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ALOS PALSAR Image for Landcover Classification Using Pulse Coupled Neural Network (PCNN)

Mouli De Rizka Dewantoro[1], Nur Mohammad Farda[2]

Undergraduate Program Cartography and Remote Sensing Universitas Gadjah Mada Indonesia[1],

Doctoral Program of Geography Universitas Gadjah Mada Indonesia[2]

derizkadewantoro@yahoo.com[1], farda@geo.ugm.ac.id[2]

ABSTRACT - ***This research examined the landcover classification using remote sensed image radar system and using a computational vision system of cortex. The aims of this research, 1) to use SAR (Synthetic Aperture Radar) Image for landcover classification using PCNNN, 2) to utilize image processing software for landcover classification using PCNN, 3) to analyze the ability of SAR image for landcover classification using PCNN. Method was used in this research, remote sensed image processing using artificial neural network with PCNN architecture. The field sampling frame work of the landcover classes using stratified random sampling. The field data were analyzed by confusion matrix to determine the level of accuracy. The results of this research are landcover classes of SAR image classification using PCNN, landcover classification using SAR image and PCNN utilized by image processing software, produce three classes of landcover consist of buildings, vegetation, and open land/water body, with an accuracy level of 70,03%.***

Keywords **- Landcover, Synthetic Aperture Radar, Pulse Coupled Neural Network (PCNN), Remote Sensing**

I. INTRODUCTION

Landcover is covering all aspects of the earth's surface either natural phenomena or the result of human activity. Landcover associated with all types of appearance in the earth's surface [1]. Terms related to the type of landcover or landuse types that appear on the earth's surface [2]. Landcover is an important aspect in the assessment, planning and management relating to the earth's surface. landuse can’t be separated by landcover which covers all aspects relating to land on the surface of the earth, while the landuse associated with the dominant aspects of human activity on Earth's surface. Study of landcover has long been developed. Coverage of landcover that knows no boundaries in which the entire surface of the Earth has varied landuse characteristics make landcover factors are important aspects to be studied. Each region at the time and different regions have different factors of cloud cover.

Remote sensing image with the optical system has a disadvantage because of differences in cloud cover at different times and regions. Cloud cover factor can be overcome by using remote sensing imagery with radar systems or microwave. Wavelength radar has a longer

wavelength than the wavelength used remote sensing image with an optical system makes the radar system with a certain wavelength has the ability to penetrate clouds and heavy rains. Microwave imagery has the advantage that it can be used on the day and night and can penetrate even through heavy rain clouds by using the range of wavelengths that have a long [7].

Method of artificial neural networks was first modeled by McCulloch and Pitts in 1943. This method begins with admiration to the man who is able to absorb a lot of information, among others, able to recognize text, and face. Sensing capabilities are centered on the brain and the processes that occur in the brain that is able to recognize a phenomenon makes the structure of the human brain as a reference in the modeling of artificial neural networks, [8].

Artificial neural networks is a computational method for digital image processing has been applied in various fields. The development of this method is much applied in digital image processing of medical images in medical science, but it also is widely used methods for image processing in agricultural engineering sciences to identify each difference in age of the plant. Methods of artificial neural networks also started a lot developed for remote sensing image analysis in the discipline of geography. Several kinds of methods of artificial neural networks, among others, is the architecture of neural networks of pulse coupled neural network (PCNN). PCNN process generates a binary image representing a particular object based on the data used as

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input in the process of computing. PCNN is expected to be a good alternative in remote sensing image processing, especially in radar image processing. Looking at some of the statements above, the authors are interested to know how PCNN ability to landcover classification using remote sensing imagery radar system.

A. Based on the above statement is the purpose of this study are:
   1. Remote sensing image analysis system of radar for landcover classification using artificial neural networks with the architecture of pulse coupled neural network (PCNN).
   2. Utilizing image processing software that can be used to make the process of land cover classification using artificial neural networks with the architecture of pulse coupled neural network (PCNN).
   3. Knowing the capabilities of artificial neural network method with the architecture of pulse coupled neural network (PCNN), the classification of landcover using remote sensing imagery radar system.

II. METHOD

The method started from pre-processing stage, processing stage, and the stage of validation results.

A. *Calibration of ALOS PALSAR image Back Scattering*

Calibration of PALSAR backscattering on the image through two stages, the first step is to convert the digital value on the original image so that brightness value of the units in the converted image in the form of desible (dB). Image conversion result is called the image of Beta Nought (β °). This process is performed using the following equation according ERSDAC:

$$\beta° = 20*\text{Log10}(DN) \quad (1)$$

where:
DN: Digital Number

After the conversion of digital value of the original image is completed and the image pixel values have been converted into the brightness of the conversion process is then performed subsequent to the calibration of the backscattering coefficient with units that remain the same, namely desible (dB). Image of this process is called the image of Sigma Nought (σ °). This process is done using the following equation according to Shimada:

$$\sigma° = \beta° + 10\ \text{log10}(DN^2) + CF \quad (2)$$

where:
β° : Brightness Value
DN : Value of Converted Brightness
CF : Calibration Factor

The results of this second process generates a value PALSAR image at each pixel describes the backscattering coefficient of the reflecting object, so the image is represented backscattering values at each pixel.

B. *Noise Reduction (speckle)*

Filters in image processing are usually done prior to the next stage. Lee filter is based spatial filter made by Speckle more applicative models, and can be calculated with the local statistics that keep key information, especially the boundary edge image and appearance of objects in the image effectively, Xiao, Li,. and Moody; 2003, in Butler (2010). The Lee filter equations are based on estimates of the intensity that does not exist Speckle (unspeckled) which minimize the error propagation. Lee filter equations can be described as follows:

$$(|Xa - Xb|^2) \quad (3)$$

Where:
Xa = Estimate of the filtered image
Xb = The intensity of the image that does not exist Speckle (unspeckle).

This filtering process can reduce interference with the radar image and soften the image, but this filtering technique in some cases can reduce or eliminate the information contained in the image due to the sensitivity of the adaptive filter, [6]. Lee filter is modified in order to maintain the sharpness of the edges of the object relative to the image in order to reduce the sensitivity by using the cover (mask) which is direct to determine which window is homogeneous. Filtering process in this study using the smallest window in filtering, which is a 3x3 windows to minimize the loss of information in the image.

C. *Image Processing using Pulse Coupled Neural Network (PCNN)*

Pulse coupled Neural Network (PCNN) is one of the artificial neural network architecture which has advantages in minimizing the problems caused by the transformation of geometrical factors and complex computational process, [3]. Classification process with PCNN method is performed using the following five equations:

$$F_{ij}[n] = e^{-\alpha f} F_{ij}[n-1] + S_{ij} + V_f \sum_{kl} m_{ijkl} Y_{kl}[n-1] \quad (4)$$

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$$L_{ij}[n] = e^{-\alpha L} L_{ij}[n-1] + V_l \sum_{kl} w_{ijkl} Y_{kl}[n-1] \quad (5)$$

$$U_{ij}[n] = S_{ij}[n]\big(1 + \beta L_{ij}[n]\big) \quad (6)$$

$$\Theta_{ij}[n] = e^{-\alpha\Theta} \Theta_{ij}[n-1] + V_\Theta Y_{kl}[n-1] \quad (7)$$

$$Y_{ij}[n] = \begin{cases} 1, & if\ U_{ij}[n] > \Theta_{ij}[n] \\ 0, & otherwise \end{cases} \quad (8)$$

The first equation from the equation until the fifth is an integral equation PCNN. **F** is called Feeding, **L** is called Linking, **U** is the internal activity of the PCNN, **Θ** is a threshold (threshold), and **Y** is the output result of the overall process of PCNN, while **ij** indicates the coordinates of pixels.

PCNN process by applying the five equations is performed using on 3x3 windows so as to produce results more to minimize errors, on 3x3 window is given weight (weight) at each pixel in the window. Weighting in this study refers to the maximum results from the trial (trial error) conducted by Xiong., Et al [8] the following:

$$W = \begin{pmatrix} 0.707 & 1 & 0.707 \\ 1 & 1 & 1 \\ 0.707 & 1 & 0.707 \end{pmatrix}.$$

where:

W : weight the 3x3 windows

Observation window is an important part in this process because it affects the whole execution process of the equation PCNN.

D. *Sampling (Field View)*

Method of field sampling is stratified random sampling method. The use of sampling methods in this study consider of classes obtained from the classification based on the value of backscattering on the previous process. Sampling also take into account the affordability of sample sites using other supporting data.

E. *Result Validation*

This stage is performed to determine the accuracy of classification results are used as the basis for the descriptive analysis of how the ability of the method of pulse coupled neural network (PCNN) can be used for classification landcover using ALOS-PALSAR imagery. The results has been analyse with the results of field surveys of land cover classification using the confusion matrix, so that can know the accuracy of classification results using the method of pulse coupled neural network (PCNN) and be able to answer the purpose of this study.

III. RESULT AND DISCUSSION

Landcover classification was performed using ALOS PALSAR image of the L band with HH polarization, carried out by using the equation PCNN. Results obtained from the landcover classification with the input produce three binary images that show each of the classes of landcover. Process input image produces three classes of landcover and land cover classes are defined by using field data. Three classes of landcover obtained from the results of this PCNN process. Class generated from PCNN is a landcover classes of buildings, vegetation, and combination of open land and water bodies. Results of land cover classes generated in this process with a binary image containing only colour pixels with a colour that shows the landcover classes and the show other than black class.

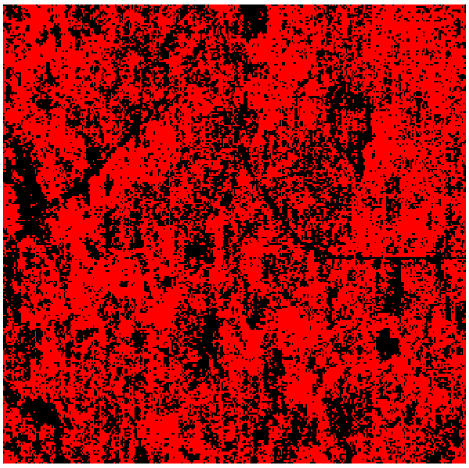

Fig. 1 The Result of PCNN (Buildings)

Figure 1 shows the results of the PCNN which displays the class of buildings and landcover in addition to the building. Building on that image is displayed in red while the object in addition to the building shown in black. The results of the first PCNN process shows that the dominant image of the white colour indicates that the area of research is dominated by buildings. Visually, the results obtained in accordance with the reality on the ground where the object of the study area is dominated by a form of residential buildings and offices. Black pixels which displays objects in addition to the building in which the display objects that are straight lines such as roads, and objects that show the meandering river the appearance of such objects, other than that there are areas that are composed of pixel that are black.

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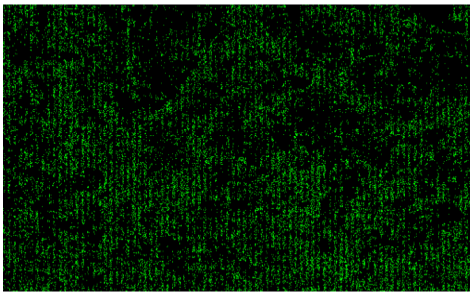

Fig. 2 The Result of PCNN (Vegetation)

Figure 2 shows the results of the PCNN is an object of vegetation landcover classes, the same as the previous results on the image consists of two colours: green and black pixels where the pixels of the object shown in green vegetation. Based on visual observations on this image indicates that the vegetation is not dominant in a particular area but are spread almost evenly throughout the study area, it is appropriate to the circumstances in which the research areas of vegetation in the study area lies between the land up in the form of residential or office. Black pixels on the results of a second PCNN process is addressing the areas that show the object in addition to vegetation, could be open land, buildings, and objects that form the body of water, but the patterns such as roads or rivers are not seen clearly due to the object form of roads and water bodies are also scattered vegetation around the object.

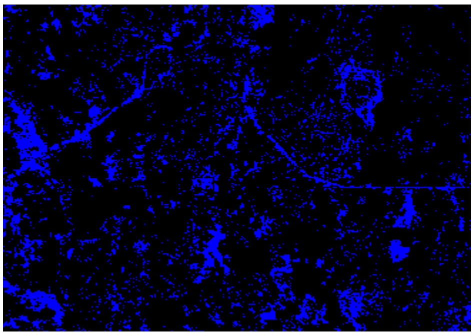

Fig. 3 The Result of PCNN (Open Land/Water Body)

Figure 3 shows the results of the PCNN is showing land cover classes in the form of an open body of water and soil. Blue pixels showed open land object and the body of water. Visually, the blue object is composed of several patterns such as straight lines extending in the form of an object path, in addition to visible objects that show the meandering stream object. The appearance of blue pixels in addition to road and river is a collection of pixels with not too wide area which is the object of open land and water bodies. In keeping with the area where the object is the dominant form of the building, while the object of open land located between the buildings is more dominant, as well as objects that form the body of water in research areas that is not too wide and the river. Object large enough open land is only found in marginal areas is administratively located in the southern suburb of Jakarta.

Merging the three classification results PCNN image object represents a building with a red colour, the object form of vegetation in green, open land and water bodies blue. The resulting image show dominance of buildings in the research areas of vegetation interspersed with objects that are spread almost evenly throughout the image, while the object of open land and water bodies are only small areas in addition to the straight line of a road or a winding line of the river. These results are visually likes the study area dominated by buildings.

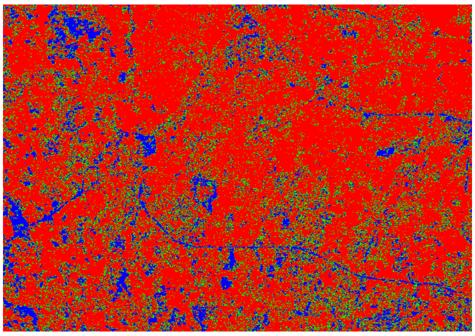

Fig. 4 The Result of PCNN (All Classified Object)

A. *Classification accuracy*

Test of accuracy required to determine the level of correctness of data classification results, so that the resulting landcover map of the classification process has a level of accuracy is the reference manual. Specifically in this study the accuracy of test methods conducted to determine the ability of pulse coupled neural network (PCNN) in the process of landcover classification from SAR images. Minimum accuracy of landcover classification results can determinant according to Anderson., Et al (1976), was 85%, while according to Congalton and Green (2009), in Butler (2010), the rate of 85% is not absolute because the accuracy of our classification results influenced by many factors including the level of detail, diversity of mapped objects, the number of samples, and several other factors in the classification, so the figure of 85% in certain circumstances be sufficient, but in some cases can even be said not enough.

Under these conditions, the results of the classification performed in this study which has 73.03% accuracy rate

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which can't be said to be in either category, but keep in mind the minimum accuracy rate of 85% is applied to the results of remote sensing image classification that uses optical wavelength. Wave remote sensing image seems to have a better ability in the present value of the spectral variations are generated, unlike the radar image that has limited the value of the spectral variations in the resulting image.

The classification of landcover using RADARSAT imagery in several research areas with the resulting degree of accuracy ranging from 40% - 60%. Accuracy of classification results in this study is the level of accuracy (content), it can be said to have better outcomes than those research it can be said better, but keep in mind that the image RADARSAR used has a spatial resolution of 30 meters while the PALSAR used in this study have spatial resolution 12.5 meters. Differences spatial resolution is very affected variation of the roughness of the object in the image resulting from the recording. Butler, (2010), [5] to map landcover analysis backscattering coefficient in HH polarization with an accuracy of 59.38% while the HV polarization with an accuracy of 64.06% with the four landcover classes. Compared with this research using the same data in accuracy (content) can be said to be better, but the accuracy of detail of the class is no better, because in this study produced only three classes of landcover. Calculation accuracy of the classification is done by using a confusion matrix, more details on the calculation accuracy of this study can be seen in the following table:

TABLE 1 CONFUSION MATRIX

	Classification Results				
Field Check	Landcover Classes	Buildings	Open Land/ Water Body	Vegetation	Total
	Buildings	26	2	4	32
	Open Land/ Water Body	3	19	5	27
	Vegetation	9	1	20	30
		38	22	29	89

Confusion Matrix of Classification Results and Field Check

Producer accuracy		User Accuracy	
26/38 x 100%	68.42%	26/32 x 100%	81.25%
19/22 x 100%	86.36%	19/27 x 100 %	70.37%
20/29 x 100 %	68.97%	20/30 x 100%	66.67%

Total Accuracy = 65/89 x 100 % =73, 03%

Accuracy of these calculations illustrate the accuracy of each landcover classes generated by the PCNN using PALSAR imagery. Accuracy is obtained consisting of two kinds of accuracy is the accuracy of the map maker (Producer Accuracy), and accuracy of our users (User Accuracy). Accuracy each landcover classes generated can be determined and the calculation of the overall classification accuracy is obtained so that the accuracy of the results obtained is 73.03%.

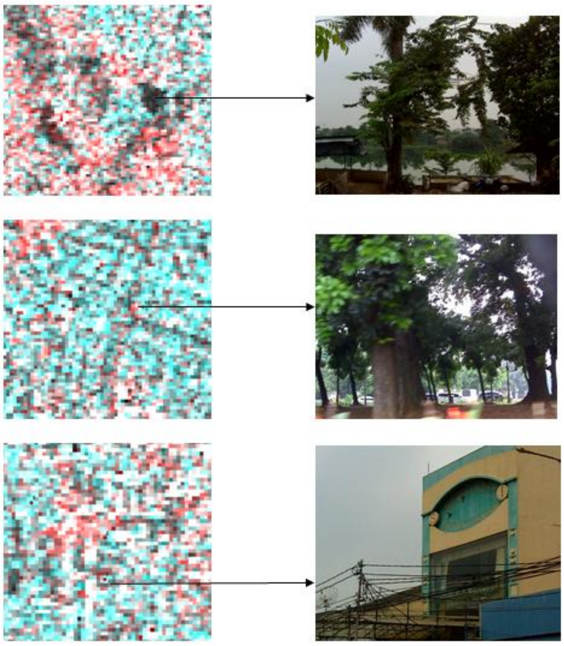

Fig. 5 Examples of the appearance of PALSAR images with the appearance in the field.

IV. CONCLUSION

Results obtained from this study can be inferred.

1. Use of radar remote sensing image system for land cover classification can be done by using a neural network architecture of pulse coupled neural network (PCNN) can be performed as an alternative in mapping landcover in addition to utilizing remote sensing data with a recording that uses visible and infrared wavelengths.

2. Utilization of software for digital image processing ALOS PALSAR using artificial neural network architecture of pulse coupled neural network (PCNN) can be done, but it is still necessary for the preparation of the programming code so that the available software can be used in the PALSAR image processing method of pulse coupled neural network (PCNN).

3. The ability of neural network architectures pulse coupled neural network (PCNN) for landcover classification of remote sensing data use ALOS PALSAR in discriminating classes of landcover in south Jakarta and

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Tangerang to the dominant object in the form of settlements and land up. The results of the classification consists of three classes of objects in the form of vegetation, buildings, open land / water body, the results obtained can be said is not maximized, because the ground can't distinguish objects open with a body of water, while the level of the resulting accuracy is good enough to landcover map accuracy generated is 73.03%.

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Biography

Mouli De Rizka Dewantoro born in Temanggung, Central Java, Indonesia in 1989. Started school at the elementary school, junior high school and senior high school in Tegal, Central Java, Indonesia. Continued his studies at the Universitas Gadjah Mada Indonesia in 2007 with a program of study cartography and remote sensing, department of geographic information science and regional development, faculty of Geography. Interested in the research field of remote sensing, geographic information systems (GIS), geo-visualization, image processing, cartography and computer programming.

Nur Mohammad Farda obtained a degree (S.Si) in faculty of geography, Universitas Gadjah Mada Indonesia in 2002. Obtained his master degree of computer science (M.Cs) from Universitas Gadjah Mada Indonesia in 2008. Continued to take geography doctoral program in remote sensing, Universitas Gadjah Mada Indonesia in 2009. Now working as a lecturer at Universitas Gadjah Mada Indonesia Interested in the research field of remote sensing, computer programming, and remote sensing to marine studies.