

Distribution of green open space in Malang City based on multispectral data

A W Hasyim, F P Hernawan

Department of Urban and Regional Planning, Faculty of Engineering, Universitas
Brawijaya, Malang, Indonesia

awhasyim@yahoo.com

Abstract. Green open space is one of the land that its existence is quite important in urban areas where the minimum area is set to reach 30% of the total area of the city. Malang which has an area of 110,6 square kilometers, is one of the major cities in East Java Province that is prone to over-land conversion due to development needs. In support of the green space program, calculation of green space is needed precisely so that remote sensing which has high accuracy is now used for measurement of green space. This study aims to analyze the area of green open space in Malang by using Landsat 8 image in 2015. The method used was the vegetation index that is Normalized Difference Vegetation Index (NDVI). From the study obtained the calculation of green open space was better to use the vegetation index method to avoid the occurrence of misclassification of other types of land use. The results of the calculation of green open space using NDVI found that the area of green open space in Malang City in 2015 reached 39% of the total area.

1. Introduction

Malang is one of the urban areas in East Java Province with 110,06 square kilometer administrative area and 851,298 of total population in 2015 (Malang City In Figures, 2016). Urban areas with a high population tendency make the need for land increasing every year. Conversion of green land into built land directly related to the needs of land which will eventually lead to a decline in the area of green land which is one of the supporting elements for sustainability of a city.

Green open space in urban areas according to law no.26 of 2007 consists of public green open space and private green open space. The proportion of green open spaces in urban areas shall be at least 30 (thirty) percent of total city area. The proportion of public green open spaces in urban areas shall be at least 20 (twenty) percent total area of the city. The green open space is an elongated / lane and / or clumped area, which is open to use, where crops grow, either naturally or intentionally planted [1].

The presence of green open space in an urban area has the benefit of an air circulation control system (urban lung). Indirectly, green open space functions in watershed protection and biodiversity conservation / for biodiversity. In addition, the presence of green space in an urban area can be utilized by the population to perform various social activities in a city where its existence produces various social, economic, and environmental impacts.

This study aimed to determine the distribution of green open space in Malang City in 2015 using Landsat 8 image. The calculation of the green open space was done by interpretation of Landsat 8 image using ArcGIS 10.3 software.



2. Methods

This study was based on the phenomenon of land conversion rate is quite high in Malang because of the high demand for land. Malang was classified in a large urban classification with a population above 500,000 who also accumulated by the existence of students and commuters that make the need for land to be high and at risk of green land conversion function.

The data used in this research was Landsat 8-OLI image with date of acquisition 16 June 2015 for scene number / row 118/066. Radiometric correction was performed to calculate the reflectance value of the image. The NDVI value (Normalized Difference Vegetation Index) is calculated by adopting a calculation method determined by NASA. NDVI value used to separate between the green area and built area for calculated of green area/ green space in Malang.

2.1. Remote sensing

Remote sensing is a technique of collecting information about objects and the environment remotely without physical touch. This technique produces some form of image that further processing and interpretation to produce data related needs in the field of geography, geology, planning, forestry and so forth [2].

The landsat 8 satellite has an OLI sensor (Onboard Operational Land Imager) and TIRS (Thermal Infrared Sensor) with a total of 11 units. Among the canals, 9 channels (bands 1-9) are in OLI and 2 others (bands 10 and 11) on the TIRS. Most channels have specifications similar to Landsat-7.

2.2. Radiometric correction

Radiometric correction was used to correct the pixel value to fit the supposedly normally considering atmospheric disturbance factor as the main fault source and also to eliminate or minimize radiometric error due to external aspect of atmospheric disturbance during recording [3].

Radiometric correction was performed using the ToA (Top of Atmosphere) correction which includes reflectance ToA and sun correction. Digital number (DN) is a digital value that describes an object's brightness level in satellite data. Digital numbers are stored in a pixel, whereas pixels are a point that is the smallest element of a satellite image. Spectral reflectance is the amount of energy reflected by an object per unit area and a certain wavelength. Conversion from digital number to spectral reflectance is done to change the value of the reflection contained in the digital number that previously did not have a unit into the energy value that already has a unit. Here is the equation for the correction of reflectance ToA:

$$\rho\lambda' = Mp * Qcal + Ap \quad (1)$$

Where:

$\rho\lambda'$ = ToA reflectance, without sun elevation correction
 Mp = Reflectance_MULT_BAND_x, which x is band number
 $Qcal$ = Digital Number (DN)
 Ap = Reflectance_ADD_BAND_x, which x is band number

Furthermore, the image was corrected to the sun angle to eliminate the difference in DN values caused by the position of the sun. The position of the sun against the earth changes depending on the recording time and the location of the recorded object. The equations for correction with the angle of the sun are:

$$\rho\lambda = \rho\lambda' / (\cos(\theta SZ)) = \rho\lambda' / (\sin(\theta SE)) \quad (2)$$

Where:

$\rho\lambda$ = ToA reflectance
 θSZ = Sun elevation
 θSE = Angle zenith sun, $\theta SZ = 90^\circ - \theta SE$

2.3. NDVI (Normalized Difference Vegetation Index)

NDVI (Normalized Difference Vegetation Index) is an image calculation used to determine the greenish level. NDVI can show parameters related to vegetation parameters, among others, green foliage biomass, green foliage area that is predictable for vegetation division.

The absorption of red light by chlorophyll and the reflection of infrared light close by the mesophyll tissue in the leaves will make the brightness that receives the satellite sensors through these channels will be much different. On land without vegetation, including areas and settlements, open land, or damaged vegetation conditions, can not provide a high ratio to the comparison of the canals. In contrast, on land with dense vegetation and healthy conditions, the comparison of the value of the two channels provides a very high value.

The value of the vegetation index is built on the difference between maximum absorption in red channels as a result of chlorophyll pigment and maximum reflectance in near infrared (near infrared / NIR) infrared spectral channel due to the effect of leaf cellular structure [4].

NDVI has a range between -1.0 to +1.0. Values greater than 0.1 usually indicate an increase in the degree of greenness and intensity of vegetation. The value between 0 and 0.1 is characteristic of rocks and vacant land. A value less than 0 applies cloud, ice, and snow. The vegetation surface has a range of NDVI 0.1 values for grassland and shrublands up to 0.8 for tropical rainforest areas.

$$NDVI = (NIR - VIS) / (NIR + VIS) \quad (3)$$

Where:

NIR = Reflectant value of near infra red channel

VIS = Reflectant value infra-red channel

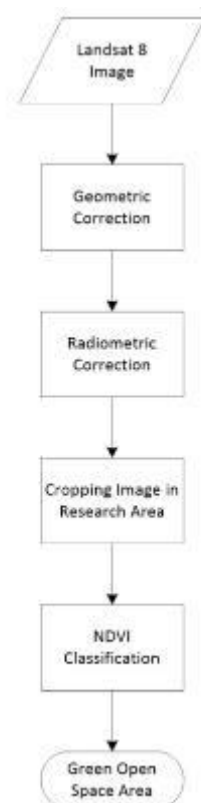


Figure 1. Flow chart of Landsat image processing.

3. Results

Image processing of Landsat 8 was done on the administrative area of Malang City. The result of Landsat 8 data before and after the ToA correction can be seen in Figure 2. The result of band composite on Landsat 8 image of Malang city using combination between band 4,3 and 2. The Landsat 8 data has been corrected ToA, the value of the Digital Number was turned into a reflectance value. To support the NDVI classification, an image calculation was performed to determine the greenness level.

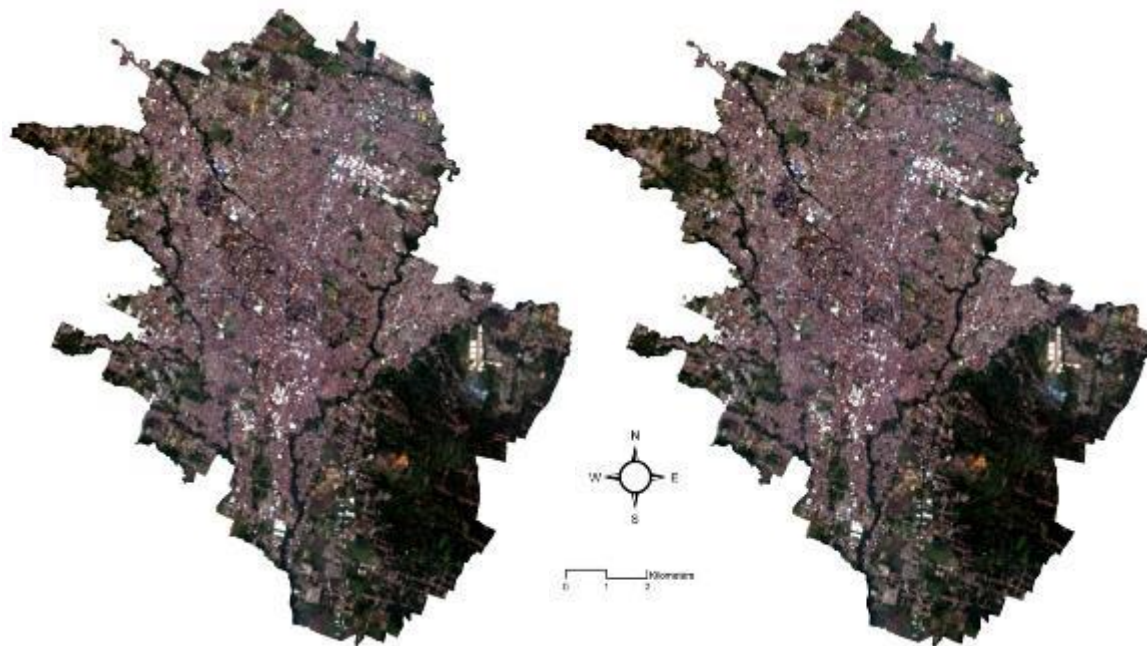


Figure 2. Landsat 8 Image Using Composite Band 432 (a) Before ToA Correction; (b) After ToA Correction

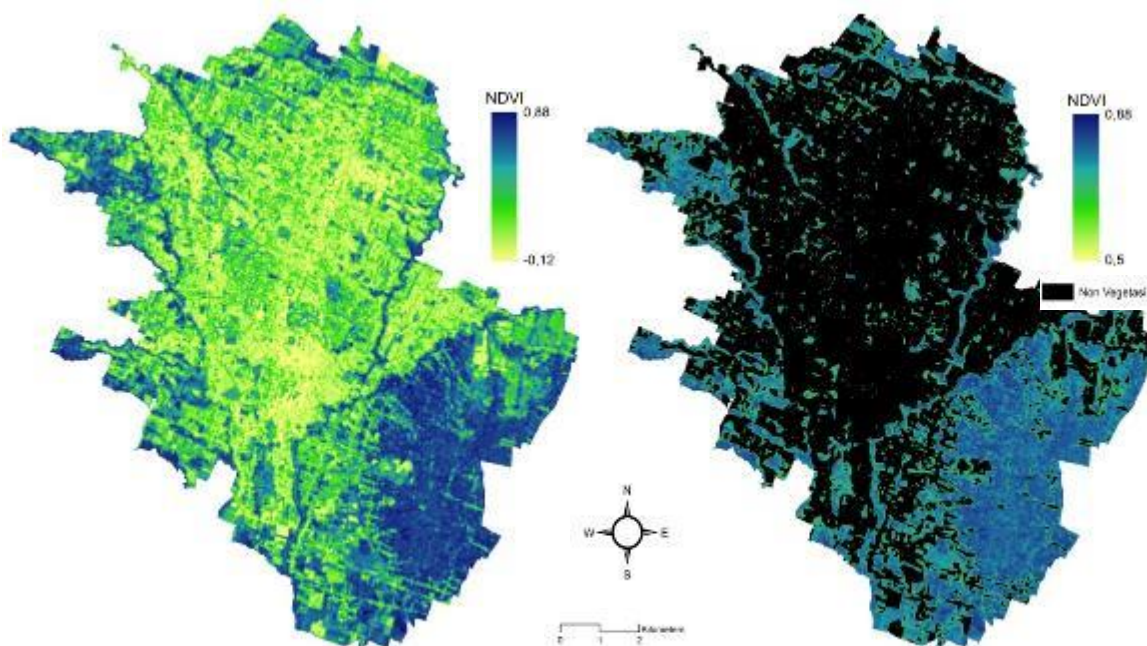


Figure 3. Vegetation Indeks (a) NDVI; (b) Reclassification NDVI

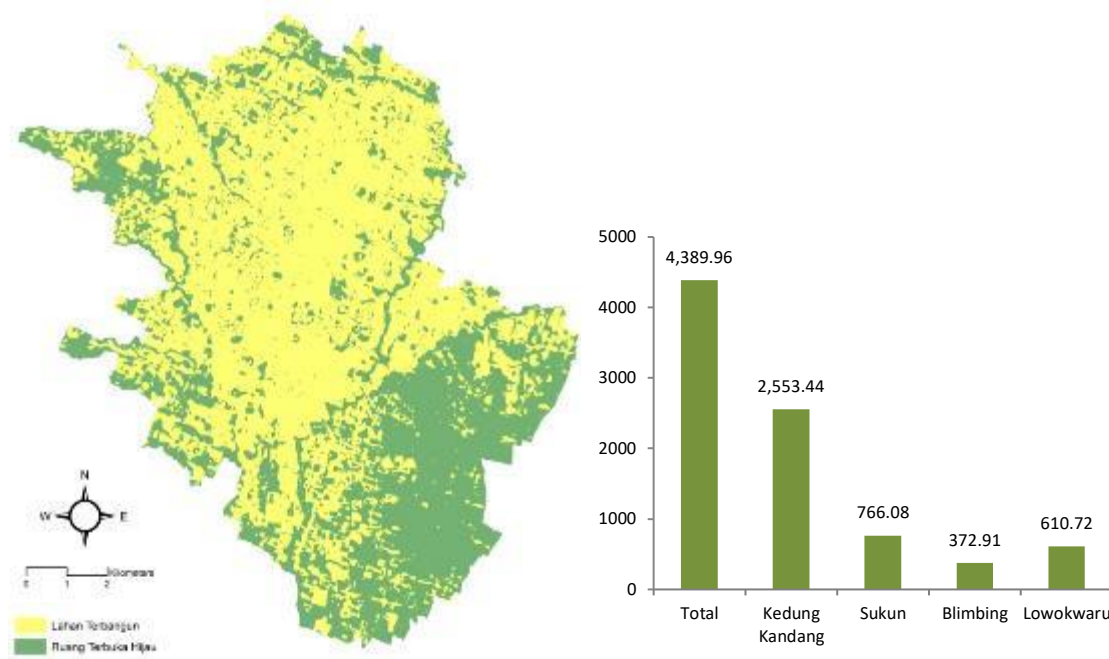


Figure 4. (a) Land Cover; (b) Green Open Space Width of Each Sub-District

3.1. The Vegetation Index (NDVI)

From the results of NDVI classification in Malang, can be seen the spread of vegetation in Malang tends to be located in the suburb of Kedung Kandang and surrounding areas. The calculation results obtained NDVI for Landsat 8 data 2015 as shown in Figure 3.

In the downtown area, the NDVI value tends to be low as it is dominated by the area built in the area. In the southeastern region is still found plants that have high NDVI value (blue) where the area is a hill that is still dominated by tall trees and forests. After the classification stage of NDVI value, calculation of green open space in Malang is done by converting the image of NDVI processing into polygon with minimum limit (classification) to determine the built area and green area (green open space). After the classification of each land, then calculated the area between land and green area. Classification for green open space used value is more than 0,5. This classification value was used to classify forage on trees, excluding grass, rice and other low plants. Thus the obtained distribution green open space in Malang has a value between 0,5 to 0,88 as shown in Figure 3.

From the results of the calculation area, it is known that the total green open space in Malang reached 4389,959 hectares. While the built up area was 6816,3913 hectares. According to its own percentage, the area of green open space of Malang City reaches 39,7% and the land area is 60,3%. The width of green open space in each sub-district can be seen in Figure 4.

4. Conclusion

From the results of the study was found that the calculation of green open space was better to use vegetation index method to avoid the error of other types of land use. By using the classification of NDVI values from 0,5 to 0,88 as green open space, it is known that the green open space in Malang reaches 4389,959 hectares. Green Open Space in each district respectively, Klojen District of 86,80 hectare, Lowokwaru District of 610,72 hectares, Blimbing District with 372,91 hectares, Sukun District covering 766,08 hectares and Kedung Kandang District with 2553,44 Hectare. The total area of green

open space in Malang reaches 39.7% of the total area in which it exceeds the minimum limit for the green open space area in a city that is equal to 30% of the total administrative area.

References

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