

TREND OF LAND COVER CHANGES USING LANDSAT IMAGERIES IN ECOSYSTEM RESTORATION FOREST

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Abstract. Ecosystem restoration is aimed to maintain and restore forest ecosystem back to its origin condition. Harapan Rainforest is the first ecosystem restoration site in Indonesia that has been declared by government in 2007 as production forest with special purpose. Hutan Harapan is lowland forest remains after HPH period which located in border areas of Jambi and South Sumatera Province. The importance of this research is basically concerned for the forest threatened by illegal logging, forest fires, and expansion of oil palm plantation. Assessment of landcover changes is needed to obtain information for decision maker for this ecosystem restoration sites to overcome such management problems like mention above. Landsat images were used from acquisition year of 1989, 2001, and 2013. Classification used was supervised with maximum likelihood method. Landcover type having changes was high dense of secondary forest that changed into low secondary forest, acacia forest, oil palm, and bareland. Oil palm plantation existed in change period of 2001-2013 with area of 9.179,86 hectares. These changes were triggered by human activities such as illegal logging, encroachment and forest fire.

1. Introduction

Ecosystem restoration is an effort to establish an area in production forest which has important ecosystem in order to maintain its function and contribution by conducting activities such as forest planting, protection and restoration. It also includes planting, enrichment, thinning, wildlife breeding, flora and fauna release to return to its origin biological and ecosystem balance (P.50/Menhut-II/2010) and One of ecosystem restoration in Indonesia is located in Jambi Province namely Hutan Harapan PT. Restorasi Ekosistem. At the time PT. REKI got the concession for ecosystem restoration from Ministry of Forestry for the areas of ex HPH PT. Asialog in 2007, there were already areas that occupied by people and converted into agricultural and settlement. People utilized forest as their source of livelihood (Rahmania 2011). Unclear border and too close access to the road has affected land cover change from forest into agricultural system such as dryfield agriculture and oil palm plantation establishment (Achmad 2013).

Harapan rainforest is the remnant lowland forest in Sumatera Island and being threatened. By illegal logging, forest fires, and plantation expansion in surrounding areas that has led to change ecological landscape and turned into oil palm plantation (Mardiana 2014). Therefore it needs proper solution to overcome the problems that must be focused and realistic. Syam *et al.* (2012) stated that remote sensing technology in forestry is one proper option to get quick, accurate, and relatively cheap to detect land use and land cover changes data. The land cover change dynamics can be identified using Landsat imageries and geographical information system (GIS) using spatial data could give high accuracy ((Kalonus 2011; Yusri 2011; Ahmada 2013). The main objective of this paper is to analyze the trend of landcover changes occurred in Harapan Rainforest. The output of this research was then be used to support identification of the factors caused land cover changes over that areas.

2. Methods

The research was conducted in Harapan Rainforest (PT.REKI). Geographically the site is on 103° 7' 55"–103° 27' 39" Bujur Timur dan 2° 2' 16"–2° 21' 14" Lintang Selatan with elevation on 30-120 m above sea level at zone 48S and datum WGS 84. Landsat imageries used were derived from acquisition year of 1989, 2001, and 2013. Other supporting data needed were administration map and village monographs.

Data from the field collected were captured for its coordinate's location using Global Positioning System (GPS). These points then were used for further digital image processing. Classification of land cover was performed using supervised classification with maximum likelihood method. Accuracy is calculated using confusion matrix whereas acceptable accuracy is greater than or equal to 85%. Landuse and land cover changes produced by comparing land cover for each acquisition of the imageries used. The calculation for landcover changes were performed the difference for each landcover class. The formula to count the rate of changes was as follows (Yusri 2011):

$$V = \frac{N2 - N1}{N1} \times 100\%$$

Note:

V : rate of change (%)

N2 : the area of landcover at second year (ha)

N1 : the area of landcover at first year (ha)

3. Results and Discussions

3.1 Landcover changes in Hutan Harapan

Landuse is changes from land condition due to utilization activities done by people for multipurpose in order to fulfill their needs (Lambin et al. 2001). Land use and land cover in Hutan Harapan based on field survey was classified into 4 categories in 1989 as high secondary forest, medium secondary forest, open land, and water bodies. In 2001, image was classified into 5 categories as high secondary forest, medium secondary forest, open land, water bodies and acacia forest. IN 2013, image was classified into 6 categories as high secondary forest, medium secondary forest, open land, oil palm plantation water bodies and acacia forest.

3.1.1 Landcover classification. Classification process in this research was performed using maximum likelihood. Overall accuracy was calculated using confusion matrices (Jaya 2016). Producers accuracy resulted from division of pixel numbers that correctly classified in each category with the pixel umbers of each training set. Meanwhile for users accuracy calculated from division of pixel numbers which correctly classified in each category with the total pixel numbers classified in the category. Overall accuracy is 90.63%.

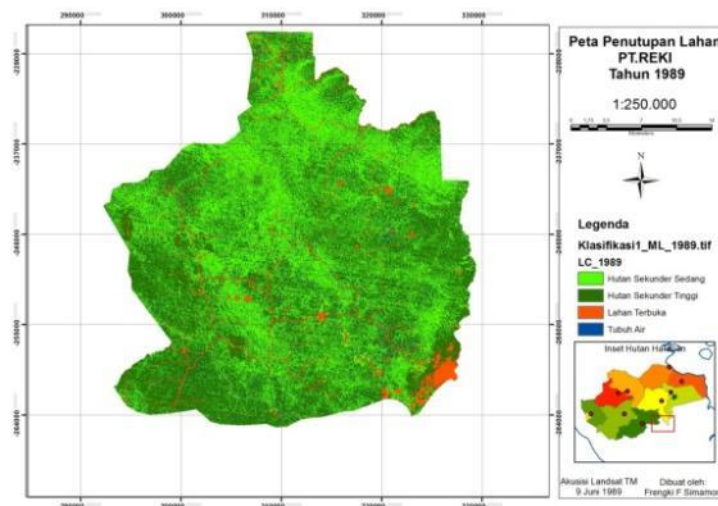


Figure 1. Landcover map of Hutan Harapan in 1989

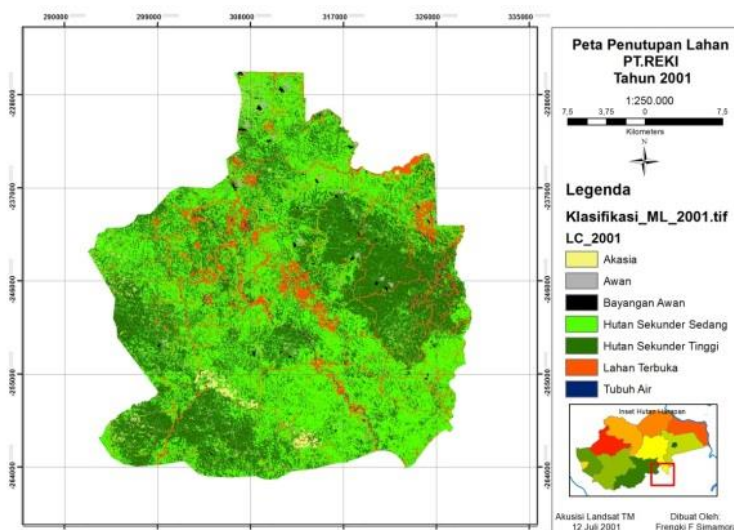


Figure 2. Landcover map of Hutan Harapan in 2001

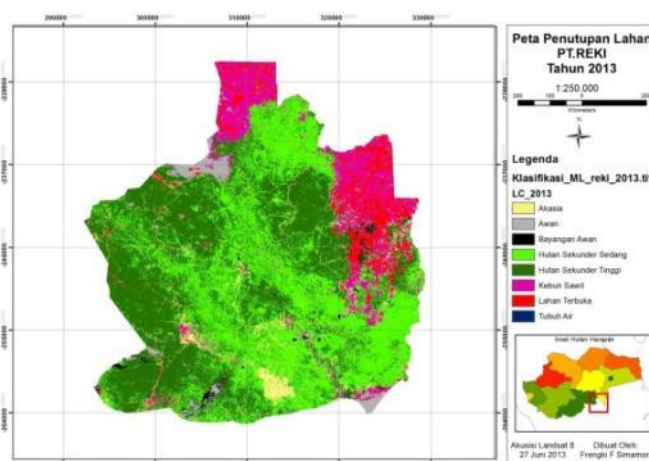


Figure 3. Landcover map of Hutan Harapan in 2013

Table 1. Landcover changes in Hutan Harapan

No	Landcover types	The areas of land cover types (ha)		
		1989 (ha)	2001 (ha)	2013 (ha)
1	High secondary forest	51911,89	37624,78	38933,29
2	Medium secondary forest	40099,01	48423,59	35995,76
3	Openland	4174,17	9054,71	6053,32
No	Landcover types	The areas of land cover types (ha)		
		1989 (ha)	2001 (ha)	2013 (ha)
4	Waterbodies	2827,38	856,87	328,51
5	Acacia		1744,92	3563,47
6	Cloud cover		523,61	3832,56
7	Cloud shadow		782,39	1125,11
8	Oilpalm plantation			9179,87
Total		99012,46	99010,88	99011,88

3.1.2 Landcover in period of 1989-2013. The changes in period of 1989-2001 significantly in class of high secondary forest with ares of 14.287,11 ha with the change rate of -27,52 %. In medium secondary forest, there was change about 20,76% with the extension of area from 40.099,01 ha to 48.423,59 ha. For open land there was addition of areas from 4.174,17 ha menjadi 9.054,71 ha, with the change rate of 116,92%. The extension of this openland was caused by human activities. In water

bodies class, there was reduction of areas from 2.827,38 ha to 856,87 ha with change rate of $-69,69\%$. The changes in period 2001-2013 in high secondary forest there was an increasing from 37.624,78 ha to 38.933,29 ha. The extension of the areas was due to 3,48%. For medium secondary forest there was reduction from 48.423,59 ha to 35.995,76 ha, with the change rate of $-25,66\%$. In open land class there was change from 9.054,71 ha to 6.053,32 ha, with the change rate per twelve years about $-33,15\%$. This area decrease caused by land transformation from bare land to agriculture system by farmer and also to oil palm plantation. In water bodies, from 856,87 ha to 328,51 ha, with the change rate of $-61,66\%$. In class of acacia forest, there was an increase 9.179,87 ha, with the change rate of $104,22\%$. In class of oil palm plantation, there was an increase from 1.744,92 ha to 3.563,47 ha, with the change rate of $917,986,70\%$.

3.2 Landcover changes dynamics in Hutan Harapan

3.2.1 *Change detection of landcover in period of 1989-2001.* Overlay results landcover types into 4 classes namely high secondary forest, medium secondary forest, openland, and waterbodies. The changes occurred in this period were high secondary forest is still in its class with area of 23.932,15 ha. Medium secondary forest has no change with area of 23.590,64 ha.

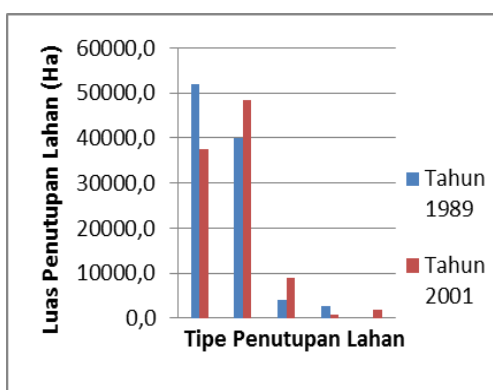


Figure 4. Changes of landcover in 1989-2001

3.2.2 Change detection of landcover in period of 2001 – 2013.

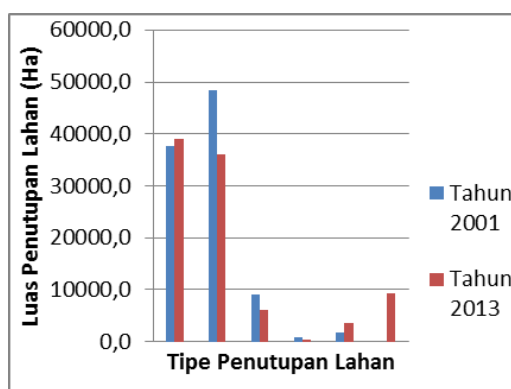


Figure 5. Changes of landcover in 2001-2013

3.3 Factors caused landcover changes in Hutan Harapan

Mardiana (2014) stated that the causes of landcover changes in Harapan Rainforest that previously managed by concession company PT Asialog occurred massively in 1999-20110, where as the legal management were still PT Asialog, in fact by defacto, PT asialog did not operate anymore. This has triggered the people surrounding occupying the area. The conversion was mainly agricultural system and settlement. Beside that, another factors causing landcover chnages were illegal logging, forest fires and deforestation.

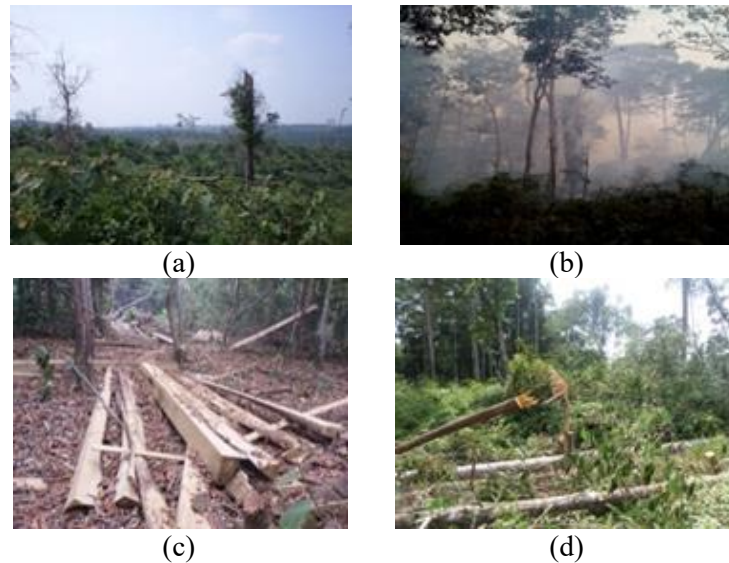


Figure 6. Activities triggered landcover changes in Harapan Rainforest. (a). Oil palm plantation (b). Forest fires (c). Illegal logging (d). Land clearing

4. Conclusions and recommendations

Landcover types existed in Harapan rainforest in 2013 were high secondary forest, medium secondary forest, acacia forest, oil palm plantation, openland, oil palm and waterbodies. New class emerged from 1989 was oil palm plantation. People did the occupation in Harapan Rainforest due to the needs for their livelihood.

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