

LANDUSE CLASSIFICATION ACCURACIES COMPARISON BASED on ASTER VNIR DATA and ASTER VNIR-PALSAR IMAGE FUSION

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ABSTRACT:

Nowadays, the abundance of remote sensing data requires synergistic development of methods for information extraction, in order to maximize the potential uses for various mapping purposes. Image fusion techniques are an alternative to the conventional uses of individual remote sensing data, because these methods can create new data that combine advantages from the input images in one hand, and minimize their weaknesses. This study tried to compare the quality of fused image, which was built using ASTER VNIR (optical) and ALOS PALSAR (radar) images, and the original multispectral ASTER VNIR bands. The quality was assessed visually and then was evaluated spectrally with respect to their ability to generate land-use classes based on multispectral classification. A Discrete Wavelet Transform (DWT) was used to combine the optical and radar images, since it can maintain the spectral quality of the combined image. It was found that for a cloud free area like Yogyakarta, Indonesia, there was no significant difference in classification accuracy between the fused and the original (optical) images.

I. Background

The land-use mapping methods have developed in both technological and analysis levels. This development is related to the importance of land use information as the basis for development planning and resource evaluation and assessment. Remote sensing is one of the most important technologies utilized for land-use mapping activities. It works based on the objects' characteristics that can be extracted using multi-temporal approach, in combination with high spatial resolution data. The process of feature extraction from remote sensing data is based on visual interpretation, spectral classification, and also object-based analysis and classification. In this respect, image quality has an important role in feature extraction process. Various method have been developed to improve the image quality in order to facilitate the feature extraction process.

Image fusion is a technique that developed by taking the advantage of the abundance of remote sensing data to integrate and generate a new image with a maximum quality. Pohl and van Genderen, (1998) stated that image fusion combines images with different sensors and spatial resolutions covering the same area to improve image quality and level of interpretation with a specific algorithm. Image fusion is intended to complement each image advantages on the fused images. Fusion between multispectral and RADAR imagery allows combination of the high spectral quality from multispectral imagery and high spatial quality from RADAR data.

Development of image fusion technique has been continuing and each technique has characteristics to be maintained, such

as Hue Saturation Intensity (HSI) technique that maintains the visual quality; or wavelet technique that maintains the spectral quality of fused image. Discrete Wavelet Transform (DWT) is a development of wavelet technique which produces fused image that has spectral quality nearly equal to the input image. This research design is based on the idea to combine the multispectral imagery (ASTER VNIR) and RADAR imagery (PALSAR), which is expected to yield fused image with high quality in both spectral and spatial aspects, in comparison with the input images. The output quality is expected to give effects in interpretability and land-use classification accuracy. In this paper, ASTER VNIR and ALOS PALSAR imagers covering a part of Yogyakarta area, Indonesia were used.

II. Objective

The research objective was to compare the accuracy levels of land-use classification results, which were generated using fused image (ASTER VNIR and PALSAR) and ASTER VNIR image (without image fusion).

III. Methods

3.1. Image Pre-Processing

Image pre processing was required prior to the data analysis process. It generally consists of geometric and radiometric corrections for multispectral imagery; and backscattering calibration and speckle reduction for RADAR imagery. Geometric correction was performed for all input image datasets to match their geometric position and accuracies. Image-to-image geometric correction was applied in this correction, by using ASTER VNIR imagery as a reference, since this data has better geometric characteristics. Ground control points were selected evenly throughout the imagery and

a nearest neighbor interpolation was used to re-sample the pixel values.

Radiometric correction is recommended during the imagery analysis with difference sensor or multi temporal analysis. Each sensor records different digital value, although they at the same coverage area. Therefore, image fusion of different sensors need to be reconstructed up to the same unit of analysis, i.e. the object reflectance. Especially for RADAR imagery, the influence of the energy variation and the incidence angle causes

spectral noises. These lead to the need for calibration of the backscattering to restore the value that represents the object. Backscattering calibration was performed in two stages. The first one is the calibration to Beta Nought t (••) imagery and subsequently is the calibration to Sigma Nought(••). These cause change in the Digital Number (DN) to backscattering value (in dB). Based on equations:

$$\bullet\bullet = 20 \log_{10}(\text{DN}) \quad (3.1)$$

which:

DN : digital number

And,

$$\bullet\bullet = \bullet\bullet + 10 \log_{10}(\text{DN}^2) + \text{CF} \quad (3.2)$$

which:

••: brightness value

DN: digital number after converted to brightness value

CF: calibration factor (-83.0 for PALSAR)

Lee Filter was applied to RADAR imagery in order to improve the visual aspect and to reduce the speckle effect. This filter is based on the minimum mean square error (MMSE) and geometric aspects. Lee filter is a statistical filter designed to eliminate noise, while still maintains the quality of pixel points and borders of the image (Hongga Li et al. 2010). Based on MMSE criterion, improvement of the quality of pixels with Lee filters was carried out using Multiplicative Speckle model which is statistically calculated based on equations :

$$\text{MMSE} = [| - x|^2] \hat{x} \quad (3.3)$$

where : Estimation of filtered/ true backscatter intensity

x: Intensity of unspeckle

To estimate the true backscatter based on:

$$\hat{\bullet\bullet} = \bar{x} + b(z - \bar{x}) \quad (3.4)$$

where b is an estimator of the variance of x to the variance of z. To estimate the mean and variance of backscatter used the equation in every window by

$$\hat{\bullet\bullet} = \hat{\sigma_z^2} - \frac{\bar{z}^2 \sigma_y^2}{(\sigma_y^2 + 1)} \quad (3.5)$$

where •y is the speckle standard deviation, it can be computed by means of the equivalent number of looks. (Moschetti,E., et al.2006)

3.2. Image Fusion Technique

Histogram matching process was performed on both of input images to make PALSAR Imagery has the same average and standard deviation with the low resolution (Wen, Dou.2008). DWT transformation was applied to the PALSAR image to produce four components, which includes structural

information on vertical (V), horizontal (H), and diagonal (D) components, resulted from the high-pass filtering of the image that have same spatial resolution as ASTER VNIR, and the approximation component (A) as a result of the low pass filtering with 12.5 m spatial resolution. In the approximation component, the spatial resolution of PALSAR was retained to be used as a commutator to produce a fusion image with spatial resolution of 12.5m. Image fusion is the combination of the two input images with a better spatial resolution, while the spectral quality is maintained. These process shown on the diagram 3.1

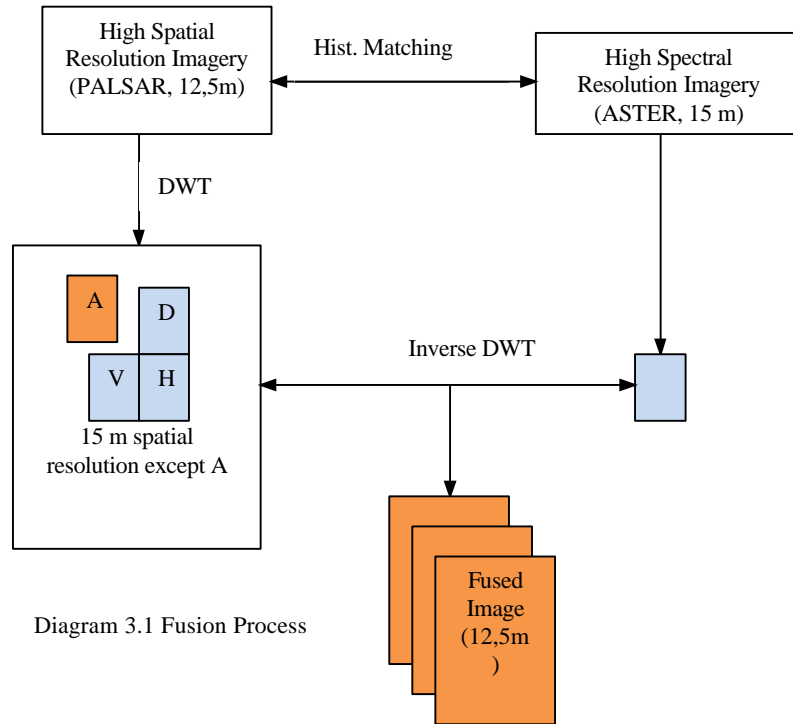


Diagram 3.1 Fusion Process

3.3. Classification

Land use classification was performed using maximum likelihood algorithm, based on the fused image (ASTER VNIR and PALSAR) and the ASTER VNIR image only. The land use classes consist of water bodies, vegetation cover, bare soil, and impervious surface. The classification process generated a tentative map, which need validation on its classification accuracy. The validation was carried out using a stratified random sampling strategy that allows each class to have a proportional number of samples. The minimum sample size is twice as the area size represented by pixel resolution (McCoy, 2005). The number of samples is determined based on the assumption that heterogeneous objects with low separation level requires a number of samples more than homogeneous objects with a high level of separation.

3.4. Comparative Analysis of the Classification Results

Comparison between classification results generated from the fused images and the ASTER was carried out by taking into account their accuracy levels. The accuracy assessment made use of overall classification accuracy and Kappa coefficients (Congalton and Green, 1999 in Jensen 2005), in order to show the degree of agreement between the classification result and the field reference. It is based on a confusion matrix consisted

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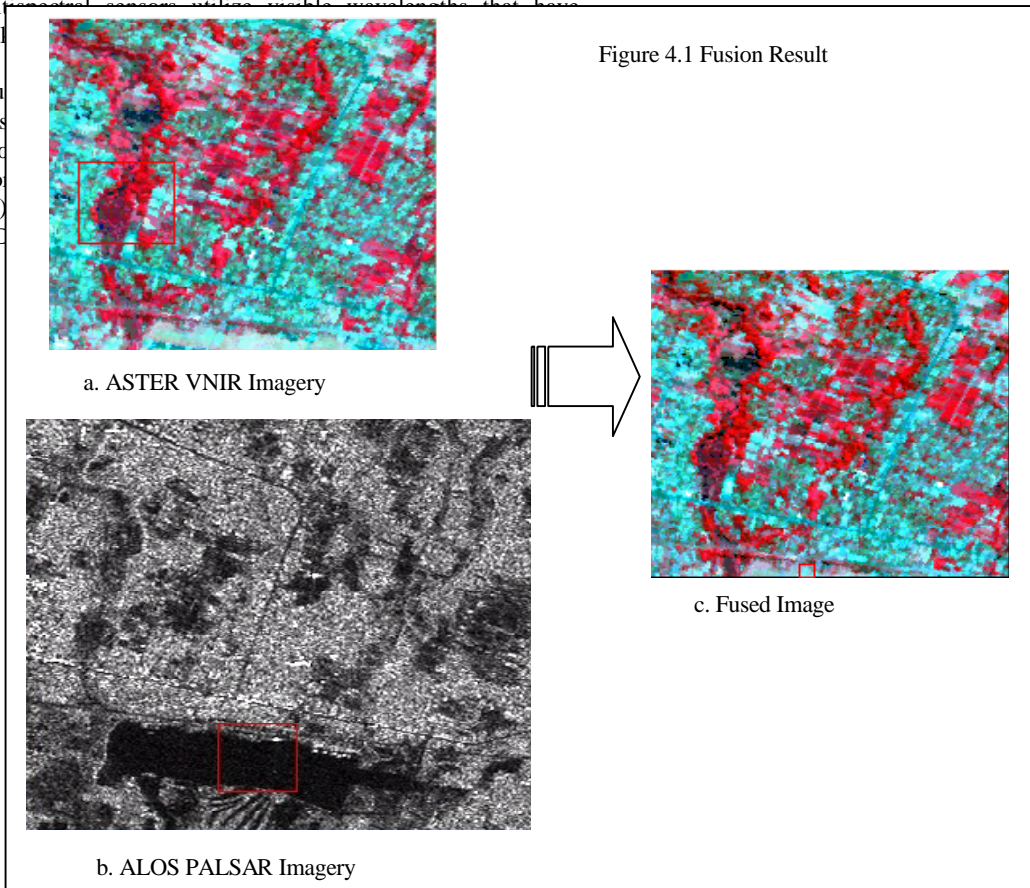
Wang Bovik Quality Index	
Band 1	0.999994
Band 2	0.999997
Band 3	0.999995

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of each original input image either spectrally or spatially. Image fusion process can be based on the pixel level, feature/pattern, and levels of decision-making. In this paper model sample of image fusion uses input imagery from ALOS PALSAR and ASTER VNIR that cover a small part of Yogyakarta area, Indonesia.

IV. Results and Discussion

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frequency, and polarization. The availability of abundant remote sensing data with their respective characteristics can be combined to obtain a new image with maximum information content. Image fusion can be done for the purpose of image enhancement, improved object recognition, as well as substitution information is lost. Image fusion is the application to combine image with different sensors, and spatial resolution in the same area to improve image quality and level of interpretation with a specific algorithm (Pohl and van Genderen, 1998). The fused image is a combination of individual characteristics

that is partly cloudy covered and or hazy is recommended in order to see the effectiveness of the methods.

Table 4.1 Spectral Quality Index of Fused Image

A Wang Bovik Quality index used to identify the comparison spectral quality of the input image (ASTER VNIR) and the fused image. The value that closer to 1.0 means that spectral quality of fused image maintained as the quality of multispectral image. Based on the table 4.1 it is shown that spectral quality of fused image (PALSAR and ASTER VNIR) with DWT was maintained. In visual aspect there is no significant differences between the ASTER VNIR imagery and fused image. It gives effect on the classification result, as presented in Figure 4.2, which shows that there is no significant differences between the two.

V. Conclusions

Based on the obtained results, it can be concluded that there is no significant difference between fused image (ASTER VNIR and PALSAR) and the original image (ASTER VNIR). Visually, there is no clear difference in the appearance of both images, which means that they can be observed easily and can be interpreted visually with no difficulty. On the other hand, the spectral aspects of both types of image also give no clear difference in terms of classification accuracy. It should be noted, however, that the chosen study area has no problem in cloud and haze cover. Theoretically, areas with cloud and haze problems are usually more difficult to interpret and produce less accurate results. Therefore, a further study involving area

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