UTILIZATION OF SPOT 6/7 AND LANDSAT TO ANALYZE OPEN GREEN SPACE AND BUILT AREA IN SURABAYA CITY

Mohammad Ardha[1], Nurwita Mustika Sari[1], Mukhoriyah[1]

[1]Center for Remote Sensing/National Research and Innovation Agency, Jl. Raya Jakarta-Bogor No 32

e-mail: mohammadardha@gmail.com

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Abstract. The migration of people from rural to urban areas is a common phenomenon nowadays. One of the goals of urbanization is in the city of Surabaya. The increase in population causes the need for housing and life to increase. One of the many changes in land use is the change of land into built-up land. The increase in the built-up land area is currently a new phenomenon, where the open space area is reduced due to changes in land use. One of the changes in land use is from green open space to built-up land. This study aims to see the extent to which the growth trend of green open space and built-up land in the city of Surabaya by using the NDVI method to see the trend of changes in green open space in the city of Surabaya and NDBI for the land built in the city of Surabaya. The data used in this study are SPOT 7 images for green open space and Landsat 8 for built land. Based on this method, green open space in Surabaya in 2015 was 29.19%, in 2016 it was 21.22%, then in 2017 it was 24.54 %, and in 2018 it was 27.60%. Meanwhile, for built land in 2015, it was 26.43%. In 2016, it was 26.44%. In 2017, it was 30.99%, and in 2018 it was 42.88%. Other results were also obtained regarding the change of green open space into the built area. Growth has increased every year, namely from 2015 to 2016 by 19.90%, from 2016 to 2017 by 4.43%, and from 2017 to 2018 by 2.67%. As for the land built into green open space, namely 2015 to 2016 of 2.01%, 2016 to 2017 of 2.84%, 2017 to 2018 of 2.72%. The conclusion from this activity is that NDVI can be used to see the level of vegetation density, indicating the existence of green open space in urban areas. And NDBI can show the existence of built-up land. The city of Surabaya has stable green open space, and the amount of built land continues to increase every year.

Keywords: *Open Green Space, NDVI, NDBI, SPOT, remote sensing*

1 INTRODUCTION

The migration of residents from villages to cities is a phenomenon that is quite common nowadays. The movement of people towards big cities in search of a better life from their hometown. Migration of the population from villages to cities will trigger urban development and an increase in population. With the rise in population, more land is needed for housing (Tjiptoherijanto, 1999). The development of this city at an advanced stage will increase economic growth as seen in cities on the island of Java (Firman, 1996). One of the goals of urbanization is the city of Surabaya. Surabaya, one of Indonesia's big cities, is charming to some people, especially in East Java.

Increasing the number of residents in a city increases the needs of the existing community. The increasing needs of society are the human need for a place to live and the human need to make a living. Another impact is environmental problems, one of which is reduced green space due to increased built-up land (Harahap, 2013). One of the many changes in land use is the change in land use to built-up land. The current increase in built-up land also creates a new phenomenon in which open space is reduced due to changes in land use.

Therefore, the government plans to increase the amount of open space for planting vegetation, better known as green open space.

Green Open Space is a phenomenon that is widely reported at this time. Green Open Space is an area/lane and elongated group used openly where plants grow. Both those that grow naturally and those that are planted (Indonesian government, 2007). Green open space is needed, especially in urban areas with less air quality than in rural areas. This is because in urban areas there is a lot of pollution caused by transportation and industry (Hitchcock, Conlan, Kay, Brannigan, & Newman, 2014). Research shows that air pollution is higher in downtown as a center for business and other anthropogenic activities (Sari & Sidiq Kuncoro, 2021). In addition, green open spaces also have benefits for a comfortable microclimate and mental well-being (Aram, Higueras García, Solgi, & Mansournia, 2019)

Surabaya as one of the big cities, is also trying to apply the Green city concept. Referring to the stipulation that 20 percent of cities are green open spaces (Government of Indonesia, 2007) One of the efforts is to oblige buildings in Surabaya to provide green open spaces (Perda No. 7/2002). Green open spaces in Surabaya are still being improved in the hope of lowering the temperature in the city of Surabaya.

Remote sensing, as a science that is widely used today, can be used to map green space in an area. Green open space mapping using Remote Sensing data has an advantage in terms of time compared to direct measurements in the field. Object detection from remote sensing is carried out by digital classification with various algorithms (Kushardono, 2017). Several studies have been conducted to detect green open spaces using NDVI with SPOT 6 in DKI Jakarta (Febrianti, Pasaribu, & Sulma, 2015), other studies to see the distribution of green open spaces in Malang City using Landsat imagery (Hasyim & Hernawan, 2017) others aim to see patterns of changes in green open space based on NDVI in the Klang valley (A. Ahmad et al., 2014). Another study examined green open spaces in residential areas in Denpasar using IKONOS imagery (Nuarsa, 2013) and analysis of single urban vegetation objects with OBIA and vegetation index (Sari & Kushardono, 2016). Other studies use NDBI and NDVI to map built-up areas (Syahputra et al, 2021). Various studies have examined the relationship between green open spaces and temperature changes in urban areas (F. Ahmad, Arifin, Dahlan, Effendy, & Kurniawan, 2012) In addition, Green open space analysis has been carried out with an oxygen demand approach using ALI EO-1 Putra satellite imagery, 2012. Sentinel-2A has been used for green open space analysis with NDVI and SAVI (Sinaga, Suprayogi, & Haniah, 2018). This study aims to see the extent of the city of Surabaya, which provides green open spaces for its citizens by using the NDVI method to see the changing trend of green open spaces in Surabaya.

2 MATERIALS AND METHODOLOGY

2.1 Location and Data

The research area is in the city of Surabaya, which is the capital city of East Java with coordinates 7°15′55″ South Latitude 112°44′33. Surabaya became a research area due to the city's urbanization, causing environmental problems such as changes in land use and the number of public vehicles that produce pollution. The data used are SPOT 7 and Landsat 8 imagery for the years recorded in 2015, 2016, 2017, and 2018. SPOT 7 and Landsat 8 were selected as areas that have little cloud cover to facilitate the classification process.

Figure 2-1: Study Area in Surabaya City.

2.2 Standardization of data

The data used was standardized data processing, such as geometric correction and radiometric correction on SPOT 7 and Landsat 8 images. For SPOT 7 data, images were taken that had little cloud cover. Landsat 8 data was also chosen for low cloud cover and radiometric and geometric correction.

2.3 Methods

The method used is to build a Vegetation Density Index or NDVI model and a Normalized Density Index Model or NDBI Model. NDVI) is an image calculation used to determine the greenness of vegetation. NDVI can show parameters related to vegetation, including those related to active radiation in vegetation, green foliage biomass, and chlorophyll in green foliage areas, which are values that can be estimated for vegetation division. The index provides a number between -1 and 1, representing the vegetation cover density (Kemarau et. Al., 2021; Sinarmata et.al., 2021). In general, the index is close to 1, meaning dense vegetation, and less than zero represents water and clouds. The algorithm used to identify the greenness of vegetation uses near infrared waves and red waves (Putri et.al, 2018) with the following equation:

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

Where:
NDVI: Normalized Difference Vegetation Index
NIR : Band Near Infrared
Red : Band Red.

The NDBI model has similarities to NDVI in obtaining building detection (Zha et al, 2003) and the difference is the band used for the NDBI index here is the equation for the NDBI index.

$$NDBI = \frac{SWIR - NIR}{SWIR + NIR} \quad (2)$$

Where:
NDBI: Normalized Difference Water Index
NIR : Band Near Infrared
SWIR : Band Shortwave Infrared.

The range of NDVI values has its meaning for each object which is carried out by recording Remote Sensing data, one of which is research conducted by (Sofan, Febrianti, & Prasasti, 2014) which makes ranges of values and averages for each object in urban areas. The area is shown in the table below.

Tabel 2-1: NDVI Value in Land Use In Jakarta

Class Number	NDVI	
	Mean	Range
Grass	0.363	0.051-0.448
Open Space	0.25	0.02-0.487
Mixed Garden	0.38	0.094-0.504
Plantation	0.567	0.32- 0.736
Settlement	0.136	-0.073 - 0.532
Industries	0.089	-0.028 - 0.425
Moor	0.369	0.222 - 0.505
Paddy Fields	0.256	-0.105 - 0.538
Mine	0.115	0.008-0.385
Water	0.081	-0.103-0.569
Grass	0.363	0.051-0.448

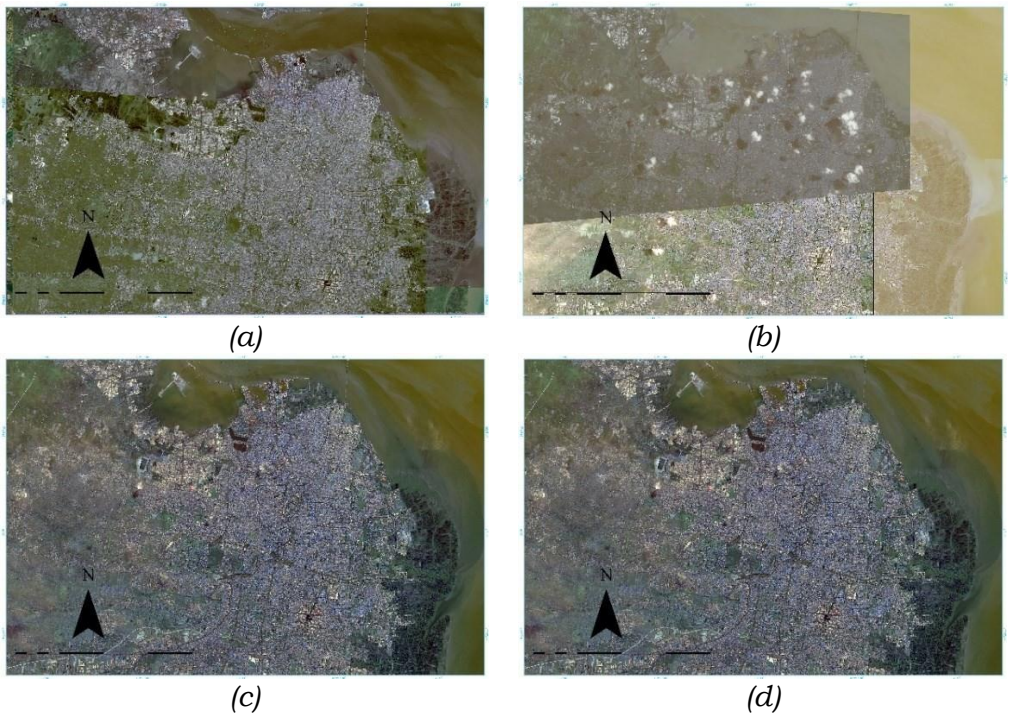

Figure 2-2: (a) SPOT image in 2015; (b) SPOT image in 2016; (c) SPOT image in 2017; (d) SPOT image in 2018.

The distribution of vegetation can be identified using the VDVI model, and NDWI is usually used to identify water bodies (Singgalen et. Al., 2022).
Based on the average value of each object which then takes a minimum NDVI value to explain the object, whether open green space or not open green space in this case the value used has a minimum range of values of 0.02 Parwati et al,2014. The selection of 0.02 is based on the value of objects included in vegetation; the table shows that vegetation objects have values greater than 0. Rather than NDVI, which determination threshold from the previous research specified for an object for NDBI equations and NDBI determination defined from a value greater than 0. So, the threshold used to determine the built area is 0. Other research from he et al,2014, and Zha et al,2003) define built are more significant than 0 and has a positive value. When the result of the open green space area and settlement area is known spatially, then an overlay technique is used to see land use change from open green space to settlement or settlement to open green space area.

3 RESULTS AND DISCUSSION

The results of the NDVI value calculation were carried out on the SPOT Image 2015-2018, which could see the distribution of presentations between the open green space and not the open green space following the display of the classification results. Several images in 2016 had quite a lot of cloud cover compared to other years, so areas covered by clouds were replaced with Landsat data with clean cloud coverage. The results of NDVI processing show that green open space in the city of Surabaya is focused on the Southwest and Eastern parts of Surabaya. This is appropriate because the image shows that the settlement is in the middle of Surabaya and the north, which is an industrial area characterized by a white appearance. When viewed using SPOT imagery. The following is a comparison of the area of green open space in the city of Surabaya with non-green open space.

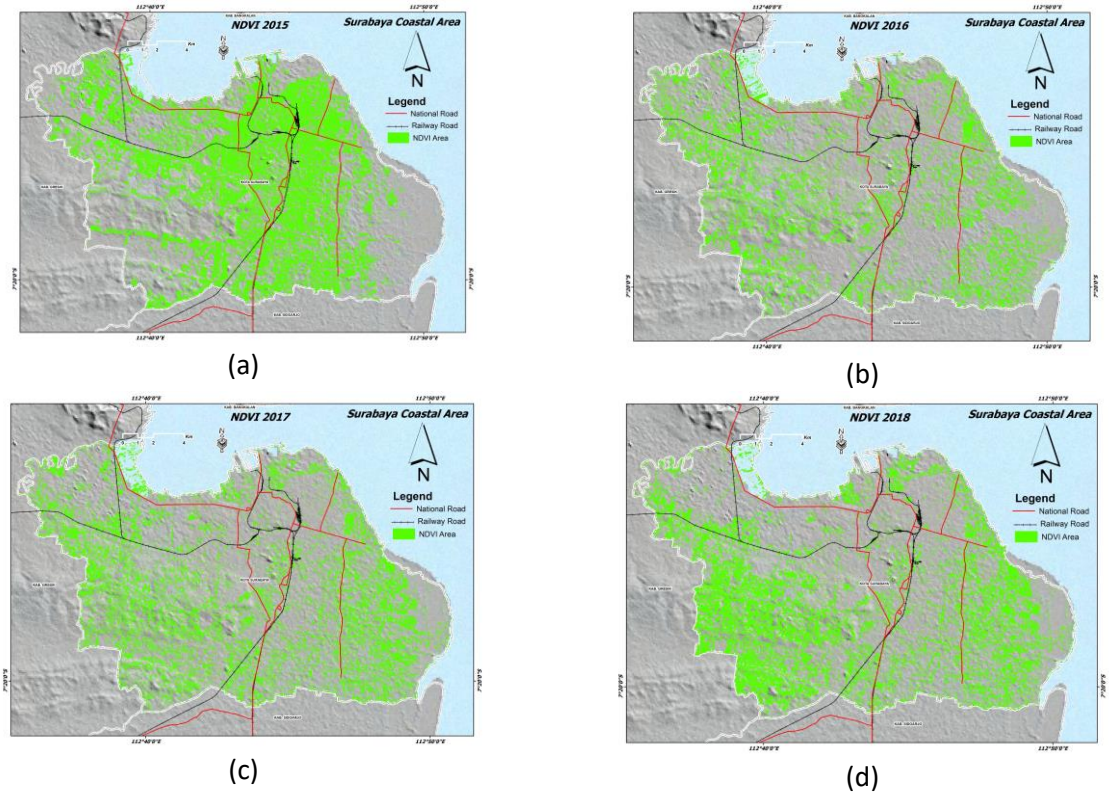

Figure 3-1: (a) NDVI in 2015; (b) NDVI in 2016; (c) NDVI in 2017; (d) NDVI in 2018

Tabel 3-1: Total Area and Percentage Open Green Space In Surabaya

Years	Area (Ha)	Percentage (%)
2015	9588.52	29.19
2016	5987.46	21.22
2017	8061.54	24.54
2018	9075.46	27.63

Based on this value, it can be seen that the most significant green open space was in 2015, with a total green open space of 29.18%, exceeding the minimum green open space that must be in urban areas, namely 20%. Furthermore, the trend of green open space in Surabaya decreased to 21.22% in 2016, but the provision that green open space is still above 20% is still followed. We can see that after 2016 the trend of open green space increased by around 3 percent in a year in 2017, 24.54 % and 27.63 % in 2018. this could happen because of the policy of the Surabaya city government, which makes a lot of city parks, as well as a policy known as a green city, which focuses on making Surabaya a green city and one of the focuses of the initial stage is on open green space. (Kusuma et al,2020).

The obstacle to detecting green open areas is that clouds cover some parts of the SPOT image to detect open green spaces, so they need to be replaced with Landsat data for cloudy areas.

The results of the NDBI show that settlements in Surabaya increased yearly from 2015 to 2018. Here, the table shows the percentage of the increased settlement area

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Tabel 3-2: Total Area And Percentage Built-up Area In Surabaya

Years	Area (Ha)	Percentage (%)
2015	8683.19	26.43
2016	8684.43	26.44
2017	10180.69	30.99
2018	14083.11	42.87

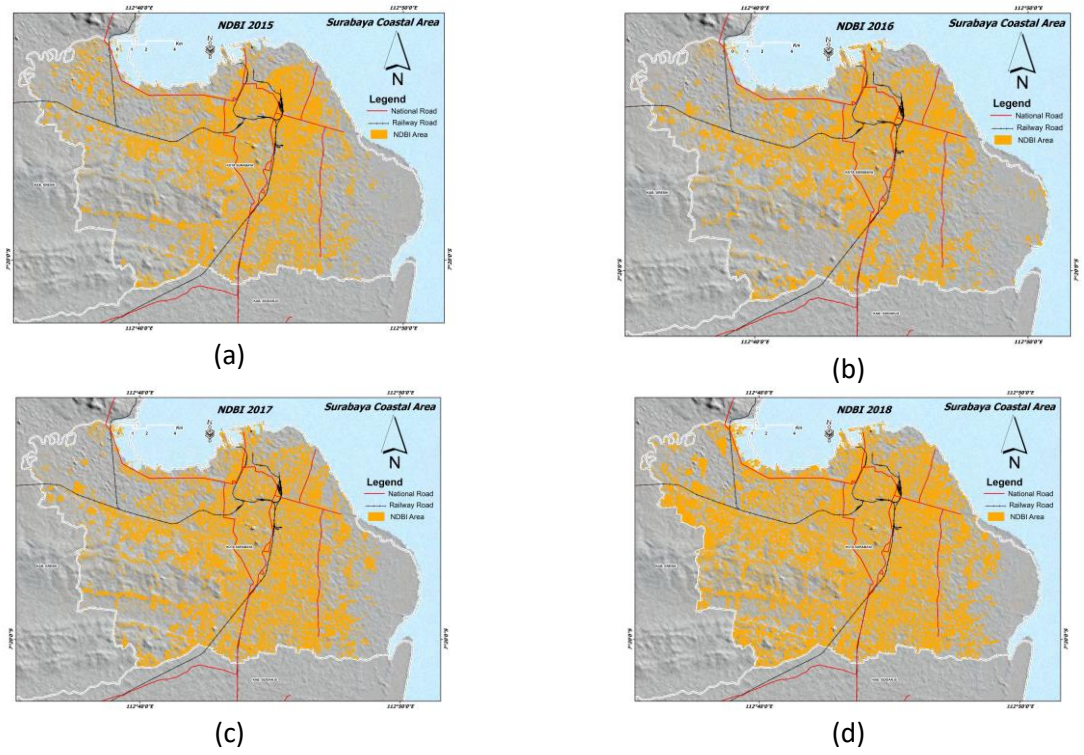

Figure 3-2: (a) NDBI in 2015; (b) NDBI in 2016; (c) NDBI in 2017; (d) NDBI in 2018

From this image, we can see the settlement growth in the northern area. The industrial area in Surabaya is focused on the northern area, which is close to the port area. If we see from open green space area and settlement area has reverse spatial distribution. So, with the overlay technique, we could see land use change in Surabaya, especially in the open green space and settlement areas. Here is the image below.

The obstacle faced in detecting buildings from NDBI is the similarity between open land and the appearance of buildings. In this case, to strengthen the accuracy of SPOT data, it is used to see buildings from NDBI results that are used with Landsat data.

From the image spatially, the result of 2015 to 2016 from open green space to settlement has the most significant change than others, and from the image, we can see that land use change from settlement to open green space tends statically. it could be happening because the quality of SPOT in 2016 still not good although its already substituted in some part area using Landsat data but still has a problem. It means there are no substantial changes from it. Here is the table showing the total area change in Surabaya City .

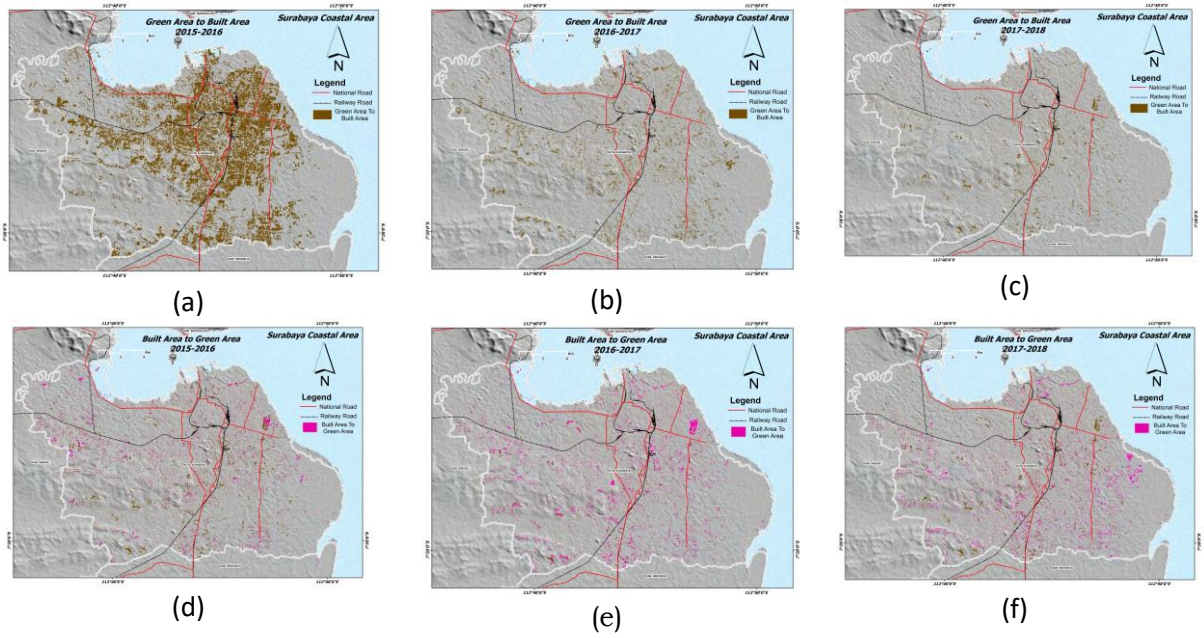

Figure 3-3: (a) Land Use Change Open Space To Built are in 2015-2016; (b) 2016-2017; (c) 2017-2018; Land Use Change Built Area To Open Space (d) NDBI in 2015-2016; (e) 2016-2017; (f) 2017-2018

Tabel 3-3: Total Area And Percentage and Land Use Change in Surabaya

Years	Green Area To Built Area (Ha)	Percentage (%)	Built Area To Green Area (Ha)	Percentage (%)
2015-2016	6540.3	19.9 %	659.42	2.01
2016-2017	1453.92	4.43%	931.75	2.84
2017-2018	877.72	2.67%	893.48	2.72

Based on a Statement from the Surabaya City Government in 2018 Surabaya succeeded in reducing its temperature by 2° Celsius, this happened because of the mayor's policy, which regulates the addition of green open space in the city of Surabaya and can be seen from the increase in the area of green open space in the city of Surabaya. (Hakim et al.,2018)

Previous research has shown how a decrease in vegetation areas can impact various aspects, both environmental comfort and health aspects. In the physical environment, reduced vegetation can increase surface temperature (LST) and potentially an Urban Heat Island (UHI). Even worse, it can increase the risk of heat waves. The UHI phenomenon was found to affect the decline of health quality aspects in cities, which are lower than in rural areas (Heavisde et al, 2017)

4 CONCLUSION

NDVI can be used to see a vegetation density indicating a green open space in an urban area. Based on the results, it can be concluded that the city of Surabaya experienced a increase trend in green space above the threshold for metropolitan areas in range 2015-2018 which is above 20%, but in 2016 it has the highest point almost near 30 % but for 2017-2018 had slightly increased and its shown Surabaya had to imply government rules about open green space. And NDBI could use for detection settlement area it is shown settlement in Surabaya has Increased in 2015-2018. Based on results Government of Surabaya must has regulation to limitless settlement to keep temperature stabile and increase green space area .The results of this study will be better if the clip area is done using pre-existing open green space data to obtain a more accurate area.

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