Potential Development for Absorption of Carbon and Reduced Air Polutionby Urban Forest : Implementation Using Remote Sensing Method in Banjarbaru, South Kalimantan, Indonesia

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Banjarbarucity – located in South Kalimantan province, Indonesia – has high temperatures average and rain intensity. Those cause various disasters and adverse impacts on human life. Moreover, high urbanization and infrastructure development contribute landcover change and the increase of non-vegetation landcover. Air pollution from transportation needs to be reduced by developing urban forest in order to absorb carbon and pollution in the air.

The purpose of this study is to explore how remote sensing method helps identification recent urban forest as the basis for further development in the city of Banjarbaru.

Keywords: *urban forest, remote sensing, pollution, carbon, urbanization*

1. INTRODUCTION

Recent world community are facing serious environmental problem, i.e. global warming and the resulting climate change (Houghton, 2004). One of main source of greenhouse gas – the agent of global warming – is forest degradation. Forest stock in Indonesia is decreasing by 6% a year, and forest degradation is responsible for two third (Mudiyarso et al 2008). Urban forest (green spcace) in Banjarbaru plays important role not only for environment, but also for social, and economic function. Therefore developing urban forest in Banjarbaru has very important benefit for both environment and socioeconomic. Moreover, green space (including urban forest) has to be available at least 20% of total city area (Anon 2007). It is need to study how recent condition of urban forest or green space in Banjarbaru for further development.

Defining the potential development of urban forest, and green space in general,needs an identification of current condition. Remote sensing technique is a promising tool for assessment of current urban forest and or green space. One of widely used algorithm for vegetation study is Normalized Difference Vegetation Index (NDVI) which is formulated in Jensen (2007) as follow.

$$NDVI = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}}$$

where as

NDVI : Normalized Difference Vegetation Index
ρ_{nir} : Near infrared radiant flux
ρ_{nir} : Red radiant flux

Cooke et al (n.d) promotes the threshold of NDVI=0.3 in separating forest and non-forest are.

2. STUDY SITE

Banjarbaru is a city in South Kalimantan Province which covers about 37,138 ha. It is located on longitude 114^o 41’ 22” – 114^{o}54’ 25” and latitude 03^o 25’ 40” – 3^o 28’ 37” and have elevation average of 20*m.asl*. It is a place for 171.496 people (Anon 2009).

The study was performed in two urban forests in Banjarbaru, i.e. Pinus1 and Pinus2 urban forest as can be seen in the following figure.

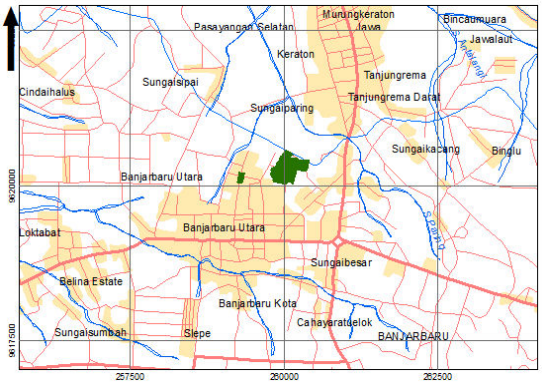

Figure 1. Pinus1 (left) and Pinus2 (right) Urban Forest

3. DATA

Landsat-7 EMT+ data was downloaded from USGS repository (http://edcsns17.cr.usgs.gov/EarthExplorer/). It is a 117-62 path/row of 27thFebruary 2010acquisition date (filled by 11 February 2010 acquisition date). Field survey data was collected by direct measuring two urban forests in Banjarbaru using uncorrected GeoExplorer GPS data.

4. METHODS

Selecting satellite images for study is an important factor in the early stage. Considering cost and availability, Landsat-7 images were selected as the image. It is

available in some repositories to be downloaded and therefore it is virtually free. The coverage of the image also almost covers any places on earth. Even Landsat-7 EMT+ image has stripping due to scan line corrector error; it is still powerful for vegetation study.

Data preprocessing was carried out before the image was analyzed. It consists of geometric correction, gap filling, and image cropping in range of 240936*m* - 269676*m*and 9604247*m*– 9627557*m*of UTM Zone 50 South projection system.

Some thresholds of NDVI value then are calculated to seek the most appropriate index in detection of urban forest. It started from NDVI=0, NDVI 0.1 and continue increase by 0.1 until visual inspection shows that the value is far underestimate the result.

Field checking was performed to measure the area of two urban forest in Banjarbaru, namely Pinus1 and Pinus2. Data collection was carried out using uncorrected TrimbeGeo-Explorer GPS data.

Performance test was used to compare the application of NDVI thresholds in calculating the area of urban forest. Field survey is used as proxy for actual are. Visual and accuracy assessment are criteria for selecting the most appropriate NDVI threshold for urban forest detection in Banjarbaru.The selected threshold then chose to predict the green space area in Banjarbaru city. The resulted figure then compared with 20% minimum area for green space based on Indonesian regulation

5. RESULTS AND DISCUSSION

Developing urban forest or green space in general needs an assessment of the current condition in Banjarbaru. NDVI methods may provide fast estimation about the current area and its spatial distribution. The resulting estimation then is compared with 20% green space requirement.

Selecting threshold for NDVI slicing was performed using visual inspection about the correlation between actual (GPS measured) and calculated urban forest with interval 0.1 of NDVI value starting from NDVI=0.0. The threshold of NDVI =0.0 gives overestimate result which can be seen in Figure 2.

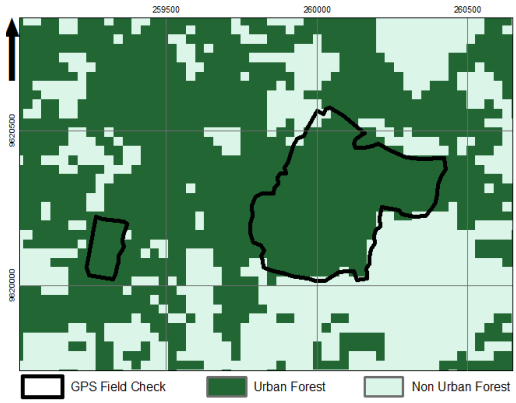

Figure 2. Predicted and Actual Urban Forest on NDVI=0.0

The threshold then be increased by 0.1 scale until stopped at the condition when visual inspection gives afar underestimate area which was at NDVI=0.3 as can be seen in Figure 3.

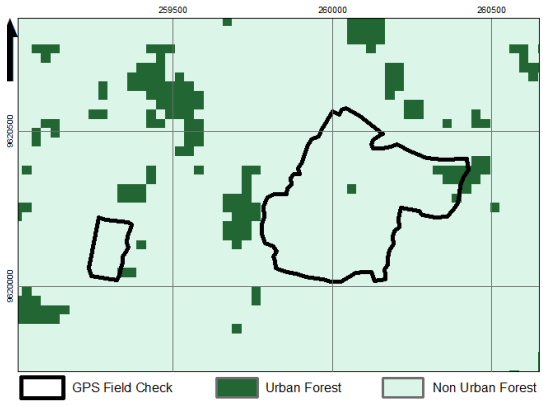

Figure 3. Predicted and Actual Urban Forest on NDVI=0.3

Therefore, there are 4 (four) NDVI threshold values studied, namely 0.0, 0.1, 0.2, and 0.3.Their accuracy in detecting urban forest shown in Table 1.

Tabel 1. Accuracy Assessment of Urban Forest Identification

NDVI Threshold	Actual(ha)		Predicted (*ha*)		Accuracy (%)	
	Pinus1	Pinus2	Pinus1	Pinus2	Pinus1	Pinus2
0	1.90	20.6	blended	blended		
0.1	1.90	20.6	blended	blended		
0.2	1.90	20.6	1.8	16.5	94.7	80.0
0.3	1.90	20.6	0.2	0.5	9.5	2.6

Note: blended means the urban forest cannot be separated from surrounding features.

Broader calculation for Banjarbaru city was performed to calculate whether existing land cover, which has NDVI values over selected NDVI threshold, meets the 20% requirement. The result shows that total land cover which has NDVI at least 0.2 in Banjarbaru is **9,673 *ha***. The figure shows that Banjarbaru has a potential for urban forest because it has about 31% of landcover share the same value of NDVI with current urban forest. Elimination of small noise was not performed, however.

6. DISCUSSION

Defining the threshold of NDVI value is crucial for identification of urban forest using a combination of visual inspection and numeric accuracy assessment gives a promising technique for urban forest identification.

The result shows that threshold NDVI=0 and NDVI=0.2 gives a blended border between urban forest and surrounding area. Therefore the two values cannot be used in urban forest identification. The threshold NDVI=0.3 gives too underestimate prediction as shown in Figure 3.NDVI=0.2 gives most visually match and highest accuracy assessment by 94.7% and 80% for Pinus1 and Pinus2 urban forests respectively. The result can be seen in Figure 4. The study gives different result compare to Cooke et al (n.d) which used NDVI=0.3 to separate forest and non-forest area.

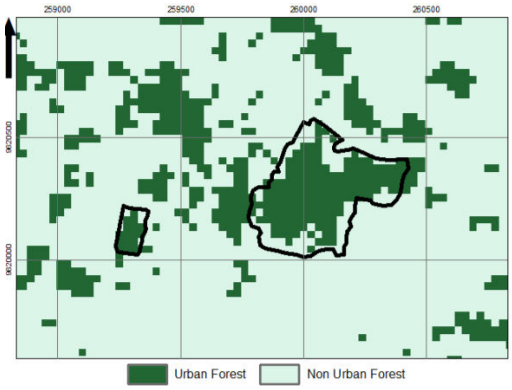

Figure 4. Predicted and Actual Urban Forest on NDVI=0.2

Identification of urban forest using NDVI=0.2 still gives non-perfect identification of urban forest by presence of non-urban forest as urban forest in the result. Further more detail study is needed including incorporating more advance algorithms and noise reduction.

7. CONCLUSIONS

Identification of urban forest is important for further development in Banjarbaru city. Remote sensing technique is a promising tool for the identification by combining NDVI algorithm and visual inspections. The threshold of NDVI=0.2 gives satisfy result by 94.7% and 80% accuracy for Pinus1 and Pinus2 urban forest. The total green space of Banjarbaru meets 20% requirement by regulation.

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