Dayak Iban Tribe shifting cultivation system pattern using unmanned aerial vehicle and Landsat Data in Mensiau Village

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Abstract. Shifting cultivation by Dayak Iban Tribe in Mensiau Village have several stages, namely burn the land, rice cultivating for two or three planting seasons, and abandoned for reforestation. Vegetation growth through several stages on one cycle, ideally started from burn scar, rice field, bushes, young secondary regrowth, old secondary regrowth, then become secondary forest, so that cycle needs 20 years. The aim of this study is to identify the spatial characteristic of shifting cultivation from UAV data, calculating the change on cycle from Landsat NDVI temporal analysis, also calculating the distance from home and access to the field using Euclidean Distance Analysis. The result shows most of shifting cultivation happen on hilly area with 15-25% slope and Ultisol soil type. NDVI analysis for some field shown increasing of cycle time from 3 to 5 year, and distance analysis reveal that shifting cultivation mostly take place near the roads.

1. Introduction

The shifting cultivation system is very long applied by farmers in the tropics, especially in Southeast Asia [1], one of them by the Iban Dayak Tribe. Asian agriculture, especially in the developing countries, lacks resilience, capacity and sustainability [2]. The shifting cultivation system was chosen as an agricultural system because the general land in Kalimantan Island is poor in minerals and nutrients. Increased shifting cultivation cycle have latent impacts on the environment, such as loss of biodiversity, forest degradation, soil degradation, changes in hydrology systems and forms of geomorphology [1]. Although the impacts caused by shifting cultivation are not as large as oil palm plantations or timber extraction efforts, they can still result in reduced forest cover that results in reduced biomass.

Observation of shifting cultivation systems using satellite imagery has been done for a long time [1]. Observation of shifting cultivation cycle has its own challenges, because spatially the area used is so small that it is difficult to identify, and temporally the frequency is so dynamic that it requires time series data with high frequency of data collection. There are two satellite images that are often used in observation, namely Landsat, MODIS and Sentinel [3,4].

Besides MODIS and Landsat, currently UAV (Unmanned Aerial Vehicle) recording data can be used for monitoring shifting cultivation. The advantages of UAV compared to satellite imagery is that they can be operated quickly and suitable for detecting changes in real time. In addition, UAV can fly at low altitudes so that resulting in high spatial resolution [5], including identification of rice paddy fields [6,7].
2. Methods

Study on shifting cultivation pattern of the Dayak Iban was approached through two stage, namely analysis of shifting cultivation location and analysis of shifting cultivation cycle. The UAV data used was sourced from CIFOR (Center for International Forestry Research) with data collection date in November 2016. Meanwhile, Landsat satellite imagery used was recording from 2000 to 2016.

The shifting cultivation cycle was approached through temporal analysis of NDVI values of Landsat data from 2000 to 2016. Temporal analysis was used to see the years of shifting cultivation marked by trace burns in the image and continued by the farming process. The burn trace data used as a base year is the burn trace data through UAV recording. Landsat data used is obtained from Google Earth Engine, where the existing data has been corrected geometrically and radiometry. A very large difference in resolution between UAV (13 centimeter) and Landsat (30 meter) data, resulting in a distortion in the pixel value, so that the purification of NDVI spectral values originating from Landsat using the Pure Pixel Index method for burn, field, bush objects shrubs, young thickets, old thickets, and secondary forest. NDVI has widely used in many applications, and one of them is for identifying plant characteristics in the ground [8], [9]. Some of the NDVI application was specifically used in agricultural and forest [10, 11].

Determining the location of shifting fields was approached by analyzing the distance to the road network, river network and residence obtained from the land use classification data. The analysis used is Euclidean Distance Analysis, where the distance between two objects is the length of the segment on the cartesian diagram that connects the two point.

3. Results and Discussion

Mensiau Village consists of very complex land use (Figure 1). The influence of the Iban Dayak tribe traditional values is highly reflected in their landscape. The division of land use classes used two methods, which are based on color, shape, texture, and local knowledge.

![Figure 1. Land use of Mensiau Village](image)

Based on the classification of land use in Mensiau Village, most of the land is Pengerang (secondary forest) which is more than 20 years old with an area of 408,443 hectares or 14.32% of the total area of Mensiau Village. Furthermore, the jungle with an area of 322,791 hectares or 11.31% of the total area of Mensiau Village; Young Damun (1-5 years) with an area of 352, 643 hectares or 12.36% of the total Mensiau Village area; Umai (Fields) with an area of 156,088 hectares or 5.47% of the total area of Mensiau Village; and New Umai with an area of 77,943 hectares or 2.73% of the total area of Mensiau Village.
Village. The large number of Pengerang and Damun shows the intensity of shifting cultivation in the past.

The classification results of land use show significant differences in forest and non-forest classes. The non-forest land use class has an area of 1,117.40 hectares or 61% of the total Mensiau Village area, while the forest area is only about 1,123,468 hectares or 39% of the total Mensiau Village area. This shows that the area around the Betang house is the area most often used for farming. In addition, the results of land use classification indicate that most of the paddy fields in the study area are old fields. There are 156,088 hectares or 67% of the total field area are old fields, while the new fields that are visible from Train Burn (Jejak Bakar) are 77,943 hectares or only 33% of the total field area.

Based on the results of the overlay analysis between land use from the image of the UAV and the type of soil, it is known that most of the fields are located in the Ultisol soil type, with 133.03 hectares for ladan, and 67.88 hectares of Trail Burn (Figure 2). Meanwhile, based on the slope class, the distribution of fields in the study area is mostly in the 15 -25% slope class which has a hilly land area of 125.80 hectares, while the new fields are 65.71 hectares (Figure 3).

Tracing the shifting cultivation cycle is carried out by looking at changes in NDVI values in some fields (Table 1). Based on the results of tracing the NDVI values, it was found that in each field there had been more than one burning in the last 15 years (Figure 4). In field 1 and 2, burning occurred in 2004, 2009 and 2016; in field 3, burning occurred in 2005, 2009, and 2016; in field 4 burning occurred in 2002, 2006, 2009 and 2016; in field 5 and 8 burning occurred in 2005, 2009, and 2016; in field 6 burning occurred in 2004, 2009, and 2016; in field 7 burning occurred in 2000, 2006, 2009, and 2016.
### Table 1. NDVI value on the type of land use.

| Land Use                           | NDVI value  |
|------------------------------------|-------------|
| Train burn                         | 0.50 - 0.59 |
| Fields that have been planted      | 0.60 - 0.66 |
| Young damun                        | 0.65 - 0.68 |
| Damun                              | 0.66 - 0.70 |
| Old damun (shrub) and natural forest | 0.70 - 0.72 |

![Figure 4](image-url)  
**Figure 4.** The shifting cultivation cycles.  
(a) field 1, (b) field 2, (c) field 3, (d) field 4, (e) field 5, (f) field 6, (g) field 7, (h) field 8

Based on the result of distance analysis, the fields at the first 100 meters are more accessible through the edge of the road, then the river, and only a few are around the house. In the next 100 meters, an increase in the river banks was seen, while in the road decreased. This proves that shifting cultivation is carried out not in Riparian forest, but behind it so as to minimize river erosion.

The furthest distance from the field is about 1 kilometer. While on the river, the farthest distance is 1.5 kilometers. Meanwhile, the distance from the house to the fields in the range of 500 - 1500 meters. These three factors indicate that locations closer to the road are still the main location for farming as seen on Figure 5.
4. Conclusion
The characteristics of shifting cultivation in the Iban Dayak Tribe are mostly in the condition of hilly land, slopes of 15-25% and ultisol soil types. Based on cultural characteristics, shifting cultivation of the Iban Dayak Tribe has a system that has been carried out for a long time, where customary forests must always be around the fields. The shifting cultivation cycle from year to year in Mensiau Village has increased.

Analysis of the NDVI value of Landsat imagery shows that most cycles of shifting cultivation in Mensiau Village occur about 5 years. However, in several location, the cycle increases to less than five years in 2000-2016. Accessibility factors are one of the factors that influence the determination of the location of shifting cultivation. Distance analysis shows the proximity of the road as one of the biggest determinants of shifting cultivation, as well as proximity to the river. While the distance from the residence is not the main determinant in determining the location of farming.

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