PROCEEDINGS

ICACSIS 2014

2014 International Conference on Advanced Computer Science and Information Systems

October 18th and 19th 2014
Ambhara Hotel, Blok M
Jakarta, Indonesia

ISBN : 978-979-1421-22-5

IEEE INDONESIA SECTION

ICACSIS 2014

2014 International Conference on

Advanced Computer Science and Information Systems

(Proceedings)

ISBN : 978-979-1421-225

Welcome Message from General Chairs

On behalf of the Organizing Committee of this International Conference on Advanced Computer Science and Information Systems 2014 (ICACSIS 2014), we would like to extend our warm welcome to all of the presenter and participants, and in particular, we would like to express our sincere gratitude to our plenary and invited speakers.

This international conference is organized by the Faculty of Computer Science, Universitas Indonesia, and is intended to be the first step towards a top class conference on Computer Science and Information Systems. We believe that this international conference will give opportunities for sharing and exchanging original research ideas and opinions, gaining inspiration for future research, and broadening knowledge about various fields in advanced computer science and information systems, amongst members of Indonesian research communities, together with researchers from Germany, Singapore, Thailand, France, Algeria, Japan, Malaysia, Philippines, United Kingdom, Sweden, United States and other countries.

This conference focuses on the development of computer science and information systems. Along with 4 plenary and 2 invited speeches, the proceedings of this conference contains 71 papers which have been selected from a total of 132 papers from twelve different countries. These selected papers will be presented during the conference.

We also want to express our sincere appreciation to the members of the Program Committee for their critical review of the submitted papers, as well as the Organizing Committee for the time and energy they have devoted to editing the proceedings and arranging the logistics of holding this conference. We would also like to give appreciation to the authors who have submitted their excellent works to this conference. Last but not least, we would like to extend our gratitude to the Ministry of Education of the Republic of Indonesia, the Rector of Universitas Indonesia, Universitas Tarumanagara, Bogor Agricultural Institute, and the Dean of the Faculty of Computer Science for their continued support towards the ICACSIS 2014 conference.

Sincerely yours,
General Chairs

ISBN : 978-979-1421-225

Welcome Message from The Dean of Faculty of Computer Science, Universitas Indonesia

On behalf of all the academic staff and students of the Faculty of Computer Science, Universitas Indonesia, I would like to extend our warmest welcome to all the participants to the Ambhara Hotel, Jakarta on the occasion of the 2014 International Conference on Advanced Computer Science and Information Systems (ICACSIS).

Just like the previous five events in this series (ICACSIS 2009, 2010, 2011, 2012, and 2013), I am confident that ICASIS 2014 will play an important role in encouraging activities in research and development of computer science and information technology in Indonesia, and give an excellent opportunity to forge collaborations between research institutions both within the country and with international partners. The broad scope of this event, which includes both theoretical aspects of computer science and practical, applied experience of developing information systems, provides a unique meeting ground for researchers spanning the whole spectrum of our discipline. I hope that over the next two days, some fruitful collaborations can be established.

I also hope that the special attention devoted this year to the field of pervasive computing, including the very exciting area of wireless sensor networks, will ignite the development of applications in this area to address the various needs of Indonesia's development.

I would like to express my sincere gratitude to the distinguished invited speakers for their presence and contributions to the conference. I also thank all the program committee members for their efforts in ensuring a rigorous review process to select high quality papers.

Finally, I sincerely hope that all the participants will benefit from the technical contents of this conference, and wish you a very successful conference and an enjoyable stay in Jakarta.

Sincerely,
Mirna Adriani, Dra, Ph.D.
Dean of the Faculty of Computer Science
Universitas Indonesia

ISBN : 978-979-1421-225

ADVANCED PROGRAM ICACSIS 2014

COMMITTEES

Honorary Chairs:

- A. Jain, IEEE Fellow, Michigan State University, US
- T. Fukuda, IEEE Fellow, Nagoya University, JP
- M. Adriani, Universitas Indonesia, ID

General Chairs:

- E. K. Budiarjo, Universitas Indonesia, ID
- D. I. Sensuse, Universitas Indonesia, ID
- Z. A. Hasibuan, Universitas Indonesia, ID

Program Chairs:

- H. B. Santoso, Universitas Indonesia, ID
- W. Jatmiko, Universitas Indonesia, ID
- A. Buono, Institut Pertanian Bogor, ID
- D. E. Herwindiati, Universitas Tarumanegara, ID

Section Chairs:

- K. Wastuwibowo, IEEE Indonesia Section, ID

Publication Chairs:

- A. Wibisono, Universitas Indonesia, ID

Program Committees:

- A. Azurat, Universitas Indonesia, ID
- A. Fanar, Lembaga Ilmu Pengetahuan Indonesia, ID
- A. Kistijantoro, Institut Teknologi Bandung, ID
- A. Purwarianti, Institut Teknologi Bandung, ID
- A. Nugroho, PTIK BPPT, ID
- A. Srivihok, Kasetsart University, TH
- A. Arifin Institut Teknologi Sepuluh Nopember, ID
- A. M. Arymurthy, Universitas Indonesia, ID
- A. N. Hidayanto, Universitas Indonesia, ID
- B. Wijaya, Universitas Indonesia, ID
- B. Yuwono, Universitas Indonesia, ID
- B. Hardian, Universitas Indonesia, ID
- B. Purwandari, Universitas Indonesia, ID
- B. A. Nazief, Universitas Indonesia, ID
- B. H. Widjaja, Universitas Indonesia, ID
- Denny, Universitas Indonesia, ID
- D. Jana, Computer Society of India, IN
- E. Gaura, Coventry University, UK
- E. Seo, Şungkyunkwan University, KR
- F. Gaol, IEEE Indonesia Section, ID

ISBN : 978-979-1421-225

- H. Manurung, Universitas Indonesia, ID
- H. Suhartanto, Universitas Indonesia, ID
- H. Sukoco, Institut Pertanian Bogor, ID
- H. Tolle, Universitas Brawijaya, ID
- I. Budi, Universitas Indonesia, ID
- I. Sitanggang, Institut Pertanian Bogor, ID
- I. Wasito, Universitas Indonesia, ID
- K. Sekiyama, Nagoya University, JP
- L. Stefanus, Universitas Indonesia, ID
- Marimin, Institut Pertanian Bogor, ID
- M. T. Suarez, De La Salle University, PH
- M. Fanany, Universitas Indonesia, ID
- M. Kyas, Freie Universitat Berlin, DE
- M. Nakajima, Nagoya University, JP
- M. Widyanto, Universitas Indonesia, ID
- M. Widjaja, PTIK BPPT, ID
- N. Maulidevi, Institut Teknologi Bandung, ID
- O. Sidek, Universiti Sains Malaysia, MY
- O. Lawanto, Utah State University, US
- P. Hitzler, Wright State University, US
- P. Mursanto, Universitas Indonesia, ID
- S. Bressan, National University of Singapore, SG
- S. Kuswadi, Institut Teknologi Sepuluh Nopember, ID
- S. Nomura, Nagaoka University of Technology, JP
- S. Yazid, Universitas Indonesia, ID
- T. Basaruddin, Universitas Indonesia, ID
- T. Hardjono, Massachusetts Institute of Technology, US
- T. Gunawan, International Islamic University Malaysia, MY
- T. A. Masoem, Universitas Indonesia, ID
- V. Allan, Utah State University, US
- W. Chutimaskul, King Mokut's University of Technology, TH
- W. Molnar, Public Research Center Henri Tudor, LU
- W. Nugroho, Universitas Indonesia, ID
- W. Prasetya, Universiteit Utrecht, NL
- W. Sediono, International Islamic University Malaysia, MY
- W. Susilo, University of Wollongong, AU
- W. Wibowo, Universitas Indonesia, ID
- X. Li, The University of Queensland, AU
- Y. Isal, Universitas Indonesia, ID
- Y. Sucahyo, Universitas Indonesia, ID

Local Organizing Committee:

- A. Y. Utomo, Universitas Indonesia, ID
- Aprinaldi, Universitas Indonesia, ID
- D. Eka, Universitas Indonesia, ID
- E. S. Utama, Universitas Indonesia, ID
- E. Cahyaningsih, Universitas Indonesia, ID
- H. A. Wisesa, Universitas Indonesia, ID
- H. R. Sanabila, Universitas Indonesia, ID
- K. M. Kurniawan, Universitas Indonesia, ID
- M. Mega, Universitas Indonesia, ID
- M. Ni'ma, Universitas Indonesia, ID

 ISBN : 978-979-1421-225

- M. I. Suryani, Universitas Indonesia, ID
- M. Soleh, Universitas Indonesia, ID
- M. Pravitasari, Universitas Indonesia, ID
- N. Rahmah, Universitas Indonesia, ID
- Putut, Universitas Indonesia, ID
- R. Musfikar, Universitas Indonesia, ID
- R. Latifah, Universitas Indonesia, ID
- R. P. Rangkuti, Universitas Indonesia, ID
- V. Ayumi, Universitas Indonesia, ID

ISBN : 978-979-1421-225

CONFERENCE INFORMATION

Dates	October 18th (Saturday) – October 19th (Sunday) 2014
Organizer	Faculty of Computer Science, Universitas Indonesia
	Department of Computer Science, Institut Pertanian Bogor
	Faculty of Information Technology, Universitas Tarumanegara
Venue	Ambhara Hotel
	Jalan Iskandarsyah Raya No. 1, Jakarta Selatan, DKI Jakarta, 12160, Indonesia
	Phone : +62-21-2700 888
	Fax : +62-21-2700 215
	Website : http://www.ambharahotel.com/
Official Language	English
Secretariat	Faculty of Computer Science, Universitas Indonesia
	Kampus UI Depok
	Depok, 16424
	Indonesia
	T: +62 21786 3419 ext. 3225
	F: +62 21 786 3415
	E: icacsis@cs.ui.ac.id
	W: http://www.cs.ui.ac.id
Conference Website	http://icacsis.cs.ui.ac.id

ISBN : 978-979-1421-225

ADVANCED PROGRAM *ICACSIS 2014*

PROGRAM SCHEDULE

Saturday, October 18th, 2014-CONFERENCE			
Time	**Event**	**Event Details**	**Rooms**
08.00-09.00	Registration		Dirgantara Room, 2nd Floor
09.00-09.30	Opening	Opening from the Dean of Faculty of Computer Science Universitas Indonesia/General Chair of ICACSIS 2014	
09.30-10.15	Plenary Speech I	Dr. Ir. Basuki Yusuf Iskandar, MA from Ministry of Communication and Information	
10.15-10.30	Coffee Break		
10.30-11.15	Plenary Speech II	Prof. Dame Wendy Hall from Southampton University, UK	
11.15.12.30	Lunch		
12.30-14.00	Parallel Session I : Four Parallel Sessions	**See Technical (Parallel Session I Schedule)**	Elang, Kasuari, Merak, Cendrawasih Room, Lobby Level
14.00-15.30	Parallel Session II: Four Parallel Sessions	**See Technical (Parallel Session II Schedule)**	Elang, Kasuari, Merak, Cendrawasih Room, Lobby Level
15.30-16.00	Coffee Break		
16.00-17.30	Parallel Session III : Four Parallel Sessions	**See Technical (Parallel Session III Schedule)**	Elang, Kasuari, Merak, Cendrawasih Room, Lobby Level
17.30-19.00	Break		
19.00-22.00	Gala Dinner	Dinner, accompanied by music performance and traditional dances	Dirgantara Room, 2nd Floor

ISBN : 978-979-1421-225

ADVANCED PROGRAM ICACSIS 2014

Sunday, October 19th, 2014-CONFERENCE			
Time	**Event**	**Event Details**	**Rooms**
08.00-09.00		Registration	Dirgantara Room, 2nd Floor
09.00-10.00	Plenary Speech III	Drs. Harry Waluyo, M.Hum from Directorate General of Media, Design, Science & Technology Based Creative Economy	
10.00-10.15		Coffee Break	
10.15-11.30	Plenary Speech IV	Prof. Masatoshi Ishikawa from University of Tokyo, JP	
11.30-12.30		Lunch	
12.30-14.00	Parallel Session IV : Four Parallel Sessions	**See Technical (Parallel Session IV Schedule)**	Elang, Kasuari, Merak, Cendrawasih Room, Lobby Level
14.00-15.30	Parallel Session V : Four Parallel Sessions	**See Technical (Parallel Session V Schedule)**	Elang, Kasuari, Merak, Cendrawasih Room, Lobby Level
15.30-16.00		Coffee Break	
16.00-16.30	Closing Ceremony	Awards Announcement and Photo Session	Dirgantara Room, 2nd Floor

ISBN : 978-979-1421-225

Table of Contents

ISBN : 978-979-1421-225

ISBN : 978-979-1421-225

Enterprise Computing

ISBN : 978-979-1421-225

ISBN : 978-979-1421-225

ISBN : 978-979-1421-225

 ISBN : 978-979-1421-225

ISBN : 978-979-1421-225

ISBN : 978-979-1421-225

ISBN : 978-979-1421-225

Fuzzy C-means for Deforestation Identification Based on Remote Sensing Image

Setia Darmawan Afandi[1], Yeni Herdiyeni[1], Lilik B Prasetyo[2]

[1] *Department of Computer Science, Fakulty of Matmematics and Natural Science, Bogor Agricultural University, West Java, Indonesia*

[2] *Departement of Conservation of Forest Resources and Ecotourism, Faculty of Forestry, Bogor Agricultural University, West Java, Indonesia*

Email : sastra.afandi@gmail.com, yeniherdiyeni@gmail.com

Abstract— **This research report about Fuzzy C-Means for Deforestation Identification Based On Remote Sensing Image. Deforestation means that changes forest area into another functions. Clustering is a method of classify objects into related groups (clusters). While, Fuzzy C-Means clustering is a technique that each data is determined by the degree of membership. In this research, the data used are MODIS EVI 250 m in 2000 and 2012 to identify deforestation rate in Java island. MODIS EVI is one of kind MODIS image which is able to detect vegetation based on photosynthesis rate and vegetation density. The number of clusters used were 13 clusters. This research had succeeded to classify areas based on the value of EVI like areas who had a high EVI values (forests, plantations, grass land), moderate values (agricultural area), and low values (build up area, mining area, pond, and other land cover). But, EVI value is only influenced by photosynthesis rate and vegetation density. Thus, EVI value is not well to identify forest areas. this is because the value of EVI in forest areas are almost same with plantations, savanna, etc.**

I. INTRODUCTION

Indonesia is one of many countries that has the greatest potential forest in the world. According to Indonesian forestry ministry in 2011, Indonesia has 98.8 million hectares forest area. But on the other hand, the facts show Indonesian forests are very alarming shrinkage. It is caused by changing forest areas into another functions, like industrials, residences, plantation, mining area etc. it is also called deforestation. Deforestation rate period 1985 - 1997 recorded 1.6 million hectares per year. Meanwhile, in 1997 - 2000 recorded 3.8 million hectares per year. The details of the rate of deforestation in Indonesia can be seen in Figure 1.

Under these conditions, forest monitoring is very important in forest management and determine how severe deforestation rate in Indonesia. Forest monitoring process has many methods. Forest monitoring using field measurement system spent more time and more cost. So, other methods are needed that are faster, cheaper and more efficient.

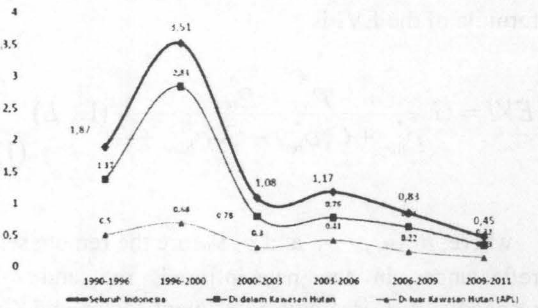

Fig. 1. Deforestation rate in Indonesia

Development of a system which can detect deforestation rate using remote sensing is one method to monitoring forest that can provide information quickly and accurately. Moderate Resolution Imaging Spectroradiometer Enhanced Vegetation Index (MODIS EVI) is used in this research. Why MODIS data used in this research?. Because MODIS data has a good spectral resolution and consists of 36 channels, having 3 temporal resolution, that are 250 m, 500 m and 1000 m and MODIS data is available every day, so we can develop a real time system for the future.

Some related research such as research which conducted by Setiawan. In that research, the authors performed classifying existing vegetations in the area of the Java island in 2000-2009 based on spectral differences reflected from every object in the image by using the k-means clustering with accuracy rate of 80.16% [1]. That research was further developed in 2013 to identify rate of change in forest cover which includes deforestation and reforestation in java island in 2000-2009 with the accuracy of 50.34% [2]. While in this research, focused to analyzes deforestation rate in the java island in 2000 and 2012 by using Fuzzy C-Means clustering method.

II. REMOTE SENSING AND MODIS EVI

Remote sensing is a technique for obtaining information about an object, area, or phenomenon through the analysis of data obtained from devices that are not directly in contact with the object, area, or phenomenon being observed [3]. Moderate Imaging Spectroradiometer (MODIS) is one type of data from satellite images. MODIS data have real visibility for 2330 km and available every 1 or 2 days. Data MODIS has 36 spectral bands and has 3 spatial

ISBN : 978-979-1421-225

resolution, those are 250 m, 500 m, and 1000 m. With these specifications, the MODIS data are able to provide much information about the state of the earth's surface, ocean, and atmosphere [4].

Vegetation indices is the result obtained from some combination band (wavelength) of image and has a relationship to the characteristics of pixels that contained in an image. Vegetation indices derived from wave energy emitted by vegetation in remote sensing image to show the size and amount of plant life. EVI is one of the transformations obtained from the comparison of reflectance red channel, blue channel, and near infrared sensor MODIS [3]. The formula of the EVI is

$$EVI = G\frac{\rho^{\bullet}_{nir} - \rho^{\bullet}_{red}}{\rho^{\bullet}_{nir} + C_1\rho^{\bullet}_{red} - C_2\rho^{\bullet}_{blue} + L}(1 + L) \quad (1)$$

where, $\rho^{\bullet}_{nir}$, $\rho^{\bullet}_{red}$ and $\rho^{\bullet}_{blue}$ are the remote sensing reflectances in the near-infrared, red and blue, respectively, L is a soil adjustment factor and C_1 and C_2 describe the use of the blue band in correction of the red band for atmospheric aerosol scattering. The coefficients, C_1, C_2 and L, are empirically determined as 6.0, 7.5 and 1.0, respectively. G is a gain factor set to 2.5 [6].

EVI value is strongly influenced by the rate of photosynthesis and the density of vegetation in an area. This is because, the vegetation will reflect near infrared and green waves and absorbs red and blue wave. if we see from the formula of EVI that has been described previously. If the vegetation in an area are very high. $\rho^{\bullet}_{nir}$ will has high value. Meanwhile $\rho^{\bullet}_{red}$ and $\rho^{\bullet}_{blue}$ will have low value. So, it will make EVI value will be very high.

III. Fuzzy C-Means (FCM)

The Fuzzy C-Means (FCM) algorithm is a clustering algorithm developed by Dunn, and later on improved by Bezdek. It is useful when the required number of clusters are pre-determined. Thus, the algorithm tries to put each of the data points to one of the clusters. What makes FCM different is that it does not decide the absolute membership of a data point to a given cluster. Instead, it calculates the likelihood (the degree of membership) that a data point will belong to that cluster. The algorithm of the Fuzzy C-means clustering is

1. Set the partition matrix µf (c) randomly
2. Set the value of w> 1 (ex: w = 2)
3. Set the value of the correction factor with a very small value (ex: Eps = 0.01)
4. Set the maximum iterations (ex: 500 iterations)
5. Set the initial value of the objective function (P_t (c)) randomly
6. Add iteration: t = t + 1
7. Calculate the center of vectors:

$$v_{fi} = \frac{\sum_{k=1}^{N}(\mu_{ik})^{w} u_k}{\sum_{k=1}^{N}(\mu_{ik})^{w}} \quad (2)$$

8. Modify the membership value:

$$\mu_{ik}(y_k) = \left[\sum_{g=1}^{c}\left(\frac{|u_k - v_{fi}|^2}{|u_k - v_g|^2}\right)^{1/(w-1)}\right]^{-1} \quad (3)$$

9. Modify the partition matrix
10. Calculate the objective function:

$$P_t(c) = \sum_{k=1}^{N}\sum_{i=1}^{c}(\mu_{ik})^{w}\left|Y_k - V_{fi}\right|^2 \quad (4)$$

11. Check the stop condition

IV. Method

Study Area

The island of Java is located on the southern rim of the Indonesian archipelago and comprises an area of 132792 km2. Forest allocation covers about 19% of area, which consist of 1916964 ha of production forest (12.74%), 650 619 ha of protected forest (4.32%), and 442,188 ha of conservation forest (2.94%) [7]. Regarding to the statistical data of Indonesia [8], Java comprises only 7% of the total land area of Indonesia, however, Java's population accounts for 70% of the total population of Indonesia or 1026 inhabitants per km2. The distribution of these allocations areas is shown in Figure 2

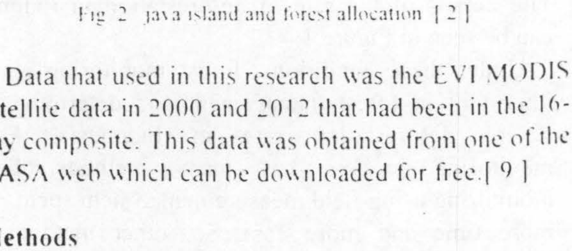

Fig 2 java island and forest allocation [2]

Data that used in this research was the EVI MODIS satellite data in 2000 and 2012 that had been in the 16-day composite. This data was obtained from one of the NASA web which can be downloaded for free.[9]

Methods

This research consists of several steps: Data Acquisition, Prepocessing Data, Image Feature

ISBN : 978-979-1421-225

Reduction, Clustering, and Evaluation. The flow of this research can be seen in Figure 3

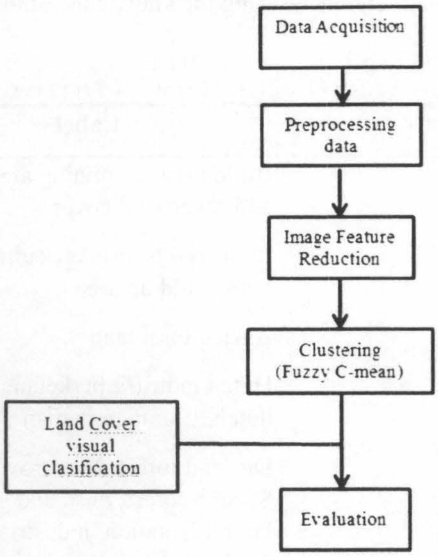

Fig. 3. Research flow

Data Acquisition

The data used is MODIS EVI (MOD13Q1) [9]. File extension is HDF. MOD13Q1 is one of the data generated by NASA for the vegetation index. This data is provided every 16 days with a spatial resolution of 250m. In this research, the analyzed area is Java island with data period in 2000 and 2012. To get an overall image of Java island requires 2 data HDF. So, it takes 46 data in a year.

Preprocessing data

At this step, it does not need to change the pixel values into EVI values, because MOD13Q1 already automatically have the value of EVI. The data have been downloaded from the NASA website with HDF extension. it will be converted into GEOTIFF using MODIS Reprojection Tools (MRT). The next step, the image is cropped in order to produce the image area of Java island only. Then, combine 23 images into one image in a year using average composite. Average composite is the process of taking the average value of each pixel from some images data. So, from 46 data used will be generated into 2 images data.

Image Feature Reduction

The next step, reducing image feature based on wavelet method.. In addition to reducing image feature, wavelet can also reduce noises in the image and reduce execution time in clustering . The type of wavelet used in this research is Haar wavelet level 1 and level 2.

Clustering

Clustering process in this research using Fuzzy C-Means (FCM). Clustering process will classify forest and non-forest areas based on the value of the EVI. To determine forest and non-forest areas of the clustering results based on data from visual classification of Land cover. After the specified area of forest and non-forest, then the data will be compared with data in 2012 and 2000 to get the area deforested.

Evaluation

The evaluation process in this result is to compare the results of this research with data from visual classification of Land cover .

V. Result

Data acquisition

Data had been taken by downloading MODIS EVI that were obtained from NASA's official website which can be downloaded for free [9]. The code of data used in this research is MOD13Q1 H28-V29 and H29-V29 with coverage of the java island. There were 86 data had been dowloaded in this research which were consist of 40 data in 2000 and 46 data in 2012. Total of data size were 5.56 GB with HDF extension file

Preprocessing data

At this step, data were converted from HDF into GEOTIFF using MODIS Reprojection Tools (MRT). Conversion process was used UTM projection type and scale of 1 pixel: 250 meters. The conversion process produced images that were 20 images in 2000 and 23 image in 2012 with the image dimensions of 9711x4501. This image covered an area of the Java island and some parts of the Borneo and Sumatra island. The next process was cropped image in order to get the image of the Java island only. Cropping process had been done by using OpenCV in order to produce data accurately and equally in every image.

Cropping process produced an image that had 4229x1385 dimensions. Next process, image pixel value in a year were averaged to produce 1 image in 2000 and 1 image in 2012. This process was due to the EVI value in agricultural areas is very volatile. Thus, in the growing season, the value of EVI in agricultural areas have a very high value, almost like EVI values in the forest area. Meanwhile, when the harvest season, agricultural area has a fairly low EVI values. So, average composite was done to anticipate the detection of agricultural areas as forest area.

Image Feature Reduction

Reduction process was done to reduce the computational time on the clustering process. Image reduction process in this research using the Haar wavelet method. Wavelet can also reduce noise in the image. Wavelet had been processed until level 2. Thus, the resulting image with dimensions 2114 x 692 at level 1 and 1057 x 346 at level 2.

 ISBN : 978-979-1421-225

Clustering

Implementation of FCM clustering was done using C++ programming language and openCV2.2 by using codeblock 13.12. Clustering would categorize EVI value of image which had 2114 x 692 in wavelet level 1 and 1054 x 346 in wavelet level 2. Clustering process was implemented using global-based approach, that`s means clustering was done simultaneously without image partition. The parameters used in this research were 500 iterations, 0.001 tolerance value and 13 clusters .

Clustering process was done by classifying the EVI values were normalized. normalization used to reduce the computation time. In this research, the process of clustering with data that has been normalized able to reduce computation time by 20%. The results of clustering on the level 1 wavelet image can be seen in figure 4, while the results of clustering on level 2 wavelet image can be seen in figure 5. The normalization process was done by using the formula:

$$EVI_{normalisasi} = \frac{EVI_{max} - EVI}{EVI_{max} - EVI_{min}} \quad (5)$$

Figure 4 and Figure 5 shows the membership of each cluster. The horizontal axis shows the cluster, while the vertical axis shows the number of pixels in the cluster.

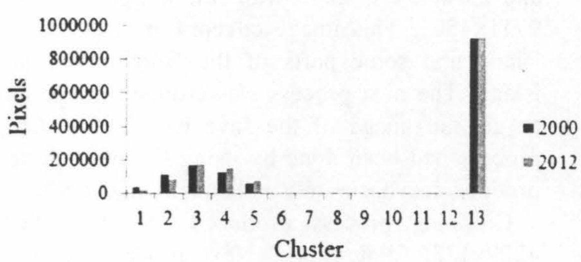

Fig. 4. Clustering result wavelet level 1

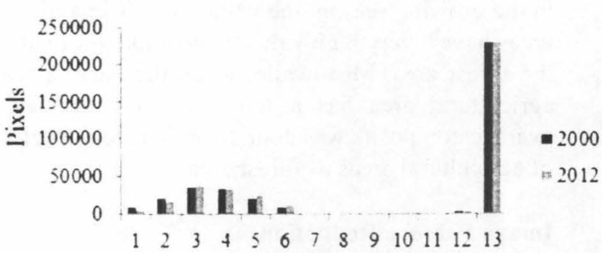

Fig. 5. Clustering result wavelet level 2

Table 1 and Table 2 described the label of each cluster. Labeling was done by compared with reference map from planologi department, ministry of forestry. Based on the reference map there are 12 areas, those are dryland forest, mangrove forest, swamp forest, bush and grass land, industrial forest plantations. plantations. agricultural land and bush, pond. build up area. mining area. swamps. and other land cover. The technique of determining the area on the map references using the knowledge of experts.

TABLE I
CLUSTER LABELLING IMAGE WAVELET LEVEL I

Cluster	Label
1	Build up area. mining area. pond, and other land cover
2	Industrial forest.Agricultural land.Build up area
3	Agricultural land
4	Hutan industri. perkebunan. hutan. daerah pertanian
5	Dryland forest. Mangrove forest, Swamp forest. bush and grass land. Plantation. industrial forest, Agricultural land
6. 7. 8. 9. 10. 11. 12	Boundary of island (Noise)
13	Outlier

TABLE 2
CLUSTER LABELLING IMAGE WAVELET LEVEL2

Cluster	Label
1	Build up area. mining area. pond. and other land cover
2	Agricultural land,Build up area
3	Agricultural land
4	Industrial forest. Agricultural land
5	Industrial forest. Plantation. Dryland forest
6	Dryland forest. Mangrove forest. Swamp forest. bush and grass land. Plantation. industrial forest. Agricultural land
7. 8. 9. 10. 11. 12	Boundary of island (Noise)
13	Outlier

Based on Figure 4 and Figure 5. and an explanation of each clustering on Table 1 and Table 2 can be seen that the wavelet level 2 was better than wavelet level 1. It was because the wavelet level 2 was able to define the image with more detail and can reduce noise by doing a filter on pixel values that are too high or too low. In this research. wavelet will reduce outlier regions and boundary regions of the island.

ISBN : 978-979-1421-225

Another advantage of wavelet in this research were able to reduce the computational time with very significant in clustering process. In the original image, the computational time on clustering process more or less for 360 minutes. Meanwhile the image of the wavelet level 1 and level 2 were for 120 minutes and 30 minutes. It can be concluded that the wavelet level 1 and level 2 can reduce the computational time for 240 minutes (66%) and 330 minutes (91%)

If we look at Table 2, there were some clusters that had the same label such as the agricultural and industrial forest areas. It was because the type of agricultural area that had many variations such as dryland farming, wetlands farming, and others. Besides that, differences in period of each plant can made differences in EVI values significantly. Meanwhile, the industrial forest was heavily influenced during growth, harvest and post-harvest period. When the post-harvest period EVI value was very low. It was because there were no photosynthetic that occurs because vegetation was not there anymore. Meanwhile, when the growth period, the value of EVI was very high because the plant had a very high rate of photosynthesis.

On the other hand, there was a cluster defined in several different areas such as cluster 6 was defined as a dryland forest, mangrove forest, swamp forest, industrial forest ,plantations, agricultural land, bush and grass land. it was because the areas had same rate of photosynthesis value and density of vegetation value. So the areas were defined in the same cluster

Table 3 described range of EVI value for each cluster. It was seen that, the outliers had the highest value. It was because the representation of value in the MOD13Q1 was 16 bits with a value of 65 536 as outlier. While EVI values was defined from 0 to 10 000. The boundary area(Noise) had EVI value from 120 - 253. Noise occured because when the average composite, EVI value of the boundary island were averaged with outlier values. So, boundary area had a very high value.

While cluster 6 was a cluster that had a very high EVI values, followed by cluster 5, cluster 4, cluster 3, cluster 2, and cluster 1. As described previously, the EVI value was determined by photosynthesis rate and vegetation density. It can be concluded that cluster 6 had a high photosynthesis rate and vegetation density very much. Whereas in cluster 1 are defined as Build up area, mining area, pond, and other land cover that had a little vegetation.

TABLE 3
EVI VALUE IN EVERY CLUSTER

Cluster	**Label**	**EVI value (degree of membership)**
1	Build up area, mining area, pond, and other land cover	1 (1) – 34 (0.43)
2	Agricultural land,Build up area	35 (0.45) – 47 (0.6)
3	Agricultural land	48 (0.53) – 56 (0.66)
4	Industrial forest, Agricultural land	57 (0.83) – 63 (0.85)
5	Industrial forest, Plantation, Dryland forest	64 (0.9) – 71 (0.9)
6	Dryland forest, Mangrove forest, Swamp forest, bush and grass land, Plantation, industrial forest, Agricultural land	72 (0.9) – 89 (0.9)
7,8,9, 10,11, 12	Boundary of island (Noise)	120 (0.9) – 253 (0.9)
13	Outlier	254 (1) – 255 (1)

If we look at table 3, cluster 1 was a cluster that had a very high EVI values and most of the members of the cluster was forested areas, so that the cluster was defined as forest area.The forest area in this research can be seen in Figure 6. Forest area on image wavelet level 2 can be calculated using the formula:

$$Area = total\ pixel * 6.25\ ha * 16 \quad (6)$$

This formula based on scale of MODIS image used is 1: 250 m so, to calculate the area of a pixel can be multiplied with 6.25 ha. While multiplication with 16 based on wavelet level 2 will reduce 1/16 image size than the actual size.

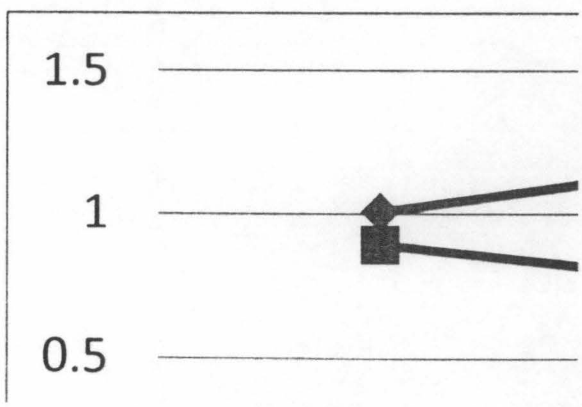

Fig. 6. Forest area

From Figure 6, we can see that the experiment result showed the increase of forest areas or reforestation of 214 700 ha. Meanwhile, reference showed the decrease of forest area or deforestation of 165 392.60

ISBN : 978-979-1421-225

ha. This difference was happened because the EVI value just depends on the photosynthesis rate and vegetation density. Thus, the forest area which was defined in this research covers dryland forest, mangrove forest, swamp forest, industrial forest ,plantations, agricultural land, bush and grass land that had EVI values are almost same. In the reference, swamp forest, grass land and plantations areas had expanded. On the other hand, industrial forest area had been detected as a forest in this research had been also increased.

Evaluation

This research had successed to classify areas based on the value of EVI such as the area that had high EVI values (forests, plantations, grass land), medium (agricultural land), and low EVI value (Build up area, mining area, pond, and other land cover). But, EVI value was only influenced by the rate of photosynthesis and vegetation density. Thus, it was difficult to detect areas in more detail. For example, forest areas were detected in cluster 1 with other areas such as mangrove forest, swamp forest, industrial forest, plantations, agricultural land, bush and grass land. In addition, the forest area was also detected in cluster 2 with industrial forest and plantation area

VI. Conclusion

This research had successed to classify areas based on the value of EVI such as the area that had high EVI values (forests, plantations, grass land), medium (agricultural land), and low EVI value (Build up area, mining area, pond, and other land cover). But, EVI value was only influenced by the rate of photosynthesis and vegetation density. Thus, it was difficult to detect areas in more detail.

VII. References

[1] Setiawan et al, *Characterizing Temporal Vegetation Dynamics of Land Use in Regional Scale of Java Island, Indonesia*, J.Land Use Sci.iFirst, 1-30, 2011

[2] Setiawan et al, *Characterizing the Dynamics Change of Vegetation Cover on tropical Foretlands Using 250 m multi – temporal MODIS EVI*, 2013.

[3] Lillesand, thomas M, Ralph W.Kiefer, *Remote Sensing and Image Interpretation*, Canada : John Wiley & Sons, Inc, 1979

[4] Schowengerdt, Robert A, *Remote Sensing (Third Edition) :Models and Methods for Image Processing.* United state of America: Elsevier Inc, 2006

[5] Duda,Richard O et al, *Pattern Clasification Second Edition*, New York: John Wiley & Son, 2001

[6] Huete, A.R., Liu, H.Q., Batchily, K., and Van Leeuwen, W, "A Comparison of Vegetation Indices over a Global Set of TM Images for EOS-MODIS," *Remote Sensing of Environment*, 59, 440–451,1997.

[7] Ministry of Forestry, 2008. Recalculation of land cover in Indonesia 2008 , The Agencyof Forestry Planning, Department of Forestry, Republic of Indonesia.

[8] BPS-Statistics of Indonesia, 2003. *Statistics of Indonesia 2003. The Indonesian Cen-tral Agency on Statistics, BPS, Indonesia.*

[9] National Aeronautics and Space Administration. (2013, Feb 14) . MOD13Q1 [online]. Available: ftp://ladsweb.nascom.nasa.gov/allData/5/MOD13Q1/

ISBN : 978-979-1421-225