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TIME SERIES ANALYSIS OF FOEST COVER CHANGE AND FRAGMETATION IN TROPICAL LOWLAND FORET, JAMBI, SUMATRA

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ABSTRACT: The logged over forests around the Bungo research forests also lasted as the remnant valuable lowland tropical forest ecosystems. After 1990's, however, land use alterations from forests to other uses have been occurred rapidly and widely. Under current situations, the logged over forests will be disappeared in the near future. To think about the forest management plan in this area, it will be required both of the conservation strategy for the remnant forests and the rehabilitation plans for the deforested area with reforestation activities. Clarifying the past land cover and deforesting trend will be contributed to the establishing the practical reforestation planes. The main purposes of this study are to outline the land cover changes around Bungo research forest area and to clarify the deforested area, especially logged over forest changes. The following things were clarified in this study.1) Estimated logged over forests were 23,022ha in 1988, 20,249ha in 1993, 10,884ha.2) While 1988 to 1993, 29.5% of the total study areas were deforested; on the other hand 70.5% were deforested while 1993 to 1999. The rate of the logged over forest disappearing were accelerated year by year. 3) The deforested area was identified and mapped .4) the forest landscape changes were categorized dissection by the construction of the logging roads, and shrinkage by the deforestations.5) Vegetation recovering and growing were observed in the transmigration area and riverside area.

1.INTRODUCTION

The most of the natural forests in Sumatra, Indonesia have been undergone the selectively cutting since ever, the remnant natural forests were existed as the logged over forests (Putera 1997). They functioned as the high biodiversity resources and huge carbon stocking pools, wild life habitat and so on. It was possible to mention that logged over forests were served as the lowland tropical forest ecosystems. The logged over forests around the Bungo research forests also lasted as the remnant valuable lowland tropical forest ecosystems relatively undisturbed. After 1990's, however, land use alterations from forests to other uses have been occurred rapidly and widely. Under current situations, the logged over forests will be disappeared in the near future. Main factor of the land use alterations were population increasing accompanied with the transmigration campaigns after 1980's and large-scale forest fire in 1993 and 1997. The expansion of the illegal logging network caused by the Asia economic crisis and the corruption of the Suharuto era also aggravated the land use alterations, especially logged over forests disappearing (Barber and Schweithelm 2000). In the illegal logging system, not only the commercial valuable trees all of the trees in the forests were felled down, therefore the damages of the logging should be affected to the whole ecosystems so severely.

There are no quantitative and objective data about the deforested area estimations and general trends of the land cover changes around the Bungo research forest area due to the lack of the study about it. To think about the forest management plan in this area, it will be required both of the conservation strategy for the remnant forests and the rehabilitation plans for the deforested area with reforestation activities. Clarifying the past land cover and deforestation trends will be contributed to the establishing the practical reforestation planes. The main purposes of this study are to outline the land cover changes around Bungo research forest area and to clarify the deforested area, especially logged over forest changes.

2.MATERAL AND METHOD

2-1.Study areas

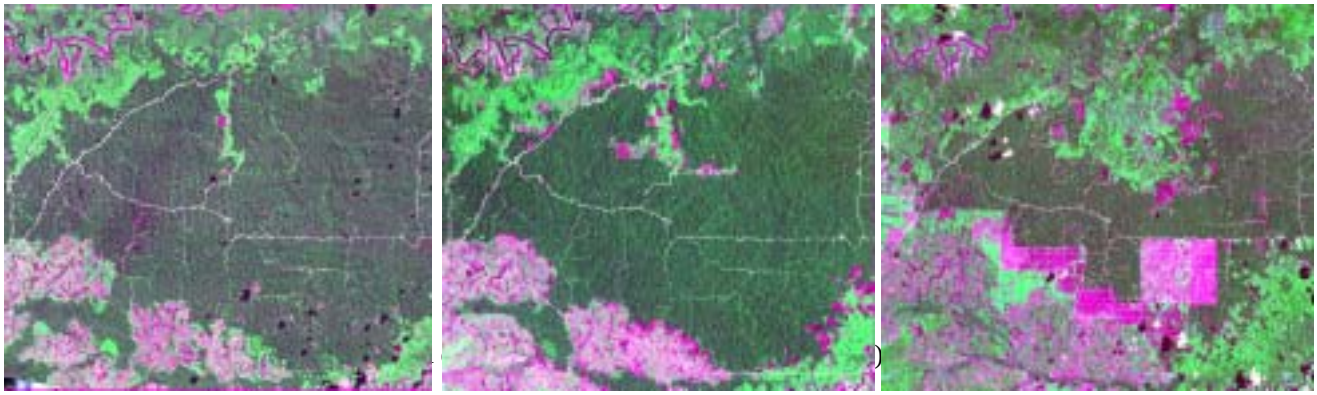
The 34,884ha study area is located at Muara Tebo, near the Hari river, Muarabungo in Sumatra, Jambi province(102° 21´- 102°39´E, 1°28´-1°38´S, altitude 30-100m above sea level).The climatic conditions for the site are those of a very humid bioclimate, i.e., the mean temperature of the coldest month is above 20°C, the annual rain fall is between 2000mm and 2500mm, and there is no month with less than 100mm of rain. The topography is regularly undulating and the drainage is good (Kato 1996).

The forest in the area is mainly 50-70 year old secondary logged-over forest and some patches with rubber trees for production. The last primary forest in the area was cut around 1980 when the last major logging company left the area. Since then it has become a research forest of the Gadja Mada University and left relatively undisturbed. However, there has been an increase in illegal logging activities by local parties (Vrielink 2001).

Figure-1 location of study area, Bungo Research Forest

2-2. Satellite image processing

Three Landsat-5 TM digital images of the study area (Path/Row 126/61) that acquired June 13 1988, September 13 1993 and April 9 1999, were purchased from Tropical Rain Forest Information Center (TRFIC). Before land cover mapping and change detection analysis, geometric and radiometric corrections were conducted based on the 1:50,000 topographic map which edited by BAKOSURTAL at 1982. At the geometric correction, RMS errors were estimated within 0.5 pixels in each satellite images.



2-3. Land cover mapping

According to Putera et al (1997) , land covers and land uses of the Bungo tebo area were categorized as follows, 1) logged-over forest, 2) transmigration area, 3) rubber estate, 4) oil palm estate, 5) secondary regrowth commonly mixed with smallholder rubber and 6) shifting cultivation or ladang(agricultural land).

Based on the supervised classification of the processed image, the method of maximum likelihood was tested to map land cover and tried to define the logged-over forest area. However, the results of this digital automatic classification were unsatisfactory, probably due to the differences of wet condition in each satellite images and vegetation growing during 1988 to 1999, also the intense human activities in the study area. In the classified images, logged over forest area contain various classified pixels especially, shadow that caused by tree canopy itself. To clarify the logged over forest area, therefore, land cover were mapped as follows, 1) bands of the processed image were transferred to the GIS. Each band was associated to an information layer of the spatial database, 2) Polygons were then generated with the on-screen digitizing.

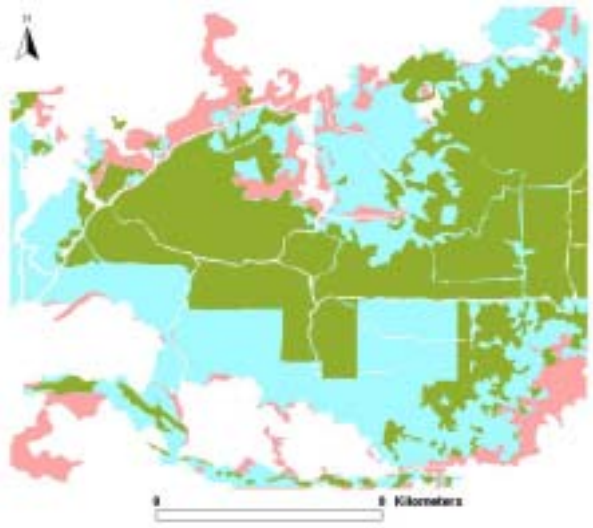


Figure-3 logged over forest in 1988(Pink+ Light blue+ Light green),
1993(Light blue+ Light green), 1999(Light green).

2-4. Forest cover change analysis

To identify and map the deforested area during 1988 to1999, the forest cover change analysis were tried to conduct using change vector analysis and tasseled cap transformed image interpretations. Before conducting

change detection, original images were transformed into tasseled cap images.

Tasseled cap transformation is a linear transformation of the raw spectral bands, devised to three main components. The first, termed *brightness*, is a weighted sum of all bands and is designed to capture the main trend of variation in soil reflectance or barren land. The second component, greenness, contrasts near-infrared and visible bands and is nearly orthogonal to brightness; this component corresponds to vegetation. The third component, wetness, is associated with canopy and soil moisture (Urban 2000). It has been known that increasing *brightness* and decreasing *greenness* were implied the vegetation loss, on the other hand opposed value changes, decreasing *brightness* and increasing *greenness* implied the vegetation recovering.

Change vector analysis

Multi spectral remotely sensed image data can be represented by constructing a vector space with as many as axes or dimensions as there are spectral components associated with each pixel. A particular pixel in an image is represented by a point in such a space, with coordinates that correspond to its brightness values in the appropriate spectral components. The data values associated with each pixel thus define a vector in the multi dimensional space. If a pixel undergoes a change form time t1 to time t2, a vector describing the change can be defined by the subtraction of the vector at t1 from the vector t2. This is called the spectral change vector. It may be calculated from either the original or transformed data, and using either individual pixels or clusters formed by a spectral clustering or spatial segmentation algorithm. If the magnitude of the computed spectral change vector exceeds some specified threshold criterion, it may be concluded that change has occurred. The direction of the vector contains information about the type of change (Deer 2001).

Tasseled cap image interpretations

After the tasseled cap transformation, brightness band in the later images of the two periods was assigned to red image plane and former brightness band was assigned to green and blue image planes. The deforested area, then, were extracted based on the composed image interpretations.

3.RESULT AND DISCUSSION

3-1.General trends of land cover changes

Through the visual interpretation of the three natural color images, 1988 and 1993, 1999, general trends of land cover changes were clarified. The most significant changes were shrinkage of the logged-over forest area that are dark green colored and existed on the center of the each images. The total areas of logged over forest in 1988 were 23,022.13ha(66% of study area), and the total areas of logged over forests in 1993 were 20,249ha(58% of study area). The total areas of logged over forests in 1999 were 10,884.5ha(31% of study area).

Forman (1995) summarized the major spatial processes in land transformation as follows, 1) perforation, 2) dissection, 3) fragmentation, 4) shrinkage, 5) attrition. Forest landscape changes in this study area were categorized to the dissection by construction of the road and shrinkage of the logged over forest. It has been known that both dissections and shrinkage cause the habitat loss and isolation.

Some vegetation recovering was found in the transmigration area that was shown left under area on the images and riverside area that was shown left upper area. Transmigration dwellers planted oil palm and other commercial crops behind their houses. Due to the oil palm growing in the trans area and secondary forest growing by the riverside, vegetation recovering was observed in the natural color image in 1999. Moreover, the land use alteration from logged over forest to large scaled oil palm plantation was found on the center of the 1999 image.

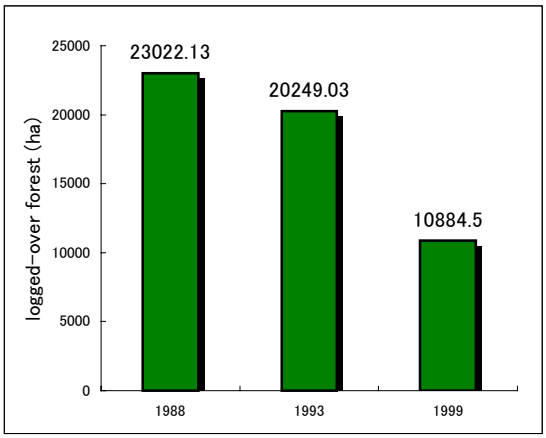


Figure-4 changes of the logged over forest during 1988 to 1999

3-2. Forest cover change analysis

To clarify the forest cover changed area, we conducted two kind of the pre-classification analysis. The change vector analysis using the tasseled cap image(brightness, greenness) could not detect changed area exactly and effectively. Therefore, we tried to the more straightforward method, that is to say, tasseled cap image interpretation analysis. Figure-5 shows the result of the tasseled cap image interpretation analysis from 1988 to 1999, and 1988 to 1993, 1993 to 1999. The deforested areas from 1988 to 1999 were estimated 12,280ha and 3,620ha from 1988 to 1993, 8,660ha from 1993 to 1999. The deforested area from 1988 to 1999 were proportioned to just 29.5% of the total deforested area, on the other hand, deforested area from 1993 to 1999 were proportioned to 70.5% of the total deforested area. These results indicate that deforestation areas were increased year by year during this study period.

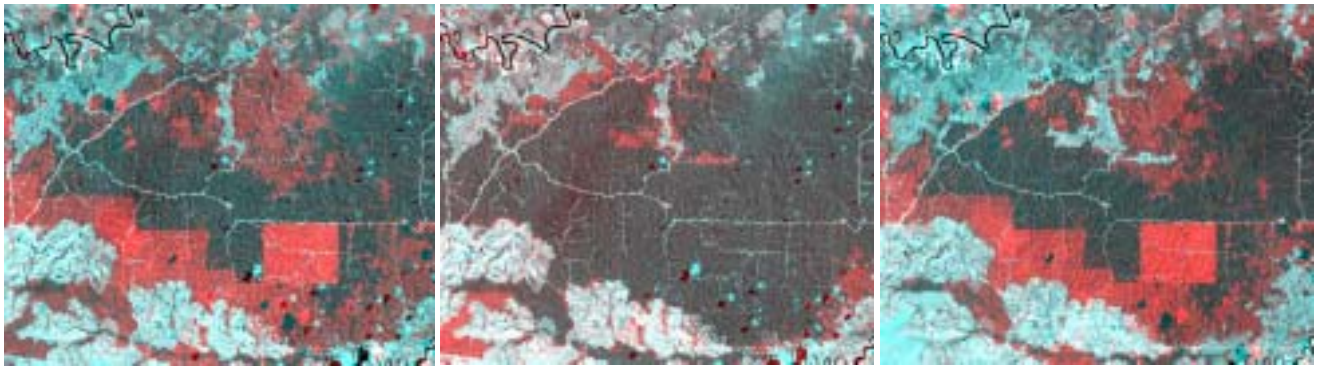


Figure-5 Results of the tasseled cap transformed images. From 1988 to 1999 (left), from 1988 to 1993 (center), from 1993 to 1999 (right). Red colored area represents the estimated deforested area.

4.CONCLUSION

The following things were clarified in this study.

1) Estimated logged over forests were 23,022ha in 1988, 20,249ha in 1993, 10,884ha.
2) While 1988 to 1993, 29.5% of the total study areas were deforested; on the other hand 70.5% were deforested while 1993 to 1999. The rate of the logged over forest disappearing were accelerated year by year.
3) The deforested area were identified and mapped in figure-5.
4) The forest landscape changes were categorized dissection by the construction of the logging roads, and

shrinkage by the deforestations.

5) Vegetation recovering and growing were observed in the transmigration area and riverside area.

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6.REFFERENCES

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