A CANONICAL VARIATE ANALYSIS METHODE TO CLASSIFY FOREST AND NON FOREST USING LANDSAT IMAGE FOR CENTRAL KALIMANTAN PROVINCE IN 2000-2008

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The information of forest and non forest for Central Kalimantan Province in year 2000-2008 derived using Landsat 5 and 7 images. This research is conducted by Indonesia's National Carbon Accounting System (INCAS) project in order to support a mechanism scheme plan of decreasing emission from Reducing Emissions from Deforestation and Forest Degradation/REDD. The INCAS activities in LAPAN are inventoring Landsat data, scene selection, orthorectification, radiometric correction, cloud masking, mosaicing wall to wall per year, and classification. This paper is only discussed of classification of forest and non forest. The criterion of forest in this term is a trees, having canopy cover more than 20%, and 2 meter tall. The data are Landsat 5 and 7 in year 2000 and 2008. The secondary data are Ikonos, Quickbird, geology, and ground truth data. The stages of process are decided training sample, forest base probability, forest matching, and stratification zones. The methodology to make forest base probability is using canonical variate analysis (CVA) to derive the indices and threshold. The result are forest extend and changes per year.

Keywords: INCAS, Landsat, Canonical Variate Analysis, Central Kalimantan Province

Introduction

Indonesia as a developed country taking apart in action to overcome global issue on climate change by develop and arrange national system to support mechanism of decreasing emission from Reducing Emissions from Deforestation and Forest Degradation/REDD. Indonesia's National Carbon Accounting System (INCAS) is being established as part of this action. INCAS is a collaborating project between Indonesia and Australia. This project aims to support design and implementation of robust forest monitoring in Indonesia by adopting the system that successfully implemented in Australia.

The INCAS activities in LAPAN are collecting Landsat 5 and 7 images from 1998 to 2012, scene selection with maximum cloud cover 25%, geometric correction, terrain correction, cloud and shadow masking, mosaicing and digital classification for mapping forest and its changes. Forest change that has been monitored is only caused by land conversion from human activities, not by the nature disturbance, ex. flood, and landslide.

The location of this research is focusing in Central Kalimantan Province, which has 15.399.229Ha of wide spread area that counted base on Bakosurtanal region border. Forest in Central Kalimantan Province has many types. There are a widespread area of peat swamp forest, coastal forest, forest in Meratus hills and lowland forest. Central Kalimantan Province is also one of province in Indonesia that already finish mapped for forest monitoring.

Methodology

This paper is only discussed on digital classification of forest and its changes in year 2000 and 2008. The stages of classification are making forest base probability in year 2008, making stratification zone and making forest probability in year 2000. The Landsat images in year 2008 is decided to be the images for forest base probability, because it has nearly close to

current year and the high resolution images that provided to make a training sample become more accurate, mostly acquired in year 2008. This image in year 2008 would be a base for making forest probability compare to other years.

a. Data

The images are mosaic Landsat 5 and 7, multispectral and multitemporal in year 2000 and 2008 with spatial resolution with cubicconvulation resampling into 25meter. The secondary data also needed to increase the accuracy in taking a training sampel of forest and non forest. They are Quickbird and Ikonos images in 2008-2009, geology data and ground truth data.

b. Software

All the processing data done using C++ in Windows Dos. They are *train_extract.exe, incas_cv_analysis_sig_v2.exe, plotcvmeans.R, plotbndmeans_v2.R, incas_enter_contrast.exe, incas_index_smooth.exe, incas_enter_index_threshold.exe, image2prob_forest.exe,* and *incas_mosaic_prb1.exe.* Ermapper 7.1 also needed to display Landsat images on taking training sample and software R to make a plotting.

c. Canonical Variate Analysis (CVA) Methode

To produce forest base probability for Landsat 7 mosaic images in 2008 done by taking training sample, choosing indices and threshold that created from canonical variate analysis (CVA) method. This indices and threshold would applied within all the location, but if any location did not match, it mean that it would need a new indices and threshold. The area that has a suitable indices and threshold then we drew as one zone stratification and so on for others zone.

The indices derived by The Canonical variate Analysis method. This method gives the best separation between forest and non forest. The indices come from linear combination from band within the images with the maximum separation. This depend on the accuracy of training sample that been chosen. Canonical vector depict maximum direction of separation and canonical root gives a value of those separation. Generally, canonical vector and canonical root could give best separation but sometimes it is need to be modified by focusing the separation of training sample. This can be done by simplify and smoothing it to obtain maximum contras value. The indices for certain area could contain two or three indices, usually it takes two indices but for ex. In coastal region needs three indices two detect the mangrove and wet land.

d. Work Flow

Work flow of this research is described in figure 1.

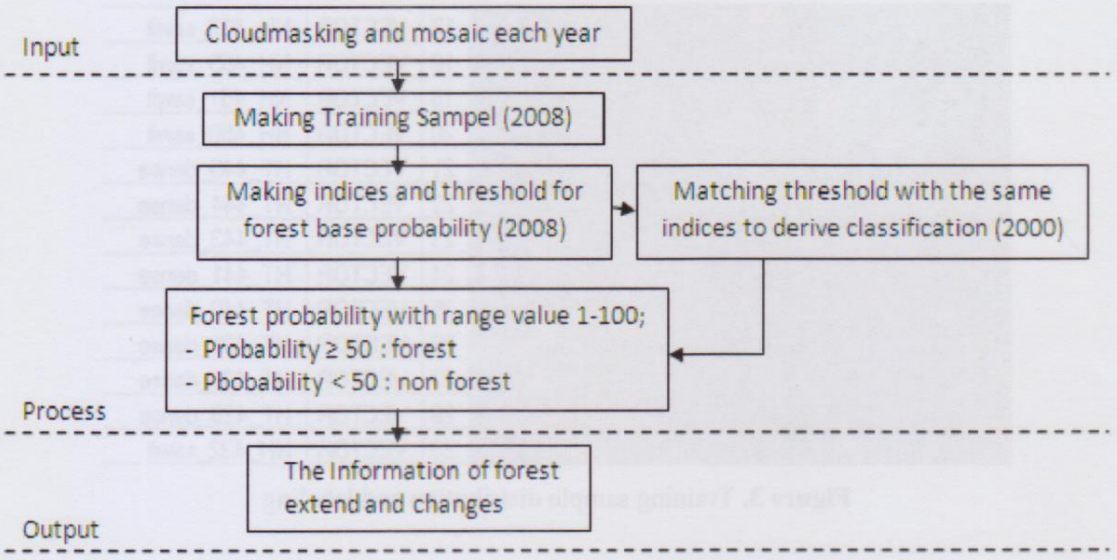


Figure 1. Work flow

Result and Discuss

a. Images mosaic

Central Kalimantan Province located at 0:48:40.72N - 3:35:16.25S dan 110:38:49.28E - 115:53:38.2E and for mosaicing Landsat 5 and 7, it needs path/row 117/61-62, 118/59-62, 119/60-62, 120/60-62.

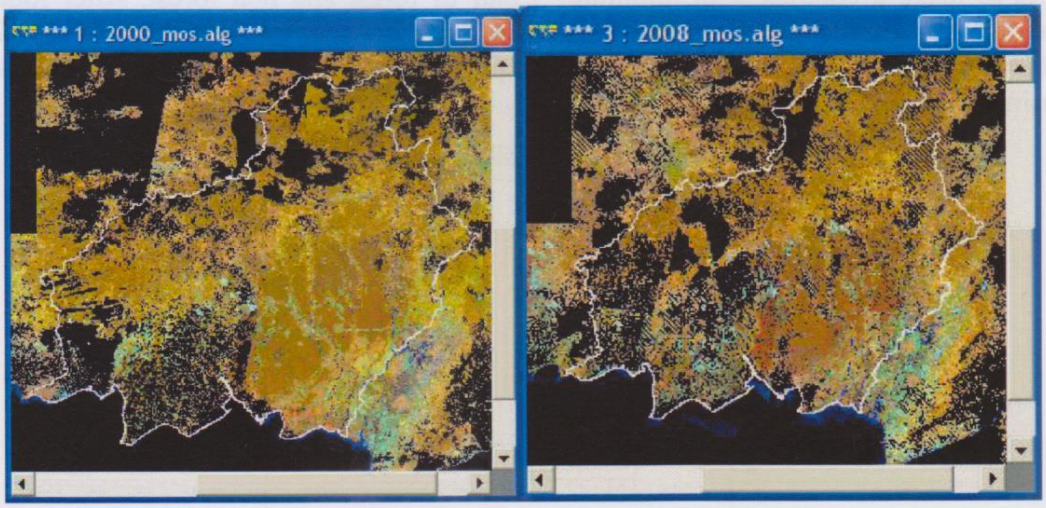
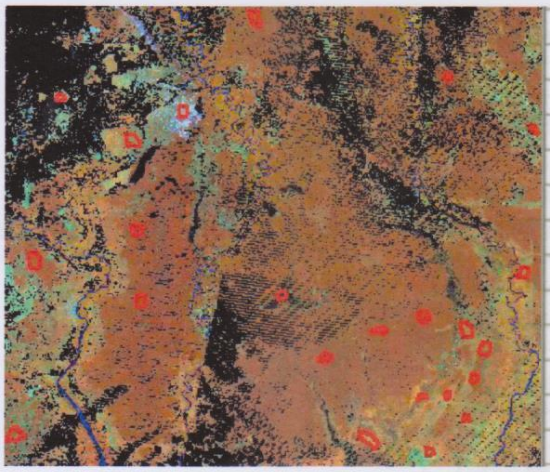


Figure 2. Mosaic year 2000 and 2008

b. Training Sample

The training sample contain of forest and non forest. This done by chosing region site in mosaic image 2008 with the accordance of secondary data. Definition of forest is a trees with canopy more than 20%, and 2m height. The forest selected is peat swamp forest, mangrove, lowlandforest, mountain forest, trees plantation ex. rubber, akasia, cinnamon, etc. Each site of training sampel contain 10-100pixel.



17	VECTOR	NH_453_sawit
18	VECTOR	NH_455_sawit
19	VECTOR	NH_451_sawit
20	VECTOR	NH_450_sawit
21	VECTOR	HT_445_dense
22	VECTOR	HT_444_dense
23	VECTOR	HT_443_dense
24	VECTOR	HT_441_dense
25	VECTOR	HT_440_dense
26	VECTOR	HT_431_dense
27	VECTOR	HT_430_dense
28	VECTOR	HT_429_dense
29	VECTOR	NH_432_sawit

Figure 3. Training sample distribution and labeling

c. Indices and threshold

The Indices and threshold for classifiying forest and non forest derive from year 2008. This image become forest base probability because the landcover condition near to present and based on the secondary data available. The next stage is to convert training sampel into ASCII format then to analyze its separataion between forest and non forest using canonical variate using software ***incas_cv_analysis_sig_v2.exe.*** The quality result of this analyze could be plot in R software using software ***plotcvmeans.R*** and stated in the information on Canonical root and Canonical vector. If the result of the maximum separation could not be achieved, the next stage is to make a contrast with minimum 5 pair of forest and non forest. After found an appropriate indices and threshold then transform it using ***Incas_enter_indeks_threshold.exe*** and then we make a final forest and non forest probability with probability scale between 0-100 using ***Image2prob_forest.exe***.

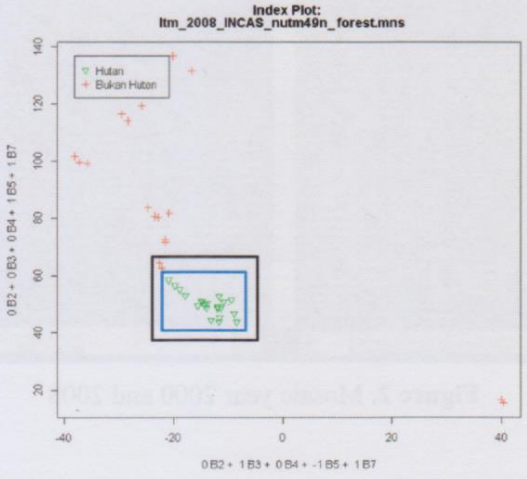


Figure 4. Example of plot bandmns using s/w R

The value of indices and threshold in 2008 stored in ASCII text file as shown in Figure 5. Zone 1 has 2 indices. Index 1 consist of band 2 – band 4 + band 5. Index 2 consist of band 4 + band 5. The certain forest located in threshold 1 (-40 to (-5)) and threshold 2 (83 to 127). The threshold for year 2000 might be different as the value of digital number in Landsat images in 2000.

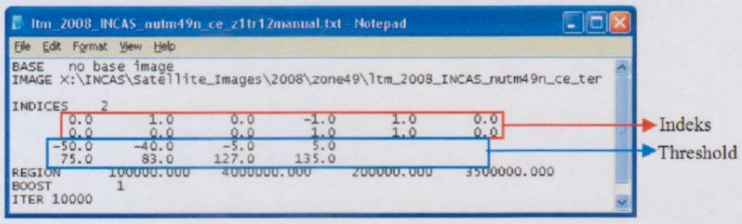


Figure 5. ASCII format of indices and threshold, zona 1 in 2008

d. Stratification

A region with different types of forest and land types need different indices and threshold to obtain an optimum classification of forest and non forest. Kalimantan has 10 stratification zones as shown in Figure 6.

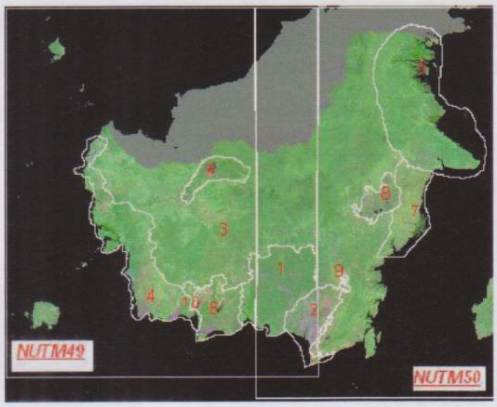


Figure 6. Stratification zone in Kalimantan

The Central Kalimantan Province has 6 stratification zone, they are zone 1, 2, 3, 4, 6, and 10. Each stratification zone needs different indices and threshold as the characteristic of forest and geographic.

e. Result of classification

The next stage of classification process after found threshold and stratification zones is to make forest base probability for year 2008. The probability would decide wheter it likely to be for forest or non forest. The probability transform into forest if it has a value more than 50 and otherwise it would called as non forest. This classification result has a possibility of missing class because of the cloudmasking process or no data. The same process to determine forest also done to image in year 2000. The result of forest classification for year 2008 in zone 1, displayed in Figure 7.

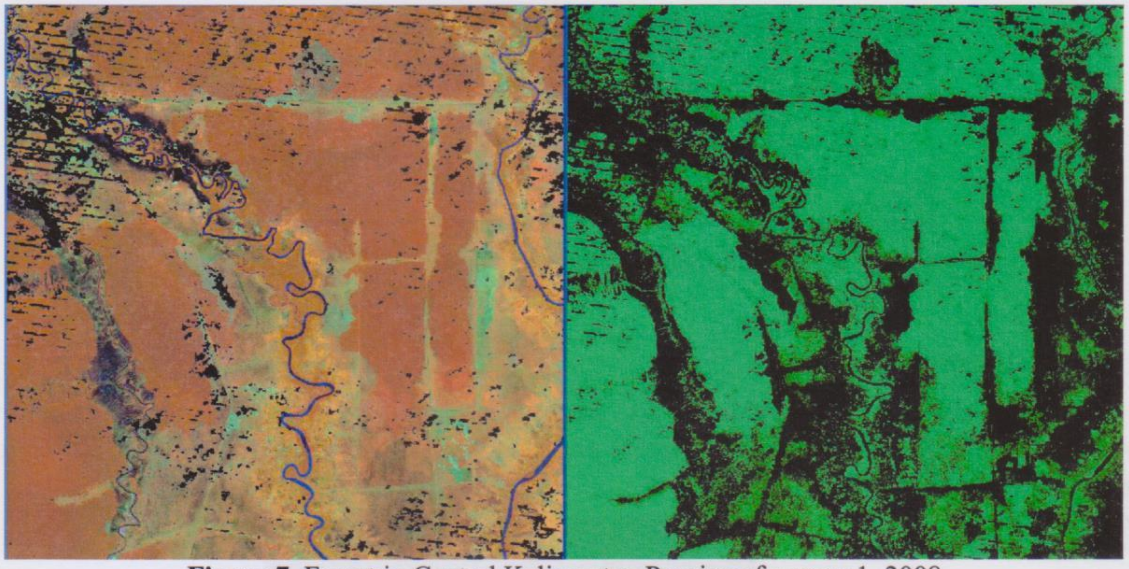


Figure 7. Forest in Central Kalimantan Province for zone 1, 2008

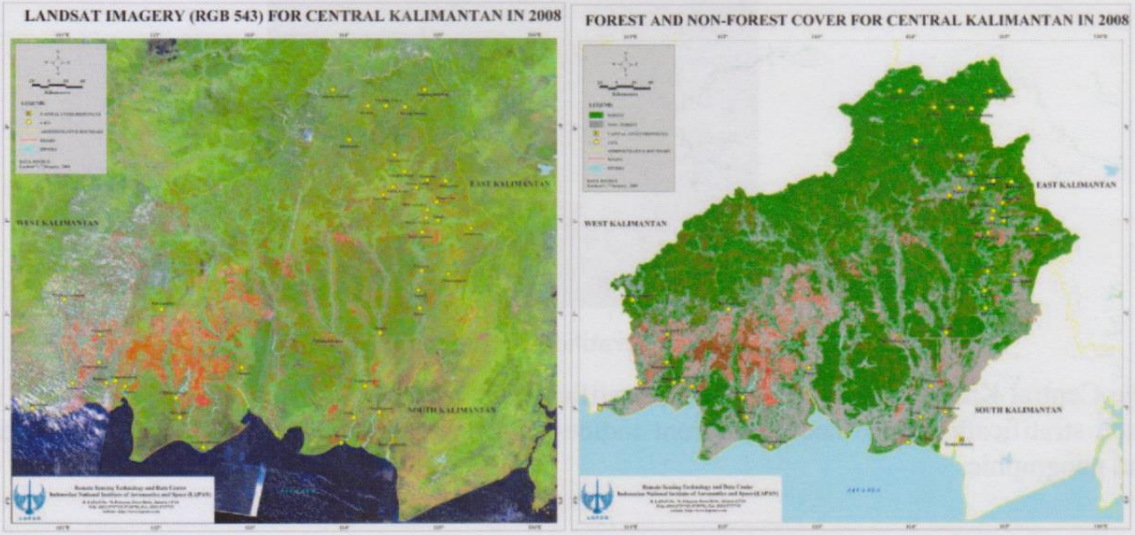


Figure 8. Landsat image mosaic and widespread of forest in Central Kalimantan Province, 2008

The tabulation of forest in 2000 and 2008 are shown in Table 1, the detail forest change in Table 2 and Figure 9 describe the widespead of Stable Forest, Loss and Gain di Central Kalimantan from 2000-2008.

Table 1. Widearea (Ha) of forest in Central Kalimantan Province using Landsat Image, 2000-2008

No.	Year	Widearea (Ha)	Precentage (%)
1	2000	10728416	69.7
2	2008	10110832	65.7

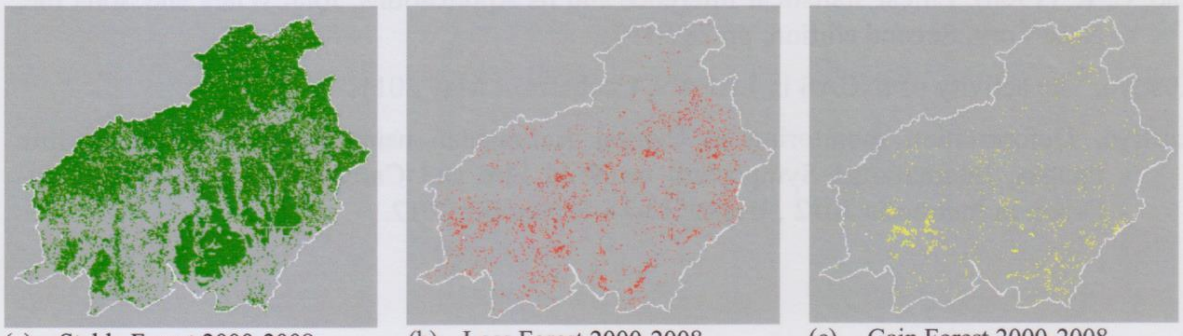
Source : analysist result with 100m resampling

Table 2. Widearea (Ha) of *Stable*, *Loss* and Forest *Gain* for Central Kalimantan Province using Landsat Image, 2000-2008

No.	Notes	Widearea (Ha)
1	*Stable* Forest (2000 and 2008)	9434772
2	*Loss*	1299044
3	*Gain*	676060

Source : analysist result with 100m resampling

The analysis result shows that in year 2000, almost 69.7% or 10,728,416Ha forest landcover dominates in Central Kalimantan Province but it is decreasing as much 617,584Ha for 8 year in 2008 become 10,110,832Ha or 65.7%. The stable forest for 8 year stays in 8,389,620Ha, deforestation/loss 8,421,56Ha, replanting 358,724Ha.



(a) Stable Forest 2000-2008 (b) Loss Forest 2000-2008 (c) Gain Forest 2000-2008

Figure 9 (a,b,c). The widespreadarea of Stable Forest, Loss and Gain for Central Kalimantan from 2000-2008

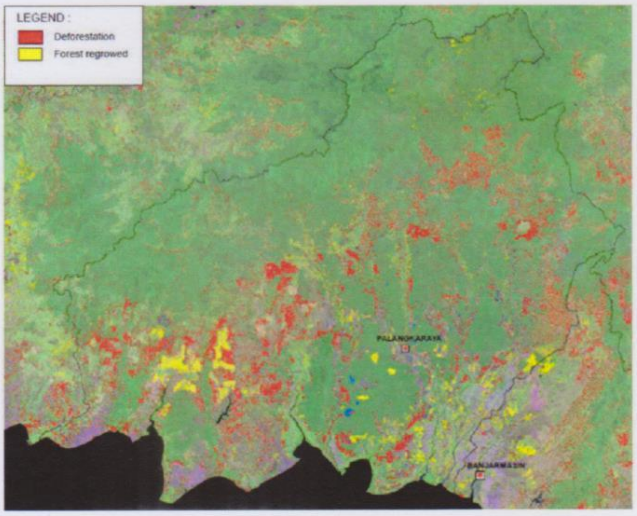


Figure 10. The widespread area of forest change for Central Kalimantan from 2000-2008

Conclusions

Landsat images had a high continuity, complete multispectral band and spatial resolution to mapping the forest extend and changes or forest monitoring. The methodology to classify is using canonical variate analysis to produce indices and threshold for matching forest in each year. The results are forest, non forest, forest loss, and forest regrowed. The next stage is produsing the multitemporal classification and verify the result by an attribution stage.

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