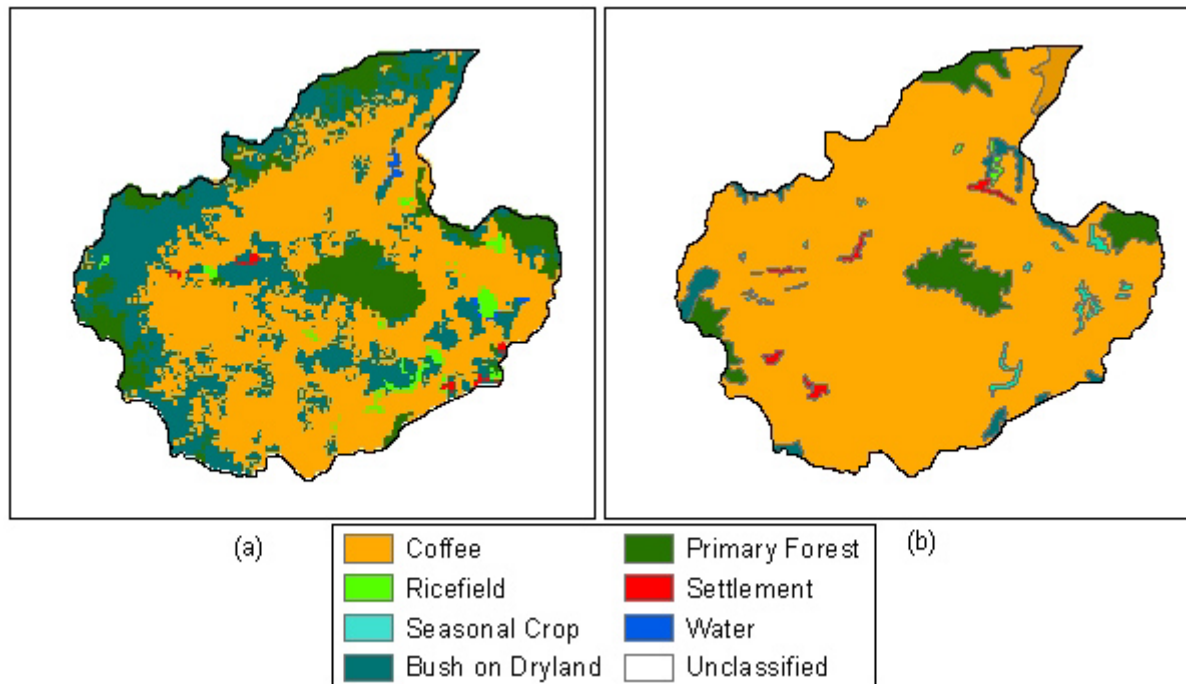


Figure 5. Classification result from (a) ALOS/AVNIR-2 and (b) previously available land use/land cover map at 1:100,000 scale.

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