IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 7.39 ⋇ Vol. 11, Issue 2, February 2022

DOI: 10.17148/IJARCCE.2022.11201

# Numerical Computation-Based NDVI Calculation for Multispectral Image

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**Abstract**: Diminishing of green areas (vegetation, park, forest, etc.) influences the climate change and the quality of life in an area. Indonesia has large are, hence, it is difficult to find the number of vegetation and without the computer-based calculation accurately. Also, nowadays, the remote sensing technology has been widely used to capture the large region using satellite sensor, e.g., Landsat, Sentinel, Ikonos, etc. from websites that give free access like United States Geological Survey (USGS). Many vertical applications can be used to calculate percentage of vegetation, e.g., IDRISI, Dyna-Clue, eCognition, etc., but in this study, a Matlab-based calculation was used. This programming language will convert a data into a mat-file that can be integrated in a single datastore, hence the program will execute the data efficiently. In a datastore, many regions can be calculated simultaneously using the big data facility in Matlab. The study shows the calculation using a special data format (mat-file) has good accuracy and fast although in this study multispectral data were used before conversion into normalized difference vegetation index (NDVI).

**Keywords**: Satellite Imagery, Multispectral, Matlab, NDVI, Near Infrared, sensors

## I. INTRODUCTION

Land Use/Cover always coverts from one type to another type. The problem occurs if the conversion reduces the number of vegetation that affects the Climate change and global temperature change. Therefore, it makes difficult to achieve sustainable development goals (SDGs) [1]. The conversion cannot be avoid in urban areas, especially in Java island, the most concentration of people in Indonesia [2]. Government should maintain the conversion by monitoring the percentage of the vegetation regularly. The satellite remote sensing data can be employed since this method can be easily access, without doing additional activities, e.g., unmanned aerial view (UAV), drone, and other capturing devices.

Most cities in Java convert its area into an urban area that perceived as the source of environmental degradation [3]. Some problems are invited in urban regions, e.g., health, socio-economic, etc. The government should uses technology that easily capture the real condition, not only based on the census since a study shows the different result between census and satellite imageries analysis [4]. This study compared the number of buildings by satellite imagery and by census. Land Change Modeler (LCM) has been widely implemented to predict the land use/cover change [5]–[7]. This method needs a land use/cover classification based on satellite imageries that will be used as well in the current study for finding percentage of vegetation in Ciamis and Pangandaran District, West Java, Indonesia, as the study area.

Satellite imageries have multispectral characteristics with a lot of band frequencies, i.e. visible and reflective infrared remote sensing, thermal infrared remote sensing, and microwave remote sensing [8]–[12]. The classification result show the multispectral and hyperspectral show the better accuracy than only RGB image. This study will analyse NIR and R bands to generate NDVI maps.

After data and methods section, this paper will discuss the results. Some findings will be concluded in the conclusions section.

## II. DATA AND METHODS

Satellite imageries used in this study is raster data. Another kind of data, called vector data, was also used for study area boundary. These data were prepared using ArcMap 10.1 with some additional projection WGS and Universal Transverse Mercator (UTM).

### A. Data

Fig 1 shows the study area with two districts: Ciamis and Pangandaran that represents two kind of region, i.e. urban and coastal, respectively. It located in the south of the border between West Java and Central Java. latitude and longitude of of these areas are about 7 degrees and 108 degrees, respectively.

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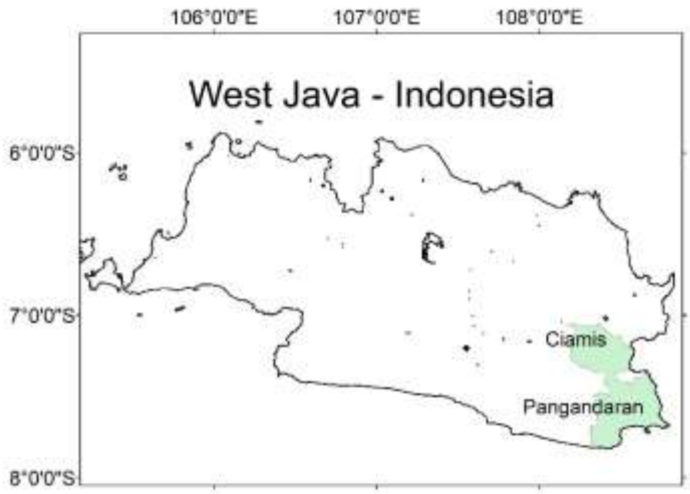


Fig. 1 Ciamis and Pangandaran District, West Java, Indonesia

The study area is predicted to grow since the longest toll road in Indonesia (Gedebage – Tasikmalaya – Cilacap) will be built across this location that will influence the grow of these areas. Table 1 shows the date and sensor of the satellite imageries data. We used NIR and R bands to get the NDVI where band 3, 4, and 5 were used that different with Landsat 7 that use band 2,3, and 4 for the same NIR and R. Two main sensors of the satellite are operational land imager (OLI) that produces 9 spectral bands (15m, 30m, and 60m spatial resolution) and thermal infrared sensors (TIRS) that produces thermal bands (100m spatial resolution).

TABLE 1. LANDSAT SATELLITE IMAGERY

| No. | Date | Sensor |
|---|---|---|
| 1. | 15 November 2019 | Landsat 8 OLI/TIRS |

B. Methods

Fig 2 shows the framework for finding the percentage of vegetation in the study area. Briefly, the framework contains two main stages, i.e., data preparation and vegetation percentage calculation. Both stages used ArcMap 10.1 for spatial analysis and Matlab 2017a for NDVI analysis.

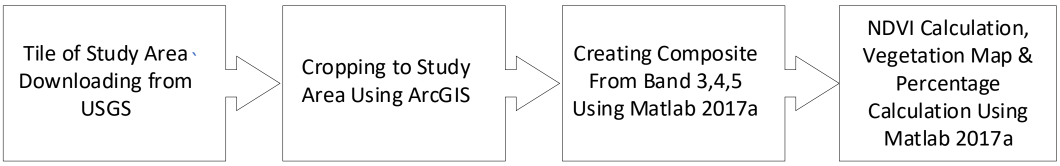


Fig. 2 Research Framework

C. Normalized Difference Vegetation Index (NDVI)

NDVI is the index for separating the vegetation from other land cover types. This index is calculated using equation 1 [8]:

$$ndvi = (NIR - R)/(NIR + R) \quad (1)$$

Where NIR and R represent the Near Infrared and Red parts. Normalized means that the value must be from zero to one.

## III. RESULT AND DISCUSSION

Every stage in research framework gives important results that affects the next stages.

A. Near Infrared and R Map Creation

In order Near Infrared (NIR) and R bands can be seen as a map, we presents the map into Red-Green-Blue (RGB) style that R,G, and B are NIR, visible red, and visible green, respectively. Function 'imshow' in matlab generate the Figure 3.

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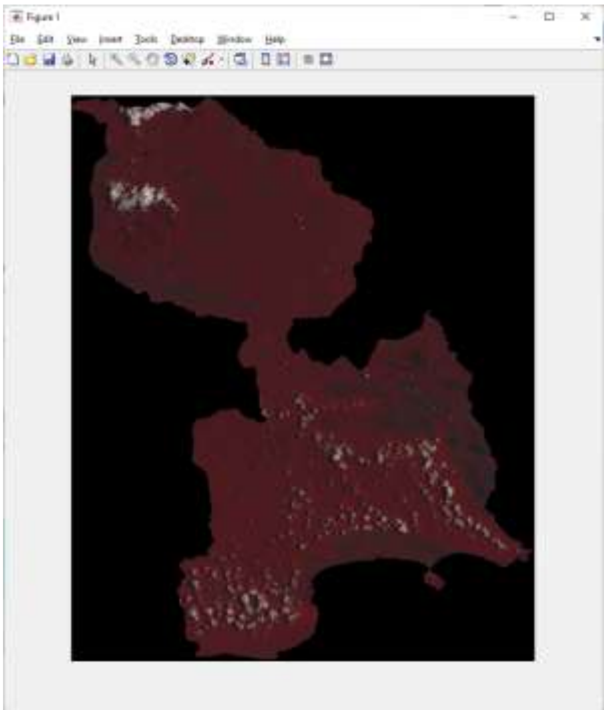

Fig. 3 NIR and R Map

B. NIR vs Red Scatter Plot

Infrared is the frequency that for separating the vegetation from other land use/cover since the vegetation with chlorophyl that absorb the infrared band. Therefore, we see the vegetation as green colour. Figure 4 shows the NIR vs Red shows the value of infrared.

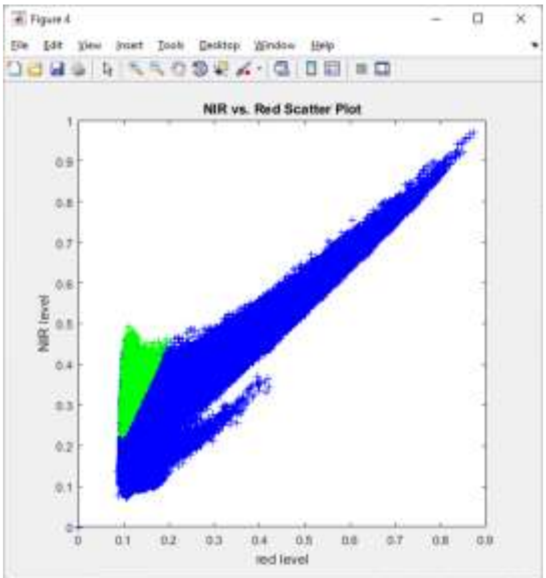


Fig. 4 NIR and R scatter plot shows NIR+R in blue and NIR+R threshold in Green

C. NDVI Map

NDVI map was created using NIR and R bands with equation 1. To find the significant vegetation areas, the threshold limitation was implemented. Figure 5 show the NDVI map and NDVI with threshold 0.4.

  

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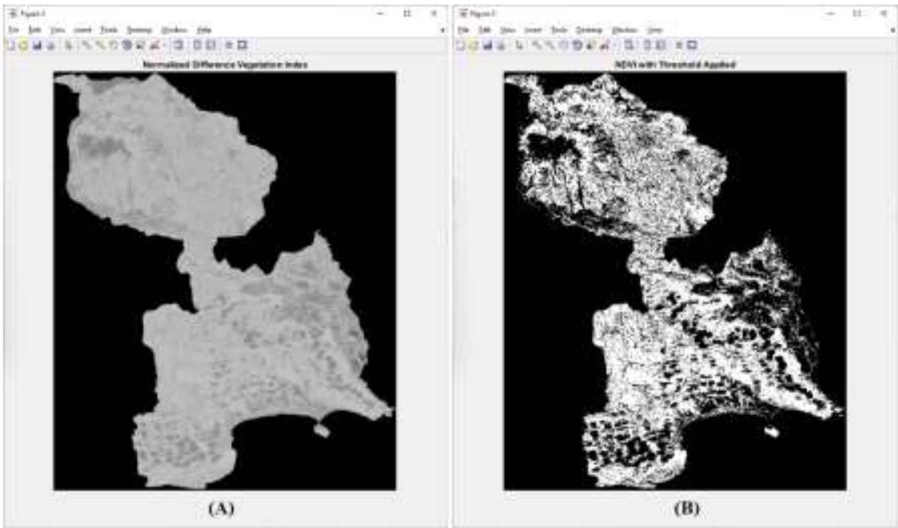

Figure. 5 White areas show the vegetation, (A) NDVI, and (B) NDVI with 0.4 threshold

The similar technique is also done for 2014 clustering map. For analysing the decrease of vegetation, in this paper we merged the agriculture and forest/vegetation as well as built-up and other land use, e.g. road, and other land cover similar to built-up. Without calculating the percentage of vegetation, figure 5 shows a lot of numbers of vegetation region in this study area. Black areas are both non vegetation and outside the study area. Figure 5 shows that there are diminishing of vegetation in Ciamis city and the coastal area of Pangandaran that contains a lot of hotel (tourism area).

D. Calculation Percentage of Vegetation

Because there is a region outside the study area in map, we must exclude this region from percentage calculation. Because if we use all pixels in the map the percentage of vegetation is low (about 26%). The technique is create a map of study area that contain a study are with 1 and the outside the study are as zero using the function:

$$studyArea = r > 0.1; \quad (2)$$

Where r represents the red, green, or blue matrix. Figure 6 shows the study area map after equation 2 implementation. The white area is ‘1’ and black area is ‘0’.

Fig. 6 Study Area Matrix

To find number of pixels of the study area we only sum all the ‘1’ in the matrix using function sum(studyArea(:)) in Matlab. Therefore we get the percentage of vegetation using the equation (3).

$$Veg=100 * numel(NIR(q(:))) / sum(studyArea(:)) \quad (3)$$

 

Where 'numel' and 'sum' are Matlab function to count number of pixels and summation, respectively. We find the percentage of the study area of 58.9%. This value show that Ciamis and Pangandaran have vegetation area higher than other land use/cover type (built-up, water, etc.).

## IV. CONCLUSION

To find the vegetation area, remote sensing data is recommended since it is cheap, fast, and wide. The study shows the usage of mat-file format from satellite imagery. In this study we only used two study area, i.e. Ciamis and Pangandaran district, but using the mat-file format, Matlab can calculate all area in Indonesia after conversion satellite imageries into mat-file using parallel processing in Matlab Big Data facility. The result show the percentage of vegetation in Ciamis and Pangandaran are higher that other land use/cover types, but in the future study we should consider the temporal aspect of remote sensing (spatio-temporal data).

## ACKNOWLEDGMENT

The authors thank to Universitas Bhayangkara Jakarta Raya in supporting this research as internal research grant. Also, for the reviewers who have given the insightful comments.

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ISSN (O) 2278-1021, ISSN (P) 2319-5940

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## BIOGRAPHY

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