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THE UTILIZATION OF REMOTE SENSING DATA TO SUPPORT GREEN OPEN SPACE MAPPING IN JAKARTA, INDONESIA

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Abstract. Green open space becomes critical in maintaining the balance of the environment and improving the quality of urban living for a healthy life. The use of remote sensing data for calculation of green open space has been done notably using NDVI (Normalized Difference Vegetation Index) method from Landsat 8 and SPOT data. This research aims to calculate the accuracy of the green open space classification from multispectral data of Landsat 8 and SPOT 6 using the NDVI methods. Green open space could be assessed from the value NDVI. The value of NDVI generated from Landsat 8 and SPOT 6's Red and NIR channels. The accuracy of NDVI values is then examined by comparing with Pleiades data. Pleiades data which has 50 cm panchromatic resolution and 2 m multispectral with 4 bands (B, G, R, NIR) can precisely visualize objects. So, it can be used as the reference in the calculation of the green open space based on NDVI. The results of the accuracy testing of Landsat 8 and SPOT 6 image could be used to identify the green open space by using NDVI SPOT of 6 can increase the accuracy of 5.36% from Landsat 8.

Keywords: *green open space, NDVI, Remote sensing*

1 INTRODUCTION

The requirement of green open space in the urban area is one of the important issues in the planning of city because green open space is closely related to the health, comfort, provision of oxygen (O_2), reduction of air and water resources pollutions, reduction of carbon emissions and pollutants, to be the place where flora and fauna life, as well as in supporting the city's spatial, environmental, and sustainable development. According to Nowak (1998) Urban vegetation can directly and indirectly to affect local and regional air quality by altering the urban atmospheric environment. Along with the increasing number of urbanization and increasing population led to the increasing landuse changes which resulted in a reduced number of land cover by vegetation, especially in urban areas, this situation causes a decrease in the quality of the urban environment (Dardak, 2016).

According to Act No. 26 of 2007 about the space management, it is stated that the proportion of green open space in the urbanized area should be at least 30% of the land area. Green open space is an area stretching/path and/or clumped, which usage is more open, in which plants grow, either grow naturally or deliberately planted. According to Chafid (2004), the green open space of the city is part of the urban space structuring that acts as a protected area. The green area of the city consists of the city landscaping, forest area green city, green city, green area of recreational sports, the green lawns. Green open space is classified based on the status of the region, not based on the form and

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structure of the vegetation turns. There is relation between increasing and decreasing open green space in increasing and decreasing air quality (Effendy, 2009).

Techniques in remote sensing are applied worldwide in resources exploration and development. This major new study examines the latest advances in satellite and sensor technology, image processing and interpretation, and assesses its role in the exploration and exploitation of natural resources, particularly in the developing countries (Szekielda, 1986). To monitor land use/land cover changes in time and space remote sensing technology has been widely used since the past few decades (Javed, 2012). Remote sensing data in the form of images is capable of displaying the complete picture of the Earth's surface including associated data green open space.

Research on the utilization of remote sensing data for green open space has been widely carried out. Some of the researches which use medium resolution remote sensing data among state that Landsat 7 ETM data with a spatial resolution of 30 meters can detect green open space in DKI Jakarta. Landsat ETM 2003 can analyze land cover in the area of Bogor City with accuracy as much as 87.10% based on the overall classification and 84.81% based on kappa performance statistics data from Spatial Plan area (Haris, 2006). Landsat 8 can interpret the vast forests of Magelang city covering as much as 73.19 ha research area. By, using Landsat 8 in 2013, Febrianti and Sopan (2014) gained value of NDVI ranged from 0.2-0.73 as a cover of vegetation. From the data, it is found that the vegetation cover in Jakarta in 2013 is 9% of the entire territory.

In addition to the use of medium resolution determination of green open space, the research was also done by using Quickbird's high resolution data. According to Hariyanto (2015) Quickbird satellite image by using object segmentation can indentify the green open space area. In the determination of the vegetation image Quickbird precision level, the interpretation of land use results obtained 91.9%, the vegetation coverage as much as 86.84%, and building density as much as 90.9% (Utami *et al.*, 2012). While the percentage of the accuracy of the classification results is quite high which can be seen from the Kappa value the accuracy for the SPOT image is 96.66% and 96.30% for the IKONOS image (Lestari, 2005). The use of ALOS AVNIR in analyzing vegetation index relates to the percentage of vegetation cover where the vegetation index values of NDVI and SAVI have the highest coefficients of determination (Sudaryanto and Melania, 2014).

One of the ways in knowing the existence of green open space is with the utilization of remotely sensed vegetation index values by using Fractional Vegetation Cover (FVC) method (Yunhao, *et al.*, 2005). Vegetation index value can provide information about the presentation of vegetation, index of plant life (Leaf Area Index), biomass plants, fAPAR (fraction of Photosynthetically Active Radiation) Occurs absorbed, the capacity of photosynthesis and estimation of absorption of carbon dioxide (CO_2) (Horning, 2004; JI and Peters, 2007). Landsat-based global map, Gong *et al.* (2013) supported training data selection with MODIS Enhanced Vegetation Index (EVI) time series from 2010, aiming to improve spectral separation between cultivated bare land and natural barren lands. Vegetation index value is a value resulted from a mathematical equation. Some bands are obtained from remote sensing data. The bands are usually the red band (visible) and the NIR (Near Infra Red) band.

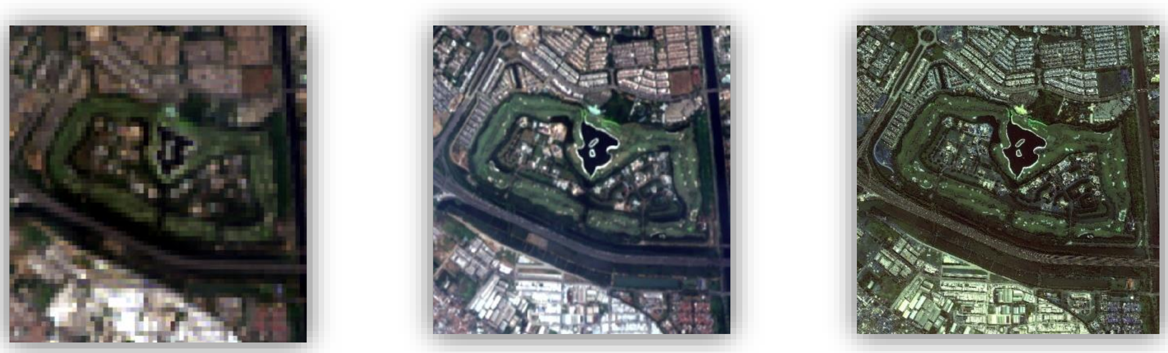
The utilization of satellite images with high spatial resolution satellites increases the amount of information on land cover at local to national scales (Aplin et al., 1999). The use of satellite imageries such as landsat 8 and SPOT 6 is very effective to classify areas of vegetation cover by NDVI. Landsat 8 is one of the remote sensing satellites whose data are easily obtained because Indonesia has acquired directly through LAPAN earth station in Parepare.

2 MATERIALS AND METHODOLOGY

2.1 Location and Data

The location of the study is Jakarta at position 6°12' S and 106°48'E. Based on Statistic Indonesia (BPS) from 2009 - 2013, the area of Jakarta is 662.33 Km^2 including Kepulauan Seribu.

The data used in this research are the Landsat 8 data, OLI path/Row 122/64 date 25 August 2013 level 1T, SPOT 6 date 27 August 2013 and Pleiades data 12 July 2013, which have geometrically and radiometrically corrected. Landsat 8 is the multispectral data that has a wavelength of 450 µm-2300 µm. Easily obtained data will certainly make it easier for each region in calculating and evaluating green open space. SPOT 6 data is one of the high resolution satellite data that can be directly acquired from LAPAN earth station in Parepare. The research that has been done using remote sensing application data from Landsat 8 or SPOT 6 imagery needs an accuracy test by using a higher resolution image. As for the image that has a high precision is the Pleiades. The Pleiades satellite, which was made by Airbus company Defence & Space, is producing high-resolution satellite imagery. The Pleiades satellite currently entering second generation Satellite named Pleiades 1B, launched on December 2, 2012. As for the Pleiades Satellites 1A, which is the first generation of Pleiades Satellites, was launched on December 16, 2011. The Pleiades satellite satellite images data resulted in two modes which are panchromatic mode and multispectral mode. The panchromatic has a spatial resolution of 0.5 metre with 1 band, while satellite imagery in multispectral mode has a spatial resolution of 2 meters with 4 bands (VNIR — Visible Near Infra Red). As for the objective of this research is to discover the accuracy of the calculation of green open space by using Landsat 8 and 6 SPOT NDVIs, and compared to Pleiades data.



(a) Landsat 8, 25 August 2013 b) SPOT 6, 27 August 2013 (c) Pleiades, 12 July, 2013

Figure 2-1: Comparison of spatial resolution imagery

Table 2-1: Imagery Description of Landsat 8, SPOT 6 and Pleiades

Component	Landsat 8	SPOT 6	Pleiades
Swath	185x185 Km	60 Km at nadir	20 Km at nadir
Temporal Resolution	16 day	-	-
Spatial Resolution	30 m	1.5m GSD (Panchromatic) and 6 m GSD (Multispectral)	0.5m GSD (Panchromatic) and 2m GSD (Multispectral)
Spectral Resolution	*Coastal/ aerosol* (433-453 nm) Blue (450-515 nm) Green (525-600 nm) Red (630-680 nm) NIR (845-885 nm) SWIR 1 (1560-1660 nm) SWIR 2 (2100-2300 nm) Panchromatic (500-680 nm) *Cirrus* (1360-1390 nm)	Blue (444-525 nm) Green (530-590 nm) Red (625-695 nm) NIR (760-890 nm)	Panchromatic (480-830 nm) Blue (430-550 nm) Green (490-610 nm) Red (600-720 nm) NIR (750-950 nm)

Source: *http://landsat.usgs.gov,* https://www.intelligence-airbusds.com/satellite-data/

2.2 Image Data Processing

The geometric imagery often experience a shift because of the altitude of the orbit of a much smaller field of view but then the geometric distortion occurs so that the geometric correction is required. Geometric correction of the imagery is performed so that the coordinates of the image corresponds to the geographical coordinates.

Radiometric correction, which aiming to improve the value of pixels match, is supposed to consider the factors of disturbance of the atmosphere as the source of major mistakes. The effect of the atmosphere causes the reflection value of an object on the Earth's surface recorded by the sensor into its original value but not become larger due to the scattering or become smaller due to the absorption (Ji and Peters, 2007).

This research uses the vegetation index NDVI, with the following equation :

$$NDVI = \frac{\rho NIR - \rho RED}{\rho NIR + \rho RED} \quad (2\text{-}1)$$

In which:
ρNIR = Reflectance Near Infrared Band
ρRED = Reflectance Red Band

Landsat 8 and SPOT 6 use NDVI threshold in the classification of green open space and non green open space, while Pleiades use training sample. The green open space classification from Pleiades is classified by visually interpreting the training sample with the RGB composition of the 321. The depictions of green open space created by training samples can distinguish the vegetation and soil. Then the data were analyzed. The Pleiades was chosen based on the Area of Interest (AoI) representing the territory with green open space in the form of a park, the boundary river, the border of the road, open land as well as public and private area.

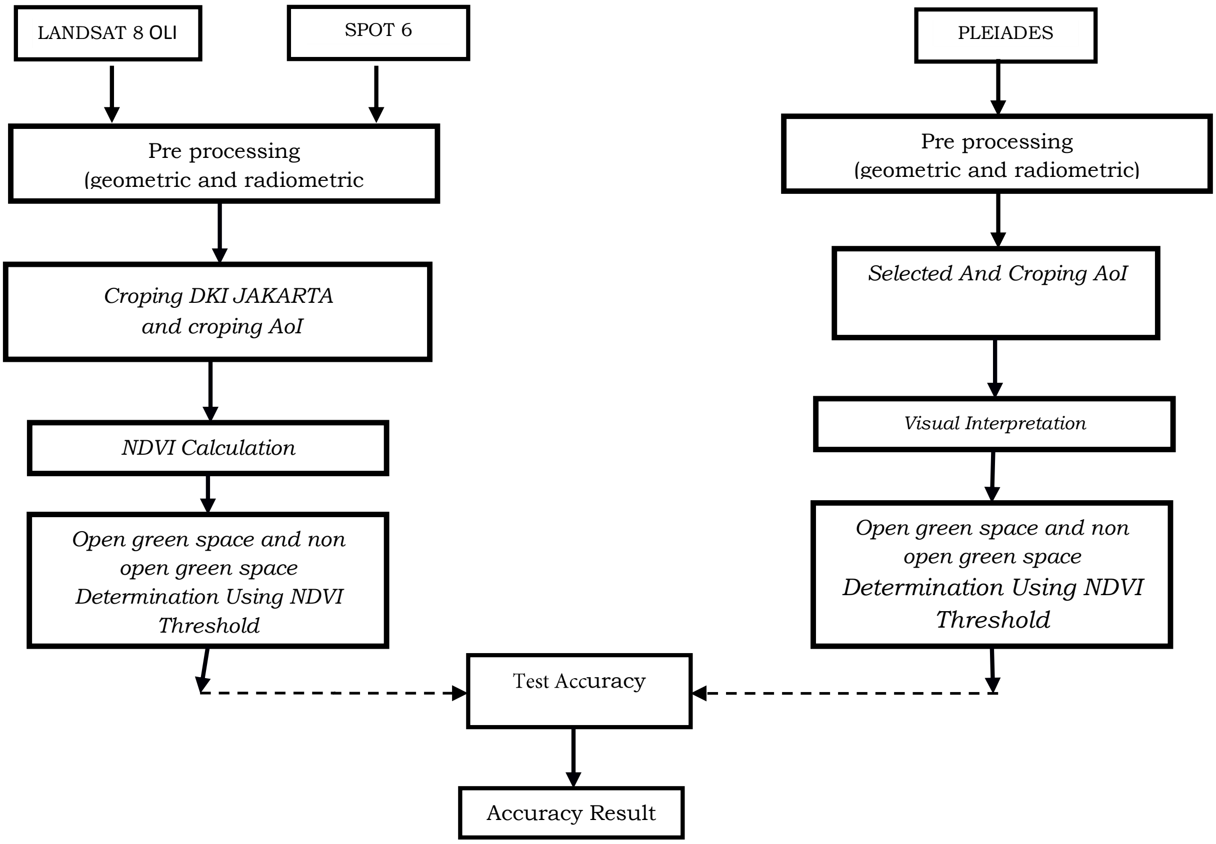


Figure 2-2: Research flow chart

3 RESULT AND DISCUSSION

3.1 Results

In the analysis of the accuracy of the green open space calculation by Landsat 8 and SPOT 6, the Pleiades image data is used of as the reference of the calculation. According to Carleer et al. (2005), the spatial resolution refinement of satellite images was attended by an increase of variability in a land cover unit. Furthermore, the spatial resolution of the sensors was improved at the expense of the spectral resolution (Herold *et al.*, 2003). Also, according to Hariyanto (2015) in a study calculating the green open space with the QuickBird data, based on the test accuracy using confusion matrix, it were determined that accuracy of interpretation results (overall accuracy) is about 90.43% and the error is about 9.57%. The panchromatics resolutions of QuickBird and the Pleiades are not much different, which are 65 cm and 50 cm. It means that Pleiades data can be used as a reference. The three data were taken in July and August 2013. It is assumed that the conditions of the areas examined has not experienced any changes of land cover in such period of time. The classification is using visual interpretation for green open space and non green open space area. Figure 3 shows the RGB 321 Pleiades image for the sixth AOI, as well as the results of the classification of green open space and non green open space.

NDVI image of Landsat 8 and SPOT 6 for the whole area of Jakarta can be seen in Figure 2-4, in which a growing green indicates vegetation has a higher density. For the Jakarta area, the concentrations of vegetation can be seen especially in the eastern part of Jakarta.

From the results of the training samples, it is obtained that the vegetation has the NDVI value greater than 0.34 for Landsat 8 and greater than 0.33 for

SPOT 6 data. Both of the thresholds between Landsat 8 and SPOT 6 indicate the range of values that are almost identical. Such result can be caused by the conditions, the time, and the same study area, as well as the same data processing method by default in the form of value reflectans. The results of the classification of green open space and non-green open space on the 6 AOI of the Landsat 8 and SPOT 6 can be seen in Figure 2-5. In general, on Figure 2-5, it can be seen that there is a second comparison data that shows detail. Based on Landsat 8 data, there is some areas of green open space that still cannot be detected compared to using SPOT 6 data. This can occur because of differences between the spatial resolution of the data in which the SPOT 6 has a higher spatial resolution (6 m) while Landsat 8 has a lower resolution (30 m) multispectral bands.

(a) AoI 1 Pleiades RGB 321

(b) AoI 2 Pleiades RGB 321

(c) AoI 3 Pleiades RGB 321

(d) AoI 4 Pleiades RGB 321

(e) AoI 5 Pleiades RGB 321

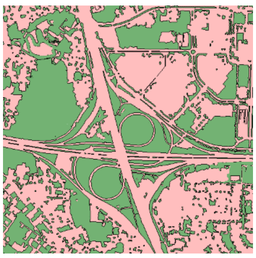
(f) AoI 6 Pleiades RGB 321

(a) OGS _AoI 1 Pleiades

(b) OGS _AoI 2 Pleiades

(c) OGS _AoI 3 Pleiades

(d) OGS _AoI 4 Pleiades



(e) OGS _AoI 5 Pleiades

(f) OGS _AoI 6 Pleiades

Open Green Space (OGS) = Non Open Green Space =

Figure 2-3: RGB 321 Pleiades Imagery and green open space classification

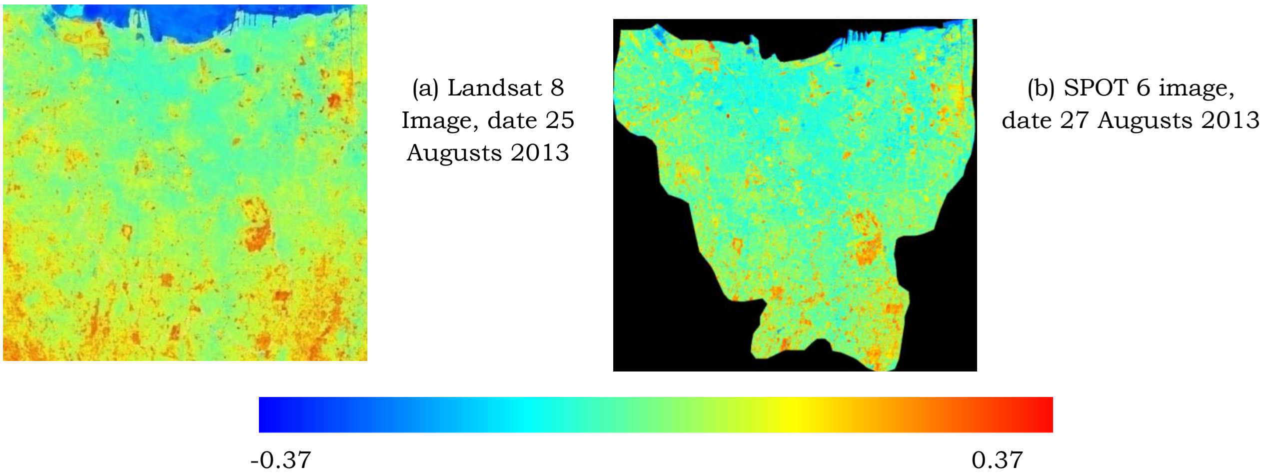


Figure 2-4: Landsat 8 and SPOT 6 NDVI

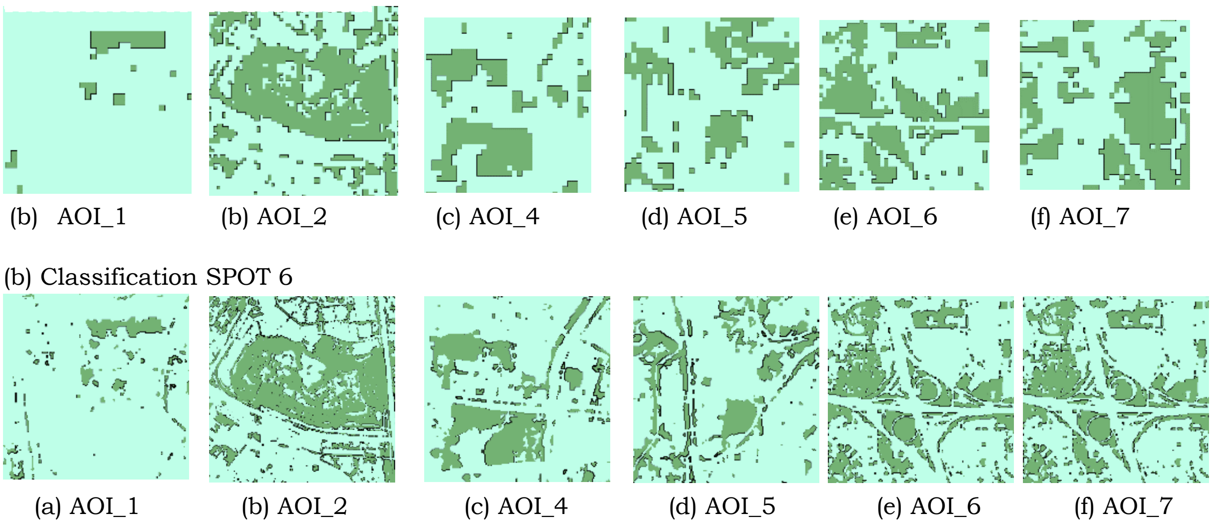


Figure 2-5: Green open space Classification based on NDVI. (a) based on Landsat 8, (b) based on SPOT 6

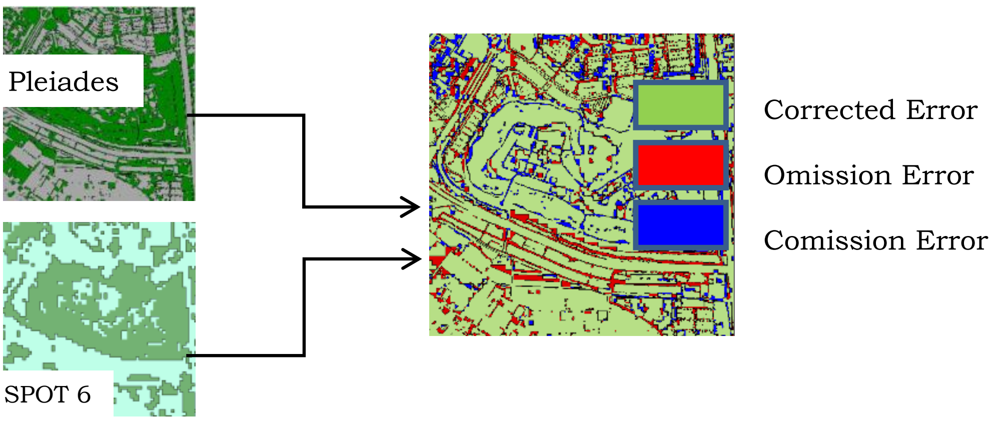


Figure 2-6: Selected Area corrected, Omission and Comission

Research on vegetation index is then used to indicate the green open space. The accuracy of the classification of green open space obtained from NDVI Landsat 8 and SPOT 6 were then tested with the Pleiades-based interpretation results.

The calculation is done using the Corrected Error, Omission Error, and Commission Error methods to overlay green open space class from NDVI of Landsat 8 or SPOT 6 with the results of the classification of green open space from the Pleiades data using the process of merging (union), later designated the area disjoint (corrected), the definitions of another class (omission) and the addition of another class (commission) as shown in Figure 2-6.

Each AOI performed extensive calculations of corrected area, Omission and Comission area an area that can be seen in tables 2 and 3, so that the retrieved% Accuracy for Landsat 8 or SPOT 6 with the following equation:

$$\textbf{Accuracy(\%)}=\frac{Corrected}{Corrected+Omission+Comission}*\textbf{100}\%$$

From the results of the calculation, of the difference in test results, the accuracy of Landsat 8 and SPOT 6 is only 5.36%. Meanwhile, the SPOT 6 has higher accuracy than Landsat 8.

Table 2-2: Landsat 8 accuracy test

NO.	AOI	CORR	COM	OMM	% ACCURACY
1	Aoi1	865,702	10,002	124,199	86.6
2	Aoi2	3,066,607	367,875	496,935	78.0
3	Aoi4	773,723	46,185	130,244	81.4
4	Aoi5	783,117	78,037	134,656	78.6
5	Aoi6	1,226,285	121,657	205,368	78.9
6	Aoi7	718,260	86,975	105,079	78.9
		% accuracy			**80.4**

Source : The calculation result, 2015

Table 2-3: SPOT 6 accuracy test

NO.	AOI	CORR	COM	OMM	% ACCURACY
1	Aoi 1	890,212	5,263	104,428	89.0
2	Aoi2	3,340,361	124,742	466,262	85.0
3	Aoi4	814,807	16,268	119,077	85.8
4	Aoi5	840,743	24,541	130,526	84.4
5	Aoi6	1,319,357	30,341	222,668	83.9
6	Aoi7	788,280	28,749	93,285	86.6
		% accuracy			**85.8**

Source : The calculation result, 2015

4 CONCLUSION

Landsat 8 and SPOT 6 image could be used to identify the green open space. NDVI values obtained from Landsat 8 and SPOT 6 compare using Pleiades data. The accuracy of SPOT 6 compared better 5.36% from Landsat 8 for green open space classification by using NDVI.

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