IDENTIFICATION OF LAND COVER CHANGES FROM LANDSAT 8 OLI SATELLITE IMAGERY USING NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI) METHOD (STUDY CASE: SURABAYA)

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ABSTRACT

Changes in land use in an urban area, such as Surabaya have a major influence on the balance of nature and the environment of its people. Analysis related to changes in land use from time to time is important to maintain the dynamics of development in Surabaya. The land use identification method in this study utilizes the Normalized Difference Vegetation Index (NDVI) to identify the effect of differences in the spectrum due to vegetation and non-vegetation. Satellite image data is analysed based on the spectrum and the results of the land cover classification have been obtained. From six classes of land cover classification results, it was found that the largest decreasing trend in the area was in class 6, one of which contained urban forest around 13% to 9%. For the trend of increasing area, the largest area occurs in class 5, which includes a land cover of undeveloped land which has the potential for building and infrastructure construction to be carried out around 15% to 19%. Surabaya has a development pattern on the use of vacant land for public and private facilities, which has the potential to reduce the area of an urban forest. Given that the function of forests in urban areas is quite necessary for the stability of air temperature and maintaining the beauty of the city.

Keyword: Land cover, NDVI, vegetation

Introduction

Urban areas are the main part of the main activities, namely the centralization and distribution of government service activities, social services, economic activities (Dwijayanti and Haryanto, 2015). The use of land in urban areas has increased from year to year with dynamic population growth. This land use requirement must pay attention to the carrying capacity of the scientific function of the land itself. One of the city areas which is the center of government and the capital of East Java (Dirk P. P. Misa et al., 2018). The built area of Surabaya City covers almost 2/3 of the total area. This development is dominated by the construction of residential areas housing) and commercial facilities. The spatial condition of Surabaya has significantly decreased, which indicates that changes in agricultural land, empty land, and green open land/green lines have turned into residential, trade and service area (Putra et al., 2011). This occurred due to changes in the land cover condition of Surabaya.

Based on 1945 Constitution of The Republic of Indonesia number 4 at article 12 in 2011, land cover is a line depicting the boundary of the appearance of the area above the earth's surface which consists of natural and/or artificial landscapes (Ministry of Environment and Forestry, 2015). Information on land cover can be used to model and understand current natural phenomena such as climate change, interrelationships between human activities and global change. This land cover information with maps can be obtained through remote sensing data which provides information on the spatial diversity of the earth's surface. This remote sensing data is an important factor for conducting land cover classification.

This study is aimed to classify land cover using Landsat 8 imagery using the Normalized Difference Vegetation Index (NDVI) method. NDVI is a method that compares the level of vegetation in satellite

image data. So that it can be used to analyse the land cover of Surabaya.

Methodology

Data and Research Areas

The research was conducted in the central part of East Java, Surabaya. The data in this research using secondary data consisting of data Landsat 8 Operational Land Imager (OLI) Satellite Image from 2016 until 2020 and Rupa Bumi Indonesia (RBI) Map. The selection of Landsat 8 OLI Satellite Image was carried out every year in the last five years, in detail on 21st August 2016, 8th August 2017, 24th June 2018, 1st October 2019, and 3rd October 2020. Landsat 8 OLI Satellite Image is secondary data that can be accessed through the USGS (United State Geological Survey) website. And the RBI map can be accessed through Ina- Geoportal Badan Informasi Geospasial (GIS) website and used to cut Landsat 8 OLI Satellite Image with the study area.

Figure 1. Natural landsat 8 OLI satellite image level 1 of Surabaya at (a) 2016; (b) 2017; (c) 2018; (d) 2019; and (e) 2020

The data will be used to identify cloud cover. This is done because it can affect the image of the earth's surface recording, so that the research location cannot be seen properly from satellite imagery. Data in 2016 may have inaccurate results because there is little cloud intrusion which can affect the distribution of the colour spectrum in the

Normalized Difference Vegetation Index (NDVI) process.

Land Cover Processing

The research is a quantitative study using real data in the form of numbers for the presentation. Identification of land cover is obtained by using the NDVI (Normalized Difference Vegetation Index) extraction method for Landsat 8 OLI Satellite Imagedata each year. The flow chart used is as figure 2.

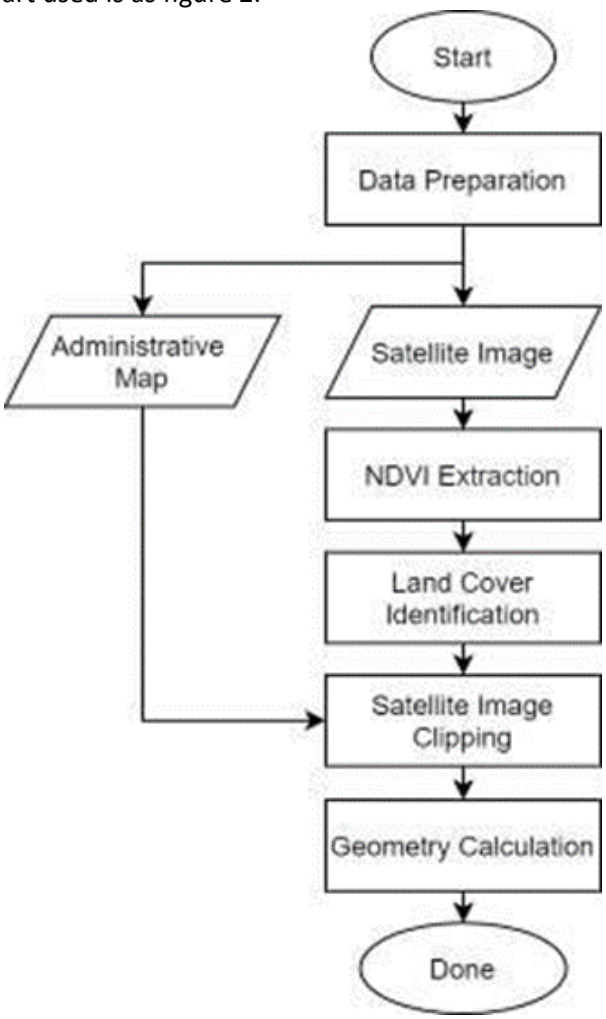


Figure 2. Research flowchart

NDVI (Normalized Difference Vegetation Index) extraction has a range pixel value of -1 up to 1. Which the vegetation class is in range 0 up to 1, and if a value close to or equal to 1 is a vegetation area with high density. The non- vegetation class is in the range of -1 up to 0. Pixel values that are less than 0 with a range of -0.14 up to 0.3 which is indicated by a dark shade indicate that the object is not classified as a vegetation or non-vegetation class (T. Lillesand et al., 2015). In the extraction process, the NDVI value is obtained by calculating Near Infrared with Red reflected by plants with the equation down below (Sobrino et al., 2008).

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

NIR is the near infrared radiation from the pixels (band 5) and Red is the red-light radiation from the pixels (band 4).

In the NDVI extraction classification, the image can be cleaned up using Enable Smoothing and Enable Aggregation. Enable Smoothing is used to remove specking noise in the image. The numbers used are odd numbers with three as the default value. And Enable Aggregation is used to remove small areas in the image (Harris Geospatial Solutions, Inc., 2020). After the NDVI extraction classification has been done, the land cover identification uses an approach secondary data by using remote sensing, Google Earth. So, we could find out the real situation in research area. Furthermore, cutting the image is done as an effort to cut the Landsat image so that it fits the research area using an administrative map using the ArcGIS 10 software.

The following are the results of the NDVI classification before processing on ArcGis 10.

Figure 3. Validation NDVI classification results with satellite imagery from Google Earth

From figure 3 above, the NDVI land cover classification is carried out and percentage in the table 1.

Table 1. Land cover classification

Class	NDVI Color	Land Cover
1	Red	Ponds and River estuary
2	Orange	Ponds and Industrial warehouse
3	Yellow	Buildings and A densely populated settlement
4	Light Green	Settlement, Park, and Garden
5	Moss Green	Reeds, Shrubs, and Undeveloped land
6	Dark Green	Urban forest areas, Ponds, and Farmland

Result and Discussion

Results

After processing and classification of NDVI is completed, land cover map is produced as figure 4.

From the land cover map above, it can be identified the pattern of land use change in Kora Surabaya from 2016 to 2020. The dynamic pattern of land use change and its area is presented in the table 2 until table 6.

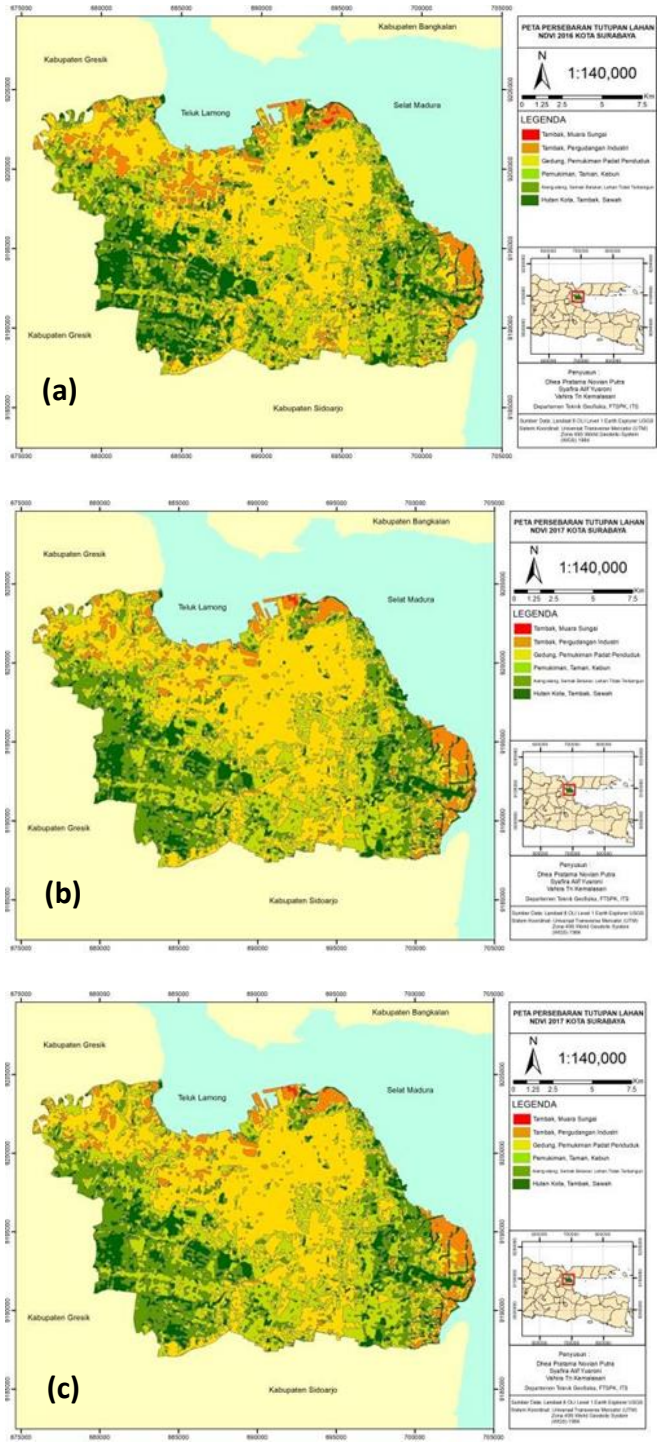


Figure 4. Land Cover Maps of Surabaya at (a) 2016; (b) 2017; (c) 2018; (d) 2019; (e) 2020

Table 2. NDVI Land cover area of Surabaya in 2016

Class	Area (ha)	Percentage area (%)
1	69.67367	0.212053404
2	2094.145	6.373576557
3	12834.45	39.06195194
4	8169.804	24.86498436
5	5192.818	15.80446092
6	4495.768	13.68297282

Table 3. NDVI Land Cover Area of Surabaya In 2017

Class	Area (ha)	Percentage area (%)
1	57.7823	0.175861733
2	1787.554	5.440461556
3	12535.88	38.15323217
4	9126.064	27.77538256
5	6006.186	18.279963
6	3343.198	10.17509898

Table 4. NDVI Land cover area of Surabaya in 2018

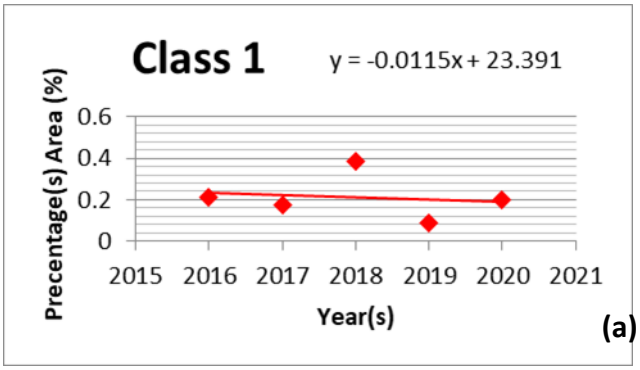
Class	Area (ha)	Percentage area (%)
1	126.6271	0.385392425
2	3371.389	10.26090006
3	13543.52	41.22001889
4	6858.375	20.87361968
5	5543.648	16.8722183
6	3413.101	10.38785064

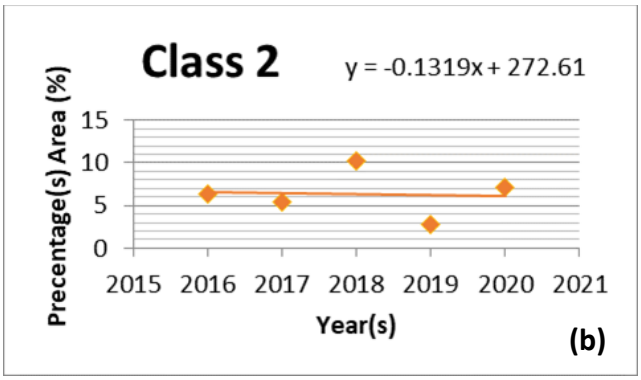
Table 5. NDVI Land Cover Area of Surabaya in 2019

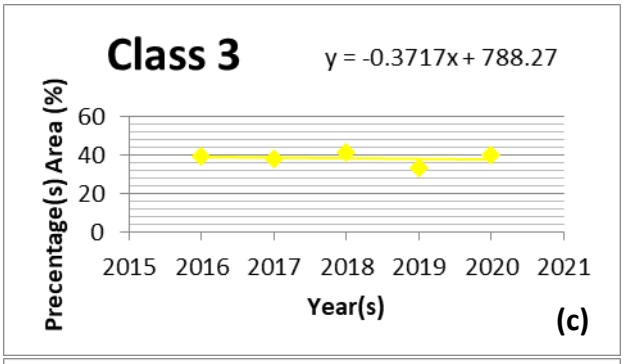
Class	Area (ha)	Percentage area (%)
1	28.85416	0.08781829
2	886.3564	2.697645877
3	10859.06	33.04978336
4	1138.771	34.66198382
5	7369.54	22.4293616
6	2324.085	7.073407056

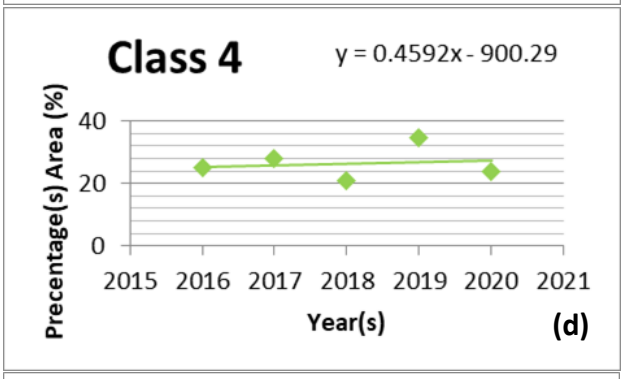
Table 6. NDVI Land Cover Area of Surabaya in 2020

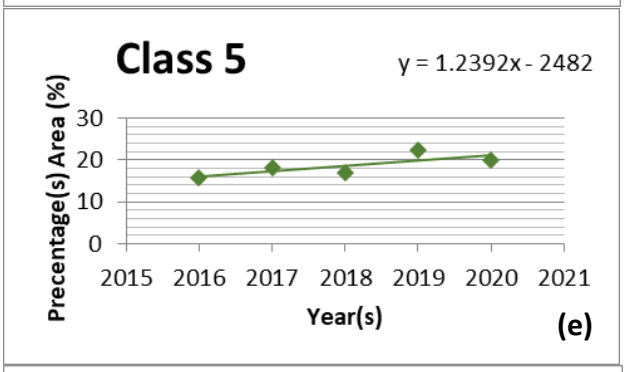
Class	Area (ha)	Percentage area (%)
1	65.26823	0.198645336
2	2327.999	7.085318509
3	13062.28	39.755349
4	7792.84	23.71768718
5	6546.929	19.92572833
6	3061.344	9.317271641











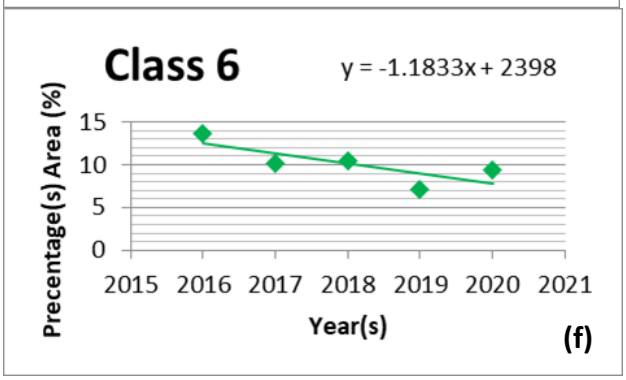


Figure. 5 Graph of NDVI land cover trend in Surabaya at (a) class 1; (b) class 2; (c) class 3; (d) class 4; (e) class 5; and (f) class 6

From the data interpretation of land area each year above, it can be modelled in the form of a graph showing the trend of data distribution on each area of land taken each year. The graph of the land distribution in each grouping class is configured as figure 5.

Discussion

Based on the results of processing and data analysis, it shows the trend of changes in the percentage of dynamic land use in the Surabaya area from 2016 to 2020, where there was an increase in the percentage of land use for class 4 (residential, park, and garden). and class 5 (reeds, shrubs, and undeveloped land) with the largest increasing gradient occurring in class 5. For other classes, there is a tendency to decrease the percentage of land use for class 1 (ponds and river estuaries), class 2 (ponds and industrial warehousing), class 3 (buildings and densely populated residential), and class 6 (urban forest, ponds, farmland), with the largest downward gradient occurring in class 6. The two classes that have opposite gradients (class 5 increase, class 6 decrease) indicate a significant change in land- use changes from urban forest areas, ponds, and farmland to areas of reeds, shrubs, and undeveloped land. Undeveloped land is managed by private or government owned. Most of these class 5 areas are open land that is deliberately allowed to overgrow with wild plants so that some of them become swamps (especially in coastal areas) or land that is under infrastructure or residential construction.

If it is based on the change in the trend of the two classes, it is known that there is a pattern of development movement in the Surabaya towards the use of vacant land to be maximized into facilities for the community as well as for the private sector. This change opens up the potential which will continue to reduce the area of the urban forest into construction areas that are not always accessible for the benefit of the general public. Changes related to reducing urban forest areas also need to be followed up. This refers to the function of the existence of forests in urban areas itself which is quite necessary, where in addition to stabilizing air temperatures and reducing greenhouse gases. Urban forests are also needed in maintaining the beauty of a city and reducing negative impacts from the environment that lead to natural instability in urban areas.

Conclusion

Based on OLI 8 Landsat image data processing using the NDVI method, it is known that there are dynamic changes in land cover patterns, especially land subsidence in class 6 in the form of forest, ponds, rice fields which can result in air temperature in the area of Surabaya.

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