IDENTIFICATION OF PADDY FIELD FROM VERY HIGH RESOLUTION IMAGE USING OBJECT BASED IMAGE ANALYSIS METHOD. (A CASE STUDY IN RANCAEKEK, BANDUNG, WEST JAVA, INDONESIA)

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Abstract: The calculation of existing land of food is very important to estimate the national food security. In this case remote sensing can be used as better alternative method in the paddy field identification. The study focuses on paddy field identification using very high resolution imagery, Quickbird imagery acquired in 2008, and applying OBIA (Object Based Image Analysis) as a method for analysis of paddy field in Rancaekek, Bandung, Indonesia. To identify an object, this method not only analyse the value of a pixel but also to consider the neighbour pixels. By the application of OBIA method in identifying wetland that it considers many parameters such as land form (shape), soil characteristics (spectral), land texture, and the relationship between wetland and other objects around them. The study found that OBIA method can be used to identify fields of raw land, generating a clear delineation of fields and also classified wetland according to the characteristics of paddy growth phase (water phase, vegetative, generative, and harvest phases) with accurate. Finally, the calculation of paddy field can be estimated from the results of image classification.

1. INTRODUCTION

As the rapid population growth rate, paddy field in Java tend decreased over period. Isa (2006) suggested that rapid conversion of agriculture land into non-agriculture is a major problem faced on the agricultural sector. This phenomenon prompted the Ministry of Agriculture to take a policy for setting a raw land so the food production continuity is not interrupted.

Rice plants (Oryza saliva) as one of the goods commodities, is the most important food and benefit the lives of the indonesian's people. Until now, more than 50% of national paddy production comes from Java. Therefore when the level of production and productivity of paddy has a decrease drastically it can affect the availability of the national paddy and will have a negative impact on other sectors.

On the globalization of information era to support the food security program required speed and accuracy of agriculture resources's information that more quantitative. It requires collecting data and agricultural information system that more accurate as soon as possible.

Remote sensing technology gives information about object over earth's surface using satellite's sensor and without coming directly to the field. Remote sensing is take a part on object identification therefore that object can be identified and distinguished with other object. All objects over earth's surface to be identified then segmenting and classifying to be different objects.Paddy field described as farming land that physically flat surface land, bounded dikes, can be planted rice crops or any other crops. (Ministry of Agriculture, 2010). Paddy field and all their characters have unique parameters so that can be distinguished with the other objects. The parameters is used as a reference on object based image analysis.

There are several methods of classification on remote sensing that belonging pixel based and object based. Pixel based method is image classification techniques with consideration of parameter values of pixels (digital number) of an image. This techniques distinguishes between object by the intensity values at each image pixel brightness.

While the object based method not only uses a value of pixels on imagery to judgement but also add more parameters such as the form (shape), spectral (texture and pixel), and relation (relations). To identify an object, object based image analysis not only see the value of a single pixel but also look at the whole object with consider condition of their neighbor pixels. With the implementation of object based image analysis (OBIA) method in identifying wetland classification is expected will get extensive paddy field close to the true value in the field.

The purpose of this research is to identify object in the form of paddy fields from high resolution imagery (Quickbird) then determined paddy field boundaries (delineation) therefor extensive's paddy field can be determined. identification and classification using OBIA.

2. DATA AND RESEARCH AREAS

The research was carried out in the area located in the Sukamanah District, South Bandung Indonesia. The data used on this research is Quickbird imagery acquire on August 13th. The image has been georeferenced to the geodetic datum WGS84 with Universal Transverse Mercator as system coordinate and TM-6 as projection system. Imagery data obtained consist 3 band of visible light (red, green, blue).

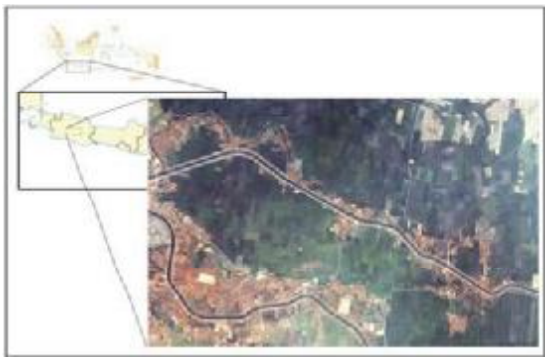


Figure 1 : Research Area, Sukamanah District, Rancaekek South Bandung

Geodetic coordinates of the area between*6° 58' 57. 02411" S, 107°. 42' 7.1083" E*until*6° 59' 56.9914" S, 107° 44' 1.8613" E*. The research area (Figures 1.) covers an area of approximately 640,7239 Ha, not only dominated by paddy field but also there are trees, houses, river, and vacant land.

3. RESEARCH METHODS

To identify paddy field there are three main step; image preprocessing, object based segmentation, and object based classification. Figures 3.1 illustrate our image analysis method and the relationship between the main components of the analysis process.

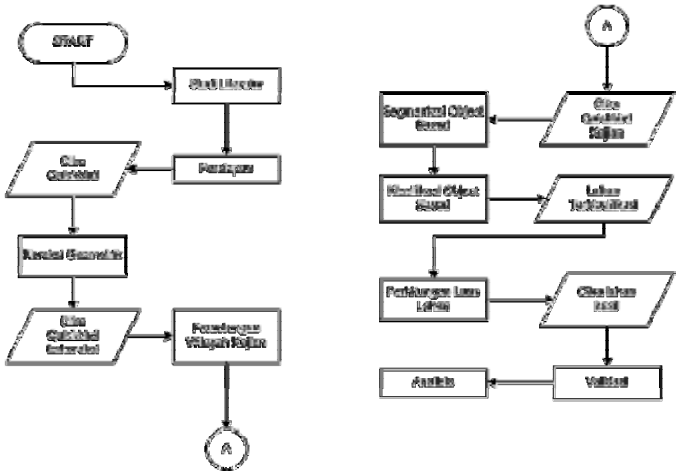


Figure 3.1 : Research Method Flowchart

3.1. Image Pre-Processing

The data that acquired from the satellite imagery can not directly used for the segmentation and analysis because it still contains systematic geometry errors. Pre-processing is the basic step of image processing therefor the image is free of systematic errors and has a form as close as possible to its original form on earth's surface. In this research image pre-processing includes geometric correction, cropping the image, and the image quality improvement.

3.1.1. Geometric Correction

The Quickbird data obtained have been corrected by the organizers of DigitalGlobe Quickbir Imagery. The image already have a projection map and an unique coordinate system. Because the image is already corrected, so no need to do geometric correction any more.

3.1.2. Imagery Cropping Based On Research Area

The data obtained covers Bandung City (Figure 3.2) while the Research area on South Bandung where the area is dominated by paddy field. Therefor, it is necessary to cut the image of the research are that will be used. Cropping images carried on the Quickbird imagery that were geometric corrected. Cropping images made within the borders *6° 58' 57. 02411" S, 107°. 42' 7.1083" E*until*6° 59' 56.9914" S, 107° 44' 1.8613" E*. Figure 1 shows the the result image cropping corresponding to research area.

Figure 3.2 : Quickbird Imagery of South Bandung

3.1.3 Image Enhancement

Image enhancement is a process to transform an imagery into a new imagery as needed through a variety ways. The common ways are transformation function, mathematical operations, filtering, and more. The main object of enhancement is to improve the quality of the image for a specific application (Sutoyo, et, al.,2009).

The image enhancement that used on this research is contras stretching process (Lillesand & Kiefer Ralpdh, 1994). Contras stretching make the area of gray level/ pixel values wider, so these values can be described in a full gray level area (Purwadhi, 2001). This process'aim is to adjust the contrast of the entire imagery to obtain a better view.

Figure 3.3 : The Data after Histogram Strecthing Enhancement

In figure 1 can be seen that the brightness level uneven areas, in the west looks darker and the east look brighter. This is possible due to the fog, clouds, or a different solar illumination intensity. Therefor, it is necessary to enhance the image by histogram strecthing with a value range of 3 standard deviation. As a result, the histogram stretching result on the Quicbird imagery (Figure 3.3), obtained better visualization so that the footpath on the border between paddy field more visible.

3.2. Object Based Segmentation

After image pre-processing by correcting geometric and radiometric error of the image, the next step is image segmentation. Segmentation is the process of making polygon (image objects) in the image. Polygon created based on parameters that determined the size and shape of the polygons.
Segmentation process construct by 5 parameters :

1. Scale Parameter
2. Color
3. Shape
4. Smooth
5. Compact

The main parameter is scale parameter that determined how many minimal number of pixel to form a polygon. Color defines the number of polygons based on the heterogeneity of gray value, shape defines the number of polygons based on the heterogeneity of form. Color and shape parameters are opposite each other, so the color plus shape should be equal to one. The higher color's value the more sensitive polygon made by the difference in value color/hue. Conversely, the higher shape's value, the smaller color's value, so that the polygon will retain its shape rather than make a variety of colors.

For segmenting an image, the fifth parameter value above must be specified for the best segmentation as expected. One set segmentation called one data level. Good level data are indicate by the form of polygon created. Good form of image objects are corresponding to the visually object on the imagery such as fields, houses, buildings, etc. In some cases, to identify an object is often not only need a data level, it requires more data level to identify and classify.

On this research, we combine segmentation's paramater including segmentation scale parameter on 5, 10, 20, 30, 40, 50, and the others percentage combination. Midle value (moderate) of each scale parameter are taken as experiment sample. Figure 3.5 shows the scheme of experiment carried out to obtain the best segmentation for paddy field.

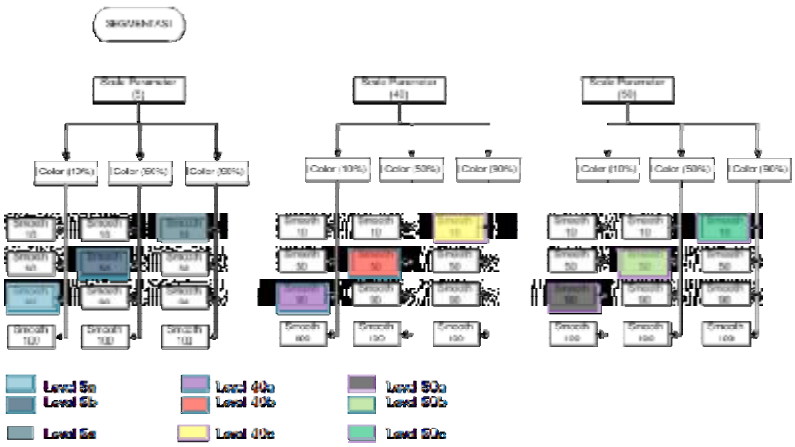


Figure 3.4 : Segmentation Experiment Scheme

Level data named based on the scale parameter's value followed by alphabet as a description of segmentation parameters percentage, as follows:

-alphabet a, 10% color's percentage , 90% smooth
-alphabet b, 50% color's percentage, 50 % smooth
- alphabet c, 90% color's percentage, 10% smooth

From each data level produced different segments. This difference segmentation is required to identify object according to its characteristics. For example, for rooftop segmentation it is better to used coarse segmentation (> level 50) because it can clearly formed polygon like a rooftop while for trees it prefer to use fine segmentation (level 5, 10, 20, 30) because of they need a small segment as the main constituent of trees objects.

3.3 Object Based Classification

After segmenting the imagery into image objects, the next step is image classification. Classification aims to identify an object to become a unique object that is different from any other. OBIA classification method based on characteristics of the classified object. Paddy field as the main object of the research is described by its characteristics, it include shape, size, digital number of paddy field's pixels, and relationship with surrounding objects such as rivers, buildings, trees, as well as with the other paddy fields.

OBIA classification method described by parameters that make up the nature of the classified objects. These parameters are layer value, shape, and relational.

3.3.1. Layer Value

Described as the parameters that classify an object based on the digital number's value of image objects. Digital number's value can be seen from the level of brightness, each band pixel values, or the difference of the pixel values on each band. Layer value compose form several parameters ; brightness value, mean red, mean green, mean blue, and maxx difference.

3.3.2. Shape

This parameter classify an object based on their shape. Shape compose from a lot of parameters :

- *area*, is the area value
- *width*, wide of area
- *length*, length of area
- *length/ width*, the ratio between the length and width of the area
- *border length*, length of the area's borderline
- *density*, density of the area
- *shape index*, complexity level of the area's form
- *compactness*, unity level of the area
- *roundness,* smoothness level of the borderline's area.

3.3.3. Relational

This parameters describes the relationship between observed object with surrounding objects. This relationship may vary, including :

- *existence of* , parameter that must detect the presence of certain objects around the observed object.
- *near of*, describe image object which adjacent/ neighbor to the observed object.
- *distance to*, describe the distance between certain objects with the observed object.
- *number of*, describe the number of image objects that directly relate to the observed objects.

Those parameters define in the certain segment, furthermore relation parameters can also describe relationship between classified object at the different data level. Figure 3.6 shows relation between observed object on level 40 with certain object on level 50 (super object) and even with object on level 10 (sub level).

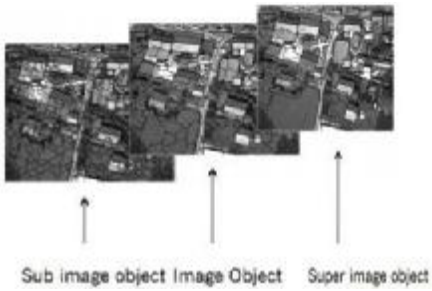


Figure 3.5 : Relationship between Observed Object and Classified Object on Different Level

Determination the value of each parameter is done by taking a sample object for classification and compared any parameters that will be used statistically. Statistical comparison are used in order to obtain the limit's value (threshold) of each paramaters so the observed object can be distinguished with the other objects. Classification parameters above can be combine all together, the combination of those parameters are exactly a model that represent the characteristic of the object in the real world. Those parameter combination called rule set.

To classify paddy field, we extract information from their spectral characteristic which has a different appearance according to the paddy's life phases (Pusat Penelitian Tanah dan Agroklimat, 2000). Table 1. shows the stage of paddy's phase.

Table 1: Stage of Paddy's Life Phase

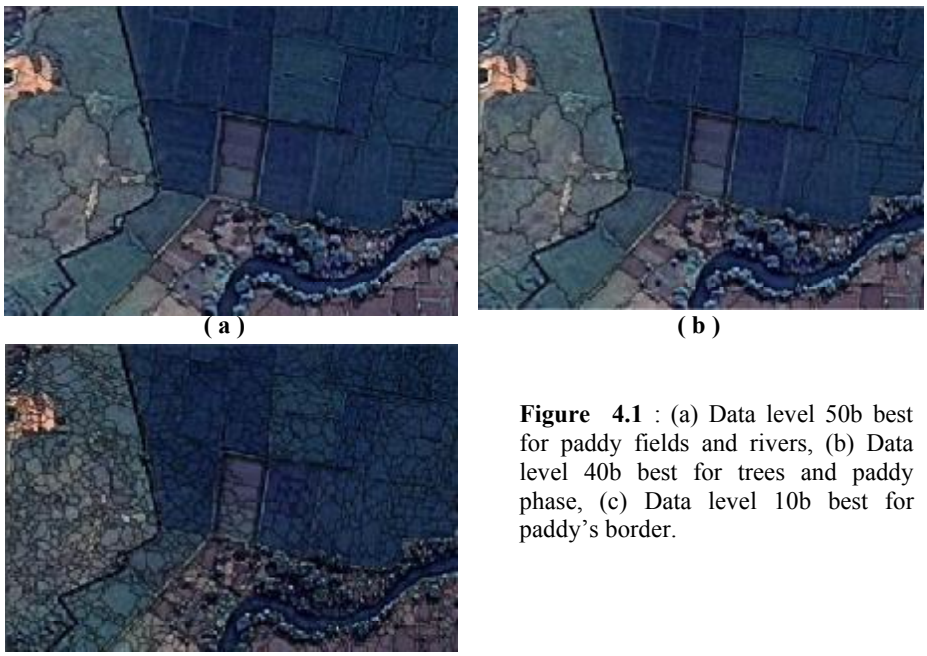
No	Phase	Description	Appearance on imagery
1	Early Growth Phase	Padddy field is dominated by water	Paddy field will appear blue
2	Vegetative Growth Phase	Appearance of leave's paddy	Paddy field dominate with green
3	Generative Growth Phase	Appearance of grain's paddy	Paddy field appear brigth yellow
4	Harvest Phase	Paddy's field left vacant for initial phase repetition	Paddy field seemed brown-red

4. RESULT

In this research, the imagery data divided into two longitudinal parts equally. Left part (west image) used to be observed area in determining the best level combination for segmentation and classification parameter for each observed object. After each object identified and classified on properly then all the level data segmentation and classification parameters (rule set) tested into right part (east image). For hypothesis, parameters that have been formed in the left part image will give a good result on the right part image so that the objects identified as clear as on the left part image.

4.1. Best Segmentation

After the experiment to find perfect composition, the best data level segmentation obtained for each observed object. Segmentation on level 50b is the best composition to identify paddy fields and rivers (Figure 4.1a), level 40b is used to identify trees and classify paddy phase (Figure 4.1 b), and level 10b is the best composition to identify paddy field's border (Figure 4.1 c).



(a) (b)

(c)

Figure 4.1 : (a) Data level 50b best for paddy fields and rivers, (b) Data level 40b best for trees and paddy phase, (c) Data level 10b best for paddy's border.

4.2. Best Classification

Determination of the classification parameter based on the physical properties of the observed objects, thereby, we obtained the best composition parameters that represent the observed objects on real world, as follow:

a. Trees parameters composition
- length/width < 2.5
- mean green < 333
- mean green > 286
- shape index >= 1.6
- distance to pohon <15

b. Rivers parameter composition
- area < 1900
- brightness <241
- existance of sungai [1] = 1
- length/width >= 2.8
- main direction >=60
- shape index >1.5
- width > 8.2
- not pohon

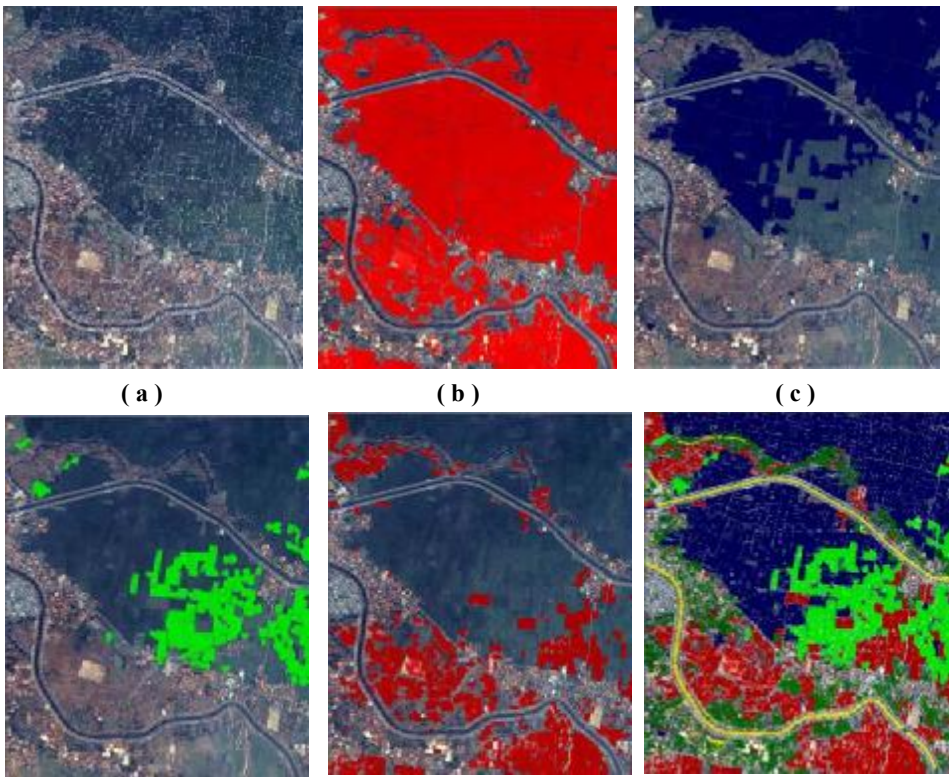
c. Paddy Field parameter composition
- area >=250
- distance to sawah <3
- number of sawah [1] >= 0
- shape index <= 2.1

d. Paddy Field's border parameter composition
- area < 60
- border to jalan <=2
- length/width >= 2.6
- number of jalan [1] <=2
- not pohon
- not sungai

e. Water phase parameter composition
- brightness < 232
- brightness > 209

f. Vegetative phase parameter composition
- area > 700
- brightness <= 250
- brightness > 232
- distance to fase vegetasi [1] <= 35
- existance of fase vegetasi [1] = 1
- mean red <= 185
- not fase air

g. Harvest phase parameter composition
- brightness <= 309
- brightness > 244
- existance of fase bera [1] =1
- length/ width <= 3
- not area < 300
- not fase air



Above is **(d)** classification result **(e)** imagery for each **(f)** object. Each classification using their paramater composition.

Figure 4.2 : (a) Paddy Field's Border Classification, (b) Paddy Field Classification, (c) Water Phase Classification, (e) Vegetative Phase Classification, (f) Harvest Phase, (g) Classification Result Merged on Left Part Imagery

4.3 Final Result

According to early method that application of segmentation and classification is divided into two part equally, the left part to be the trial part of segmentation and classification parameters that have been determined. The parameter result from the left part is used for processing on the right part,. Following the result on the right part of imagery :

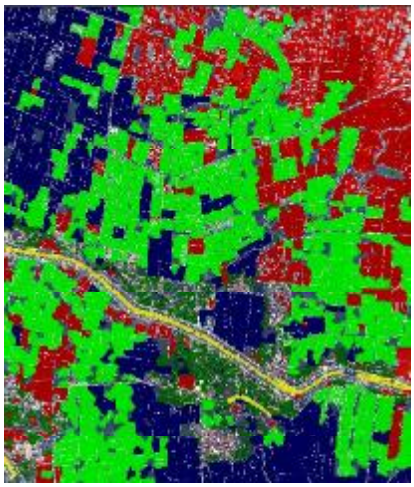


Figure 4.3 : Classification Result Merged on Right Part Imagery

4.3.1. The whole research area result

The parameter result for segmentation and classification are tested to the whole imagery directly. The results of identification the whole image are visualized in Figure 4.19 below.

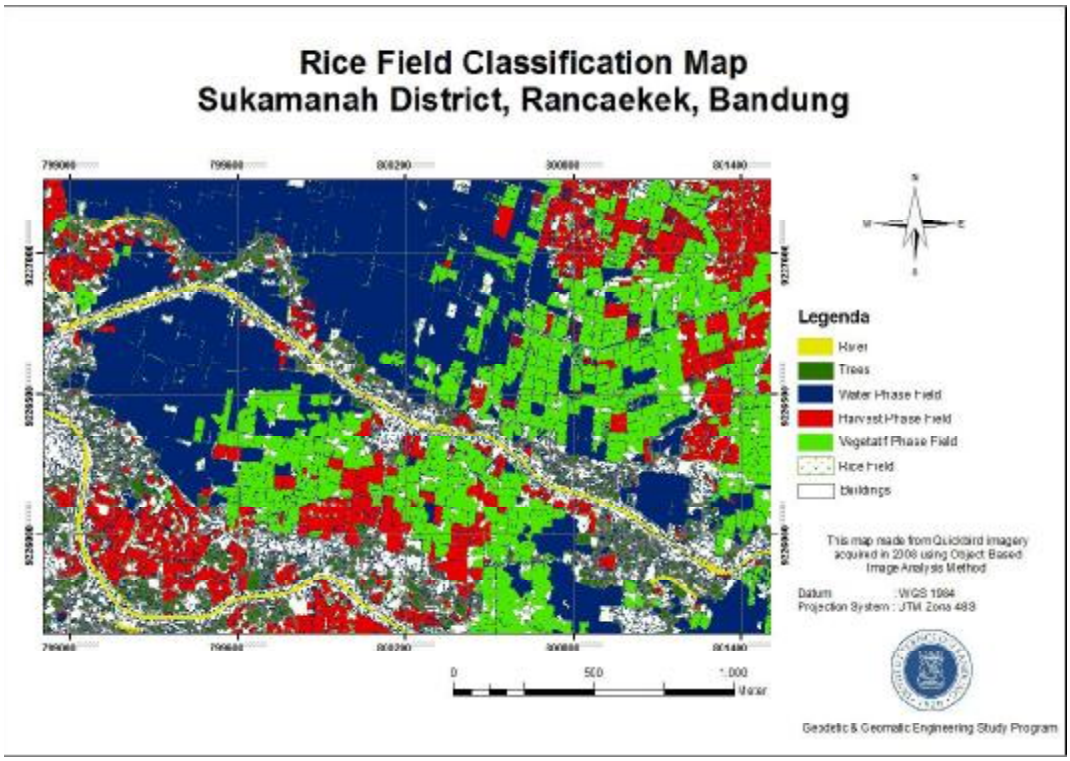


Figure 4.4 : ClassificationFinal Result

4.3.2. Data Validation

Data validation is occurred by compare paddy field classification from OBIA and terestris measurement. From the entire study area are taken sample that represent paddy field for terestris measurement.
Three area, which have different shape, are taken. First area, Area-1 (Figure 3.9) is a compound plane from some rectangle's paddy field. Second area, Area-2 (Figure 3.11) is a compound of three simple paddy field which form trapezoidal. Third area, Area-3 (Figure 3.13) is plane which doesn't have irregular shape. Those three area are choosen because of variety of shape and ease of acces to those area.

Gambar 4.21-4.27

After terestris measurement by tachimetry methode had been done, those area are compared with classification results from OBIA. Figure 3.10, 3.12, 3.14 show Area-1,2,3 that computed from OBIA. Then area from both method are calculated, as below:

Table 2: Comparation of Area Classification Result from OBIA method and terestris measurement.

No	Plane	Amount of Area (m^2)	Difference (m^2)
1	Field Area-1	27069.3010	1524.7811
2	OBIA Area-1	25544.5199	
3	Field Area-2	4739.9600	509.2400
4	OBIA Area-2	4230.7200	
5	Field Area-3	38815.8980	1204.2222
6	OBIA Area-3	40020.1202	

After some field points are taken, then we compared with OBIA classification results and noted in a confusion matrix as follows:

Table 3: Validation Data in Confusion Matrix

		GROUND TRUTH RICE FIELD	TREES	RIVER	BUILDINGS	ROAD	**No. classified pixels**	***User Accuracy***
CLASSIFIED IN SATELLLITE IMAGE AS :	RICE FIELD	**20**	5	0	2	0	27	*74.10%*
	TREES	0	**17**	0	1	0	18	*94.40%*
	RIVER	0	0	4	0	0	4	*100%*
	BUILDINGS	0	0	0	**21**	0	21	*100%*
	ROAD	0	2	0	0	**2**	4	*50%*
No. ground truth pixels		20	24	4	24	2	74	
Producer Accuracy		*100%*	*70.80%*	*100%*	*87.50%*	*100%*		

$$\textit{Overall accuracy} = \frac{20+17+4+21+2}{74} \times 100\,\% = 86.5\,\%$$

5.ANALYSIS

Based on this research, there are several points analysis related to the process and result, including:

1. Segmentation should be performed on different combination (many data level) to get the expected object.
2. Object classification using parameters are general and very determined by segmentation result. Therefore, there are objects that are not member of the class included or actually the member of the class but not included.
3. When classifying objects, there are still some areas not classified because not fulfill to all parameters. It is hard to find parameters that can include all the observed objects.
4. Manual editing still needed for in determine areas that can not be generalized. Manual editing is also required in determining the initial class as a benchmark for anti object from other objects.
5. Large of paddy field can be estimated by calculate large of paddy field that have been classified (pads field

class). Extensive that acquired is a rough estimate of the total raw paddy for quickly count prediction serves. In order to obtain more precision extensive paddy field, terrestrial survey is needed for data validation.

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