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Table of Content

PREDICTION OF PADDY FIELD CROPPING PATTERN USING TIME SERIES MODIS IMAGE IN EAST JAVA

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ABSTRACT

Land conversion of paddy field that continuously in East Java will affecting the production in the area of paddy field. Cropping intensity can supported the food safety. Mapping of distribution cropping pattern paddy field is necessarily important to obtain sustainability paddy field area. This research aimed to predict the area of paddy field in East Java Province using MODIS image product with EVI composite 16-day resolution of 250 meters and show the distribution cropping pattern of paddy field. Groundcheck was conducted as actual validation to know the cropping pattern in their location. The cropping area is 1,369,613 ha and harvested area of paddy field is 1,310,307 ha.

Key word: MODIS, paddy field, cropping pattern

1. INTRODUCTION

Adequacy of food needs can be done by ensuring the availability of agricultural land. The total population of East Java as 37,476,757 people [4], and also further increase economic development in East Java is generally accompanied by a land conversion from agriculture to the others. When this occurs with high frequency and amount, it will threaten food security. Therefore it is necessary to predict the cropping pattern in agricultural land, especially paddy in relation to cropping intensity.

According to data of village potential in 2006 [5] , there are significant transitions of land use conversion of paddy field from 2003-2006. Paddy field land use was decreased and converted into 5,665 ha (31.86%) of non-paddy land use, 8,567 ha (48.16%) of residents, 1,204 ha (6.77%) of industrial building, 693 ha (3.90%) of land for office or corporation building, and 1,651 ha (9.29%) for other purpose. This transition of land use will affect the rice production in East Java [1]. while the influence of El Niño and La Niña conducted Liyantono et al 2012 showed that El Niño does not affect agricultural production in Nganjuk, and the other hand La Niña has an influence [6].

This study was conducted to determine the type of cropping pattern in East Java by using *k-mean algorithm* in MATLAB software. This is done to help determine the intensity of land use of agricultural land, especially paddy rice cultivation.

2. METHODOLOGY

2.1. Study Area

East Java Province geographically located between 111°0' – 114°4' Longitude and 7^0 12'–$8^0$48" Latitude. East Java Province is bordered between Central Java and Bali. It has an area of 47,963 km^2 which consist of two main part, east java and Madura island [4]. The regency is administratively divided into 29 Regencies and 9 cities.

2.2. Method of Prediction

2.2.1 Collecting Data

At this stage, the data are collected in the form of image MODIS data. Map administration of East Java Province obtained from the Geospatial Information Agency (BIG). Landuse East Java obtained from government of agricultural sub-section land databases. Distribution of paddy field area of East Java obtained from Statistical Center Agency (BPS).

The MODIS product used in this study is MOD13Q1. It comprises the Vegetation Indices (VI) Composite 16-day 250 m, which provided the seasonal for the paddy field patterns. This dataset had been systematically corrected for the effects caused by gas and aerosol scattering. The EVI minimizes atmospheric influences with the aerosol resistance term which use the blue band to correct aerosols influence in red band [2]. The MODIS developed the EVI for use with MODIS data using this equation:

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$$EVI = G\frac{\rho_{MODIS,}NIR - \rho_{MODIS,}R}{\rho_{NIR} + C_1 \times \rho_{MODIS,}R - C_2 \times \rho_{blue} + L}$$

Where G is a gain factor, C_1 and C_2 describes the use of the blue band in correction of the red band for atmospheric aerosol scattering and also L as coefficient.

2.2.2. Handling and Analysis

16-day composite MODIS data for 14 years (2000-2014) collected to get EVI value. The value then stacked and joined using MATLAB software regarding to East Java Province area. From this stacking result, cropping pattern can be determined as one pixel thoroughly which is actually sized 250 m. Wavelet transform was used to reducing noise (filter). Figure 1 show the wavelet method to reduce noise on pattern.

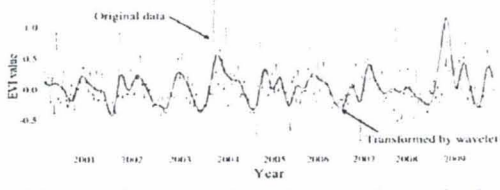

Figure 1 Reduce noise using wavelet method (Setiawan 2010)

The pattern on this MODIS data analyzed using *k-mean algorithm*. At this stage, the object for clustering is a signal that is formed based on the EVI with continuous temporal data. Determination of the clusters number or value of K is done using MATLAB software. Treatment of iterations performed to obtain class convergent. BPS data and ground check have been done to fulfill accuracy assessment.

Recognizing cropping pattern using temporal data from EVI value and the average age of cropping pattern. Normally paddy field have fourth month approximately for cultivation from preparation planting until harvesting.

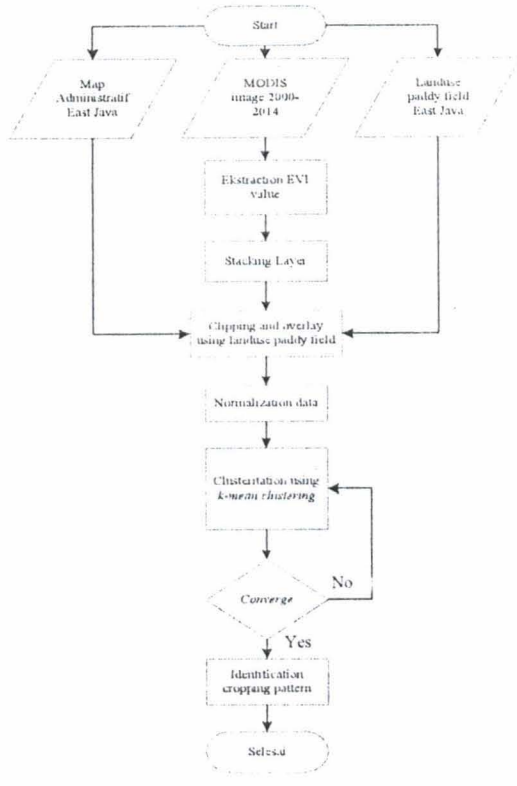

Figure 2. Flowchart methodology

4. RESULT AND DISCUSSION

4.1. Recognize cropping pattern in East Java

The process of recognizing patterns of rice plants using EVI value, as described in the methodology. Table 1 shows that the average top EVI value for the pattern of one year with three cropping seasons and also the average age of the cropping pattern. There are three types of paddy cropping pattern that can be recognized with this method as shown in Table 1. In addition to cropping paddy pattern, other plants also detected four cropping pattern that cannot be defined.

Table 1. Recognize cropping pattern of paddy field

Cropping pattern	Age			EVI value		
	Season 1	Season 2	Season 3	Season 1	Season 2	Season 3
Paddy-paddy-bare land	8.09±0.604	6.95±0.766	6.56±0.707	0.527±0.038	0.536±0.031	0.21±0.024
Paddy-paddy-secondary crop	7.524±0.823	6.886±0.637	6.504±0.768	0.600±0.029	0.542±0.035	0.460±0.029
Paddy-secondary crop-bare land	8.214±1.080	5.929±0.593	3.692±1.012	0.541±0.029	0.370±0.026	0.251±0.023
Sugarcane	18.36±0.622			0.54±0.019		
Mix and paddy in first season dominantly	18.57			0.548		
Mix and annual crop dominantly	18.29			0.475		
Mix and fishpond dominantly				0.271		

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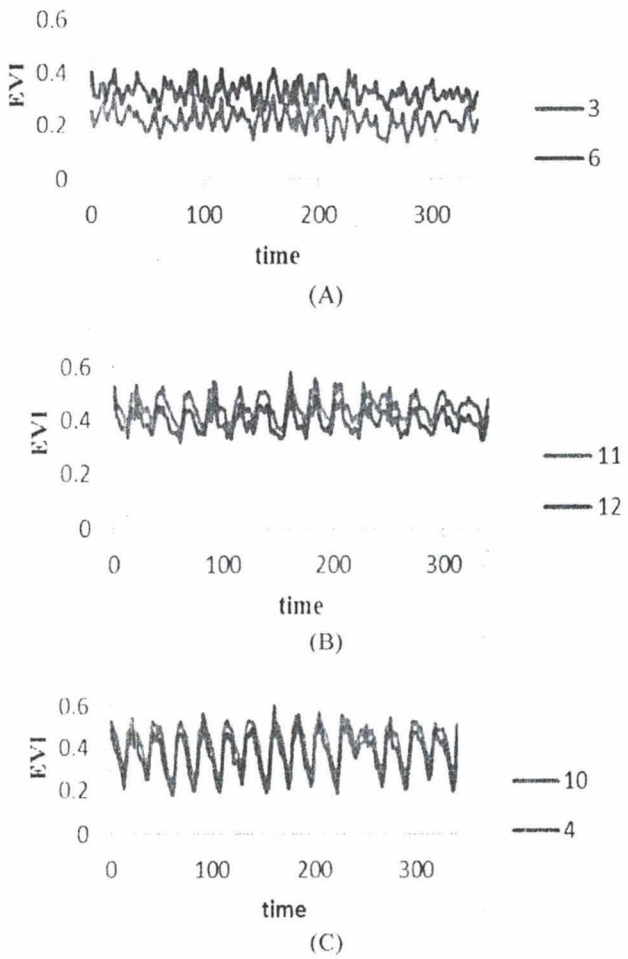
Mix and housing dominantly	0.379

4.2. Prediction using MODIS image Provinces East Java years 2000-2014

In this study, defining the cropping pattern using EVI values from stacking MODIS images is formed. To define rice cropping intensity, long-time series of MODIS images can be used [3]. The distribution of paddy fields in East Java can use landuse paddy field as data boundary in process to minimizing errors taking.

From the analysis results of EVI, at least twelfth types of paddy field were distinguished which broadly represent the cropping pattern in paddy fields of Java (Figure2). Distribution of these cropping pattern are given in Figure 3.



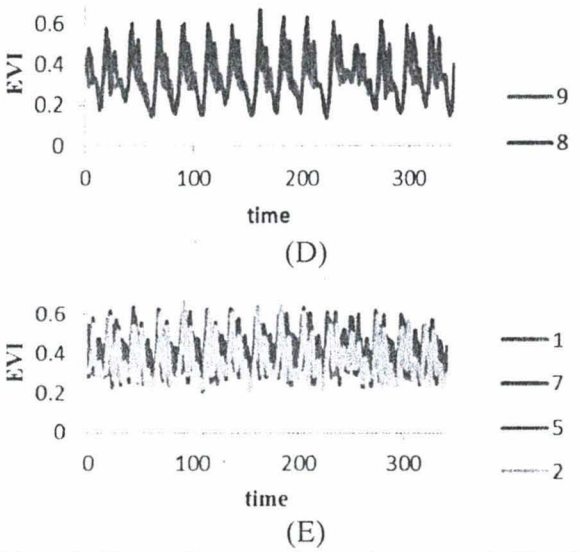


Figure 3. The twelfth type of cropping pattern in East Java from agricultural field and recognized the temporal vegetation pattern of EVI (MODQ13Q1) product. (a) type 1 and 2. (b) type 11 and 12. (c) type 4 and 10. (d) type 8 and 9. (e) type 1,2,5, and 7.

Can be seen in the image above that the cropping pattern in East Java province has diversity. The use of k-mean clustering algorithm can divide the same cropping pattern with different planting season. In Figure 2 section (E) which describes the cropping pattern of paddy-paddy-secondary crops there are four classes are defined as paddy-paddy-secondary crop, and that class have the same cropping pattern but clustered by k-mean clustering algorithm because it has a different. Then in section (D) is defined as the cropping pattern of paddy-paddy-bare land for type 8 and paddy-secondary crops- bare land for type 9.

Figure 2 in section (A) can be seen a pattern with EVI values below 0.3 for type 3 and below 0.4 for grade 6. EVI value with the pattern formed is defined as a mixture with a dominant fishponds and housing. Section (B) illustrates the pattern of annual crops, the EVI value is never below 0.4 for type 11. Then defined for that pattern is a cropping pattern of sugarcane. As for the class 12 has a pattern with EVI values below 0.3 then there are other plants that defined the dominant form of annual plants.

Table 2. Summary of cropping pattern and value of prediction

Type	Cropping Pattern	Pixel	Cropping Area	Harvested Area of Paddy	Sugarcane	Another Cropping
1	Paddy-paddy-secondary crop	13,655	85,344	170,688		
2	Paddy-paddy-secondary crop (corn dominantly)	9,660	60,375	120,750		
3	mix and fishpond dominantly	4,550	28,438			28,438
4	mix and paddy in first season dominantly	32,191	201,194	201,194		201,194
5	Paddy-paddy-secondary crop (tobacco dominantly)	17,886	111,788	223,576		
6	mix and housing dominantly	13,469	84,181			84,181
7	Paddy-paddy-secondary crop	12,257	76,606	153,212		
8	Paddy-paddy-bare land	13,505	84,406	168,812		
9	Paddy-secondary crop-bare land	11,949	74,681	74,681		
10	mix and paddy in first season dominantly	31,583	197,394	197,394		197,394
11	sugarcane	25,289	158,056		158,056	
12	mix and annual crop dominantly	33,144	207,150			207,150
	Total	219,138	1,369,613	1,310,307	158,056	517,163

Table 2 was shown identity of every single type and also value of prediction. Cropping pattern of paddy field showed on type 1,2,5,7,8,and 9. Sugarcane on type 11 and mix vegetation in another type. This condition has been affected because land convertion from paddy field to another vegetation and also size of MODIS image have 250 m in one pixel. That size represent 6.25 ha in one pixel however within the area that represented on one pixel, there are not filled with only paddy field.

That table also shown the total cropping area is 1,369,613 ha and total harvested area of paddy field is 1,310,307 ha. That approach value assest from pixel area in distribution cropping pattern of paddy field on East Java province. Sugarcane area predicted 158,056 ha from pattern and distribution that value.

Another cropping value are cropping pattern within mix vegetation that mean the cropping pattern cannot be defined currently. Because in one pixel there is have two or more vegetation and also for every EVI value vegetation is different.

Distribution cropping pattern in East Java can be shown in Figure 3. That show eight cropping pattern with distribution, each region has some cropping patterns, and also has a dominant cropping pattern.

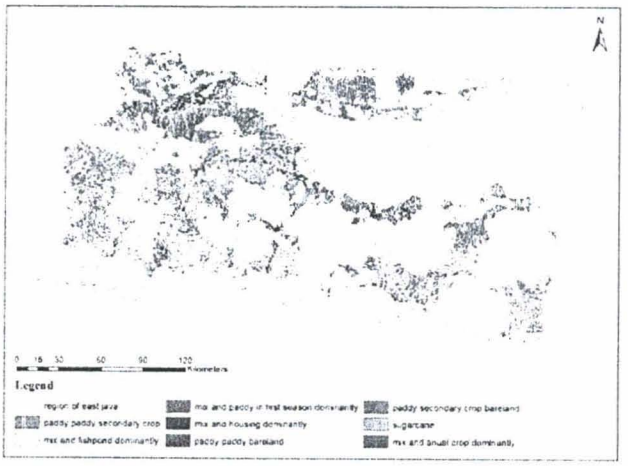


Figure 3. Distribution of these cropping pattern in East Java

4.3. Accuracy assessment

The use of cropping pattern of paddy fields in East Java, which is obtained based on the EVI and the results of prediction are three main cropping pattern paddy-paddy-secondary crop, paddy-paddy-bare land, and paddy-secondary crop-bare land. Classifications of specific types were evaluated by 48 reference samples, which revealed the overall accuracy to be 74.431%, that calculation can be shown at table 3.

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Table 3 Confusion matrix for cropping pattern of paddy field on East Java

Classified cropping pattern	Reference data cropping pattern								Users accuracy (%)	Error (%)
	P2p	CF	CP	CH	P2B	PpB	T	CC		
Paddy-paddy-secondary crop (P2p)	7				2	2			63.64	36.36
Mix and fishpond dominantly (CF)		1							100.0	0.00
Mix and paddy in first season dominantly (CP)			2				2		50.00	50.00
Mix and housing dominantly (CH)				1		1	1		33.33	66.66
Paddy-paddy-bare land (P2B)	1				6				85.71	14.29
Paddy-secondary crop-bare land (PpB)	2					6			75.00	25.00
Sugarcane (T)	2		2				3		42.86	57.14
Mix and annual crop dominantly (CC)	2				1			4	57.14	42.85
Procedures accuracy (%)	50.00	100	50.0	100	66.67	66.67	50.0	100		
Error (%)	50.00	0.0	50.0	0.0	33.33	33.33	50.0	0.0		
	Overall accuracy = 74.43 %									n: 48

Based on the results of the calculation are shown in Table 3 are the biggest error paddy-paddy-secondary crop with 36.36% error, secondary paddy crop-bare-land with a 25.00% error, paddy-paddy-bare land with 14:29% error. Low accuracy results showed inability MODIS image to identify vegetation and also the value reaches 100% accuracy is a lack of samples in evaluating cropping patterns that exist in the field.

5. CONCLUTION

In this study, image satellite is used to recognize the cropping pattern in East Java province. Methods for prediction the cropping pattern in East Java successfully with predictable eight patterns are three main patterns paddy-paddy-secondary crop with accuracy 63.64%, paddy-paddy-bare land with accuracy 85.71%, and paddy-secondary crop-bare land with accuracy 75.00%. and the method to estimate cropping pattern area is 1,369,613 ha and harvested area of paddy field is 1,310,307 ha.

6. REFERENCES

[1] Hidayat SI. 2008. Analisis Konversi Lahan Sawah di Provinsi Jawa Timur (ID). *Jurnal SEP. Vol. 2 No. 3. Hal 48-58.*

[2] Huete AR, Didan K, Miura T, Rodrlquez EP, Gao X, Ferreira LG. 2002. Overview of the radiometric and biophysical performance of the MODIS vegetation index. *Remote Sensing of Environmen*t. 83 (2003) : 195-213.

[3] Setiawan Y, Rustiadi E, Yushino K, Liyantono, Effendi H. (2014) Assessing the Seasonal Dynamics of the Java's Paddy Field Using MODIS Satellite Images. *ISPRS International Journal of Geo-Information.* 3 (2014): 110-129. doi: 10.3390/ijgi3010110.

[4] www.jatim.bps.go.id

[5] Hidayat SI. 2008. Analisis Konversi Lahan Sawah di Provinsi Jawa Timur. *J-SEP.* 2 (2008): 48-58.

[6] Liyantono, Kato T, Yoshida K, Kuroda H. 2012. The influence of El Niño southern oscillation on agricultural production sustainability in tropical monsoon region: case study in nganjuk district, east jawa, Indonesia. *Journal of Development in Sustainable agriculture.* 7 (2012): 65-74. doi: 10.11178/jdsa.7.65

This contribution has been peer-reviewed