Applied Research in Science and Technology
Vol. 01 No. 01, 2021 (46-57)
ISSN (Print) :2776-7213
ISSN (Online) :2776-7205

Land Use Change Analysis Using NDVI Approachment in Terbanggi Besar, Central Lampung at 2000 and 2020

Redhika Pangestu[1], Nikhen Santika[1], Winih Sekaringtyas Ramadhani[1*], Ali Rahmat[2], Abdul Mutolib[3], Soffan Nurhaji[4]

[1]Department of Soil Science. University of Lampung, Indonesia
[2]Research Center for Limnology, Indonesia Institute of Sciences, Indonesia
[3]Postgraduate, Siliwangi University, Indonesia
[4]Sultan Ageng Tirtayasa University, Indonesia

* Email: winih.sekaringtyas@fp.unila.ac.id

Received: 27 April 2021; Revised:28 April 2021; Accepted: 28 April 2021

Abstract: Terbanggi Besar is one of the Subdistricts in Central Lampung Regency, which has an area of 217.15 km^2. The large area of land is used as a settlement and also used to cultivate crops. Each year, the population in this Subdistrict keeps increasing; this becomes a problem since the increasing population means the need for the living area also increases. This affects is the cultivation area by turning it into a residential area. The research aims to analyze land use changes based on vegetation density in the Terbanggi Besar sub-Subdistrict in 2000 and 2020. The data from the respective Landsat 7 and 8 satellite images using multi-temporal dimensions using Geographical Information Systems (GIS) through the Argis application and Landsat imagery with the NDVI method. The results indicate that land use dynamics in the Terbanggi Besar Subdistrict have fluctuated in the last 20 years. The largest land use in Terbanggi Besar Subdistrict in the period 2000 to 2020 is medium density vegetation with an area of 21,465 hectares, low-density vegetation 17,453 hectares, and open land 2,624 hectares.

Keywords: Land-use, Landsat, NDVI, Terbanggi Besar Subdistrict.

How to Cite: Pangestu, R., Santika, N., Ramadhani, W. R., Rahmat, A., Mutolib, A., & Nurhaji, S. (2021). Land Use Change Analysis Using NDVI Approachment in Terbanggi Besar, Central Lampung at 2000 and 2020. *Applied Research in Scince and Technology*, 1(1), 46-57.

INTRODUCTION

Central Lampung Regency has a total area of 4545.50 km^2. It has a paddy field area of 79,256 Ha, while non-agricultural land is 283,873 Ha. The paddy fields in Central Lampung Regency, where 56,269 hectares of paddy fields using irrigation and 14,125 hectares are rainfed paddy fields. Terbanggi Besar is one of the Subdistricts in Central Lampung Regency, which has an area of 217.15 km^2. The large area of land is used as a residential area and a cultivation area (BPS, 2020). According to BPS data (2020), Central Lampung Regency is the fifth-highest population density after East Lampung Regency. The population in Terbanggi Besar Subdistrict increases each year. The population in Terbanggi Besar Subdistrict in 2020 has reached 129,482 people, with a percentage of the population growth rate from 2010 to 2020 around 1.83%. This increase in population affected the conversion from the cultivation area to the residential area.

According to Wijaya and Susetyo (2017), cultivation land is a source of life for all living things. This land is one of the natural resources that is needed by living things to carry out activities to meet their daily needs. Each area cannot be separated from the land and its use which is a dynamic matter. If the separation continues to happen, it can reduce the production of food crops and cause problems for environmental quality degradation, which can disrupt the balance of the ecosystem. In the end, it will cause national food production will continue to decline, imports of food from outside will increase, and national food security will never be achieved. For this reason, it is necessary to use cultivated land so that humans can sustainably meet their needs while still paying attention to environmental preservation. Indarto and Rahayu (2015) suggest that one of the ways that can be done to overcome population growth is to follow existing government programs such as family planning, the use of house yards, and also the use of integrated agricultural land in a sustainable manner.

o maintain consistent land use like in agricultural areas, a monitoring system is needed to observe, analyze, present, and make decision models to maintain sustainable agricultural activities. The use of remote sensing technology is allegedly able to present an integrated approach that can model the area quickly and on a wide scale regarding agricultural problems and their relation to the efforts of maintaining a consistent land use (Januar *et al.*, 2016). Remote sensing in Landsat satellite imagery has long been an important and effective means of monitoring land cover with its ability to provide information on the spatial diversity on the earth's surface quickly, broadly, precisely, and easily (Niagara *et al.*, 2020). Land-use analysis using the NDVI (Normalized Difference Vegetation Index) method considers the green value of vegetation obtained from digital signal processing of brightness value data from several channels of satellite sensor data from satellite imagery. NDVI is a standard method for comparing the level of the greenness of vegetation in satellite image data. NDVI can be used as an indicator of biomass, relative greenness, and the status (health/density) of vegetation in an area. However, it is not directly related to groundwater availability in the area (Lufilah *et al.*, 2017). Ramadhani et al. (2021) explained that NDVI is a method that can be used as a standard in comparing the level of the greenness of vegetation in satellite image data. Therefore, this study was carried out to analyze land-use changes from the vegetation density level of the Terbanggi Besar sub-Subdistrict in 2000 and 2020 by using data from the Landsat 7 and 8 satellite imagery, respectively, using the Normalized Difference Vegetation Index (NDVI) method. Parwati *et al.*, (2012) stated that the NDVI method is very suitable for detecting land changes from vegetation to non-vegetation. This research is carried out by using a spatially appropriate approach to identify and optimize developments in the Terbanggi Besar Subdistrict area. This research aims to analyze changes in land-use by using the spatial approach with multi-temporal dimensions using Geographical Information Systems (GIS) through the ArcGIS application and Landsat imagery using the NDVI (Normalized Difference

Vegetation Index) method. The results from this study are expected to become a reference for the community, especially officials from Terbanggi Besar Subdistrict to improve the quality and quantity of agriculture sustainably in the area of Terbanggi Besar Subdistrict.

METHOD

This research was conducted in Terbanggi Besar Subdistrict, Central Lampung Regency. There are 2 kinds of data used in this research, primary and secondary data. In contrast, the primary data is based on satellite imagery, previous research, and related documents, and secondary data were obtained from surveys and field observations to validate land-use maps and get an overview of field conditions. Landsat images used in this study are Landsat 7 (2000) and Landsat 8 (2020). Furthermore, Landsat is processed with the natural composite band to compare it with NDVI data. Landsat 8 is used in the composite band, namely band 4, band 3, and band 2. In Landsat 7, the composite band used is band 3, band 2, and band 1 (Figure 2). This natural data is compared with the land-use index in NDVI.

The ground check was then carried out randomly, with 10 observation points for each criterion, open land, low vegetation, and medium vegetation. Ground check aims to clarify the value of the land-use index used in 2020. Furthermore, the results of the NDVI were then used in the land-use calculation to determine the high percentage of land use. The analysis stages consisted of 2 stages, land-use classification and land-use change analysis. The analysis is based on Geographic Information System (GIS), following the research needs in spatial terms. The method used is the Normalized Difference Vegetation Index (NDVI) landscape-scale method

.

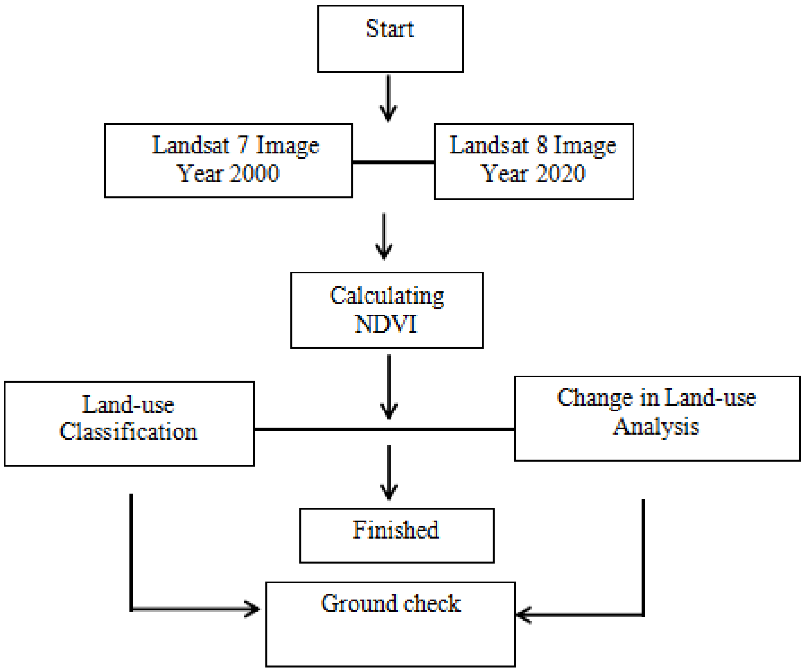

Figure 1. Research's Flowchart

Applied Research in Science and Technology
Vol. 01 No. 01, 2021 (46-57)
ISSN (Print) :2776-7213
ISSN (Online) :2776-7205

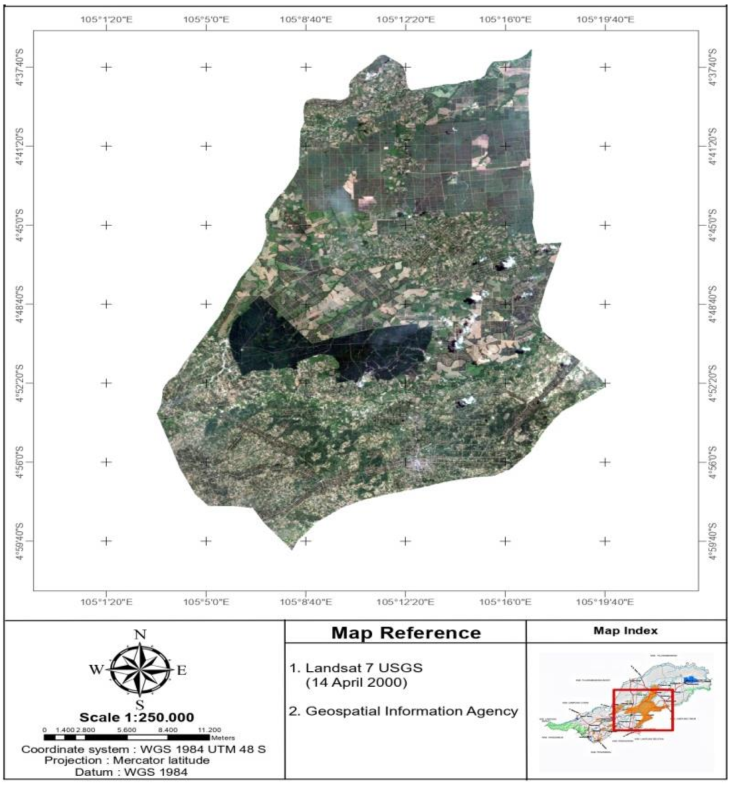

Figure 2. Natural data Year 2000

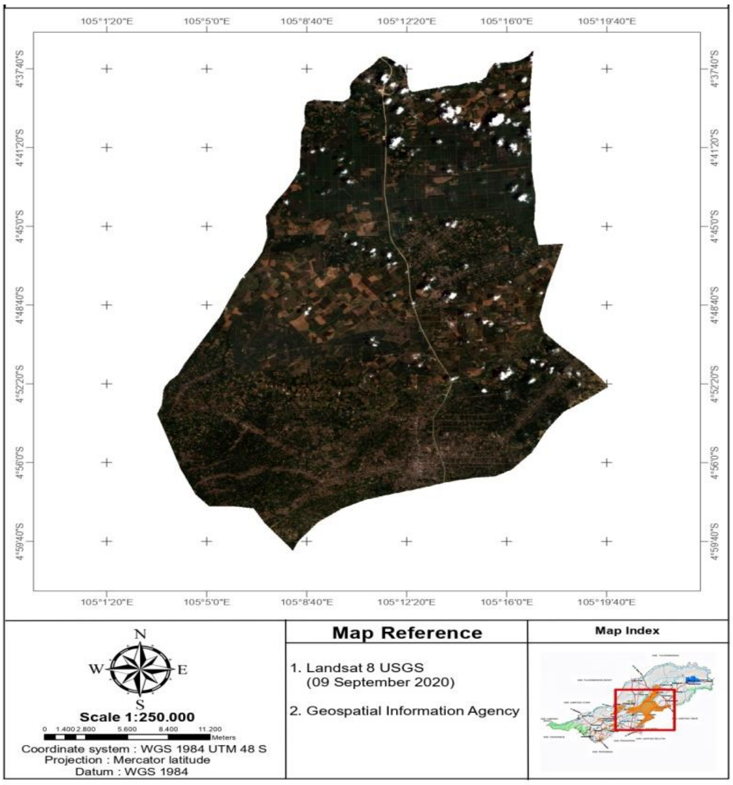

Figure 3. Natural Data year 2020

Data Collection Method

The images used in this study is the satellite image of the Terbanggi Besar Subdistrict area, which are Landsat 7, which was recorded on 14 April 2000, and Landsat 8 image recorded on 9 September 2020. Landsat image in this study was obtained from the United States Geological Survey (USGS). The Landsat images used need to have a small number of clouds in the image to make it easier to use the overlay analysis on a natural map. The image processing method used is by comparing the results of the Landsat image vegetation index value from each year with various combinations of bands that have been determined. The formula for determining NDVI on land use is as follows (Philiani *et al.*, 2016):

$$\text{NDVI} = \frac{Band\ B - Band\ A}{Band\ B + Band\ A}$$

Keterangan :
A Band : Red Band
B Band : Near Infra Red Band (NIR)

NDVI was calculated using ArcGIS 10.7; the calculation steps are as follows: using the Arctoolbox toolbar, select the Spatial analyst tool, click on Map algebra, and then select Raster calculator. In the Landsat image, the 7 bands used are band 4 and band 3, while in Landsat 8 images, band 5 and band 4 were used; NDVI values range from -1 to 1, with a classification of -1 to 0 belonging to the non-vegetation group. and 0 to 1, including vegetation groups.

Analysis method

To identify the differences in land use through several periods, 2 satellite images from 2000 and 2020. Several classifications must be fulfilled before the images can be used: the number of clouds, open land area, and low to medium vegetation. This can be determined based on the color level of each area of the pixel obtained from the previous NDVI calculations. Land-use change was analyzed by using maps from 2000 and 2020, which had been calculated and classified based on their color spectrum using the NDVI attribute analysis method in the ArcGIS 10.7 application by overlapping the land-use map with the real natural maps. Overlay analysis (overlapping) is an analysis technique by placing a map and all the attributes in it on top of another map to display the results (Cahyono *et al.*, 2019). The vegetation index was calculated by applying the NDVI equation to each image. The NIR and Red bands take each Landsat satellite image data. In Landsat 5 and 7, the NIR band is located in band number 4, and Red is located in band number 3. Whereas in Landsat 8, the NIR band is located at number 5, and Red is located in band number 4. The NDVI value of a Landsat satellite image data is processed using ArcGIS software. The result of Landsat image data NDVI is in the form of image data with a "tiff" format.

Applied Research in Science and Technology
Vol. 01 No. 01, 2021 (46-57)
ISSN (Print) :2776-7213
ISSN (Online) :2776-7205

RESULTS AND DISCUSSION

Classification of Land-use in Terbanggi Besar Subdistrict

The land use satellite images Landsat 7 from 2000, and Landsat 8 from 2020 were classified using the color range in the ArcGIS 10.7 application process. The visual image is then grouped into several different land-use sectors based on similarity. Interpretation uses image identifiers based on color, shape, and area. The following is the classification of the types of land use.se.

Table 1. Classification of Land-use Types in Terbanggi Besar Subdistrict, Year 2000

Color	Classifications	Index
White	Clouds	0,0337 - 0,26112
Red	Open lands/ Building	-0,63256 – 0,135593
Yellow	Low vegetation	0,135593 - 0,294118
Green	Medium vegetation	0,294118 – 0,623456

Tabel 2. Classification of Land-use Types in Terbanggi Besar Subdistrict, Year 2020

Color	Classifications	Index
White	Clouds	-0,0977837 – 0,133920
Red	Open lands/ Building	0,133920 – 0,226031
Yellow	Low vegetation	0,226031 – 0,389193
Green	Medium vegetation	0,389193 – 0,5844442

Based on the data shown in table 1 and table 2, it can be seen that each different land use has a different NDVI index as the year passes. According to the band on the satellite, the vegetation index is the amount of green value of vegetation obtained from digital signal processing of brightness value data from several satellite sensor data channels. The absorption of red light by chlorophyll and reflection of near-infrared light by the mesophyll network inside the leaves will make the brightness values caught by satellite sensors in these channels will be different (Yudhistira *et al.*, 2019). Land with no vegetation or low-density vegetation, including water areas, residential areas, open vacant land, and areas with damaged vegetation, will show a lower brightness value. On the other hand, in a healthy and very tightly vegetated area, the value will show the maximum.

Each type of land use has specific characteristics that are different from each other. The results of the land-use classification using the overlapping technique resulted in a multi-temporal type of land-use map in 2000 and 2020, which corresponds to the year the satellite image was recorded. The comparisons were made using data from 2000 and 2020; the image from 2010 could not be used because it had low resolution and also the level of image accuracy in determining the area through the Argis 10.7 application.

Applied Research in Science and Technology
Vol. 01 No. 01, 2021 (46-57)
ISSN (Print) :2776-7213
ISSN (Online) :2776-7205

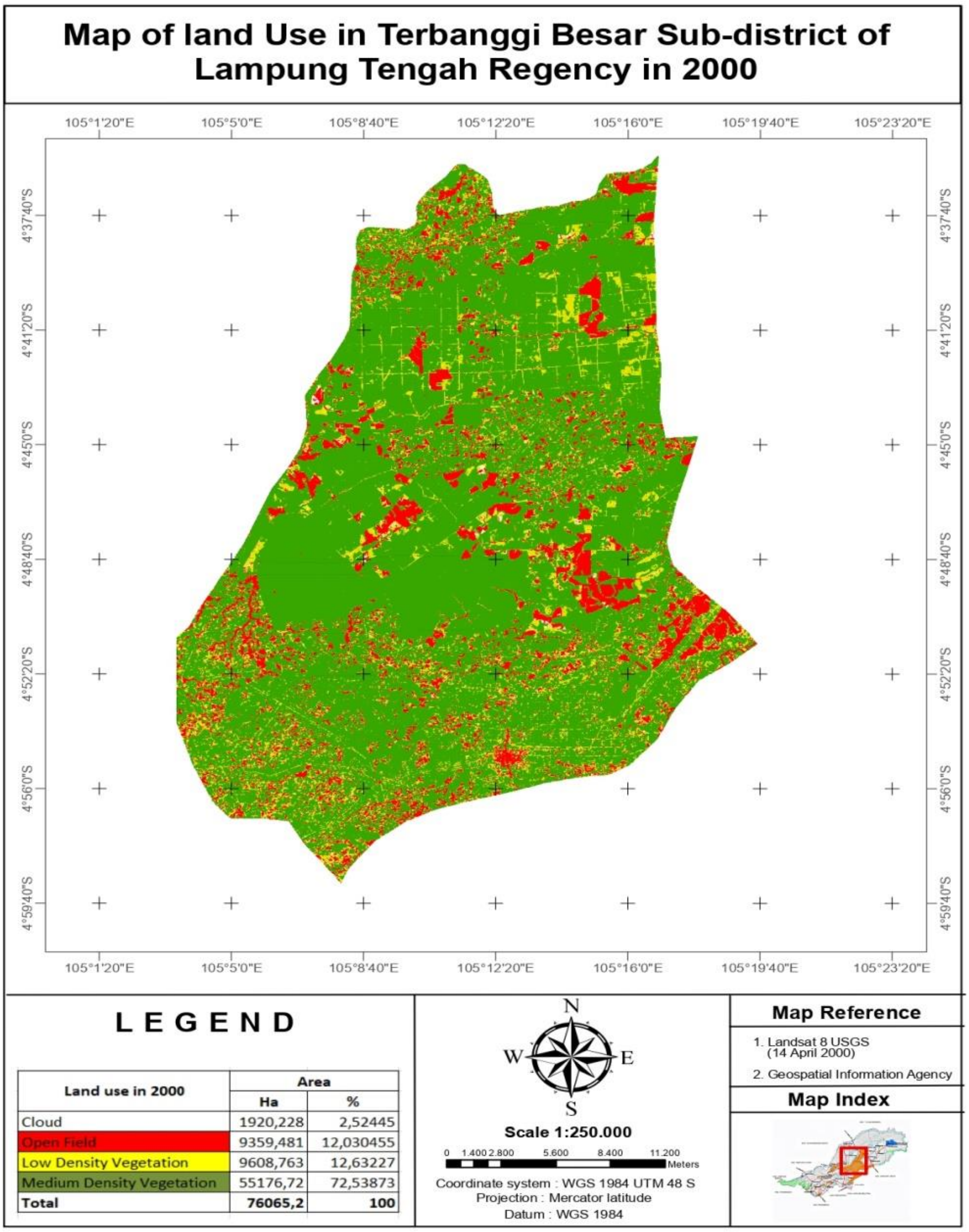

Figure 4. Land-use Map in Terbanggi Besar Subdistrict, Year 2000.

From the results data processing on the land cover map in Terbanggi Besar Subdistrict in 2000 (Figure 4) obtained data for the extent of the clouds marked in white, a total of 1920 Ha, then the open land class marked in red on the map has an area of 9,359 Ha. This indicates that in 2000, a high conversion rate, from vegetation area, is into residential, infrastructure, and the industrial sector. The low-density vegetation category marked in yellow on the map has an area of 9,608 Ha. This proves that in

Applied Research in Science and Technology
Vol. 01 No. 01, 2021 (46-57)
ISSN (Print) :2776-7213
ISSN (Online) :2776-7205

Terbanggi Besar Subdistrict in that year, there was a lot of land use with low intensity and generally in the field of seasonal crops. Furthermore, the data shows medium-density vegetation with an area of 55,176 ha. This shows that there is still much moderate-density vegetation covering shrubs and forest trees. The total area on the land-use map in Terbanggi Besar Subdistrict in 2000 was 76,065 Ha.

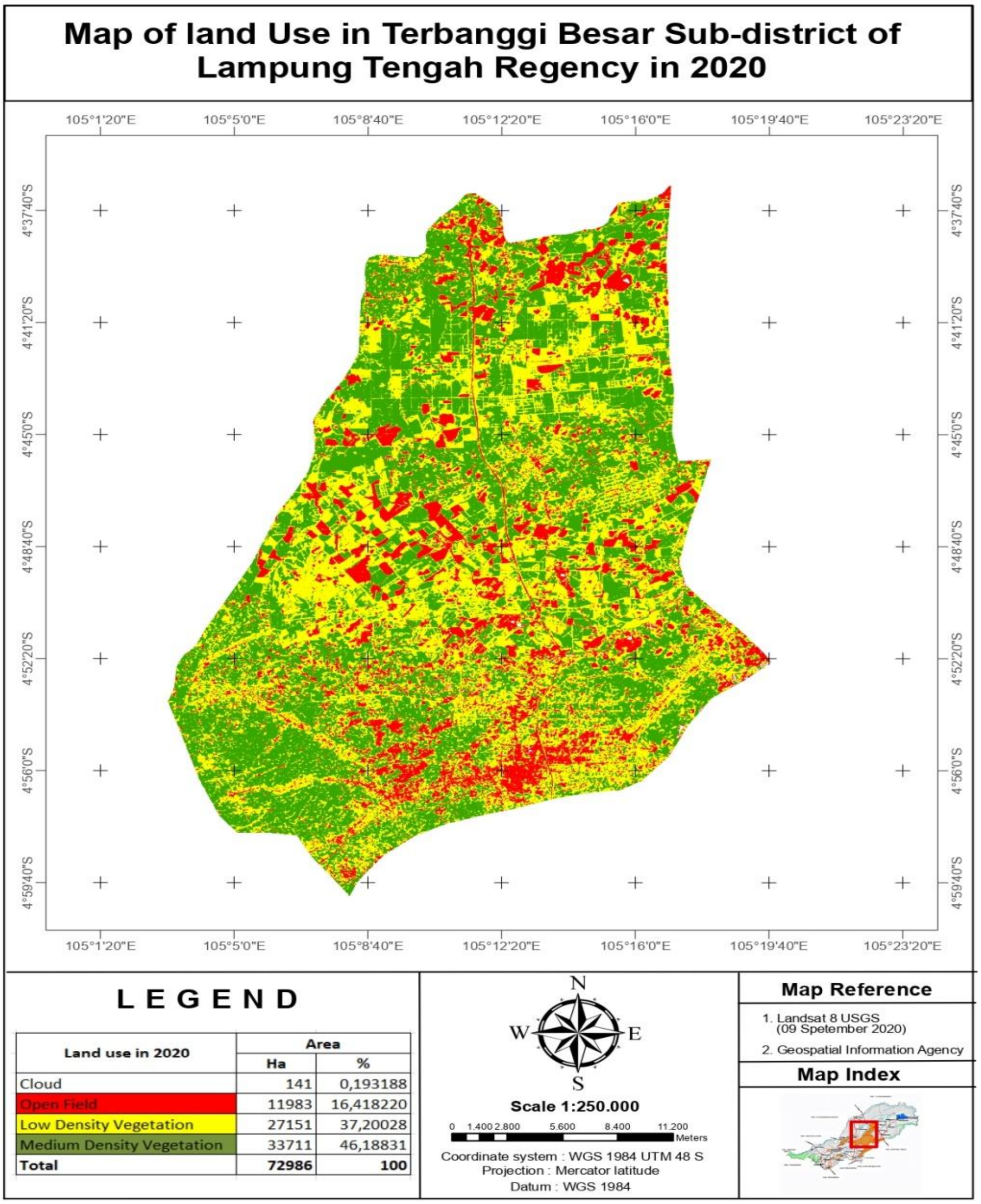

Figure 5. Map of land-use in Terbanggi Besar Subdistrict in Year 2020.

Based on the data from the map in Terbanggi Besar Subdistrict in 2020 (Figure 5), the calculated cloud area data and marked in white are 140 Ha. The map marked in red has an area of 11,983 hectares. From the data, it can be concluded that in 2020, a significant area of land has been converted into settlements, infrastructure, and the industrial sector. The low-density vegetation class on the map is marked in yellow with an area of 27,151 Ha. This shows that there has been much land use with low intensity and generally in the agricultural sector both for seasonal crops and plantation crops. There are around 33,711 hectares of medium vegetation, mostly shrubs and forest trees. The total area on the land-use map in the Terbanggi Besar Subdistrict in 2020 is 72,986 Ha.

From the NDVI transformation presented above, the areas with white color are classified as clouds. Areas with red are classified as open land, areas with low vegetation density have bright yellow gradations, and areas with high vegetation density levels have green gradations. This is one of the first steps to differentiate land-use areas between open land, low-density vegetation, and medium-density vegetation. Then the areas were calculated according to the classification and then compared with the respective Landsat satellite imagery in 2000 and 2020. From the result, it can be seen that there is a land-use change of around 2,624 Ha on open land. For the low vegetation category, the land-use change was 17,543 Ha. Whereas land with moderate vegetation density decreased by 21 465 Ha. This land change was caused by population growth which resulted in an increasing number of industrial and development sectors to meet the needs of the people in Terbanggi Besar Subdistrict. Land-use changes include infrastructure development, agricultural land clearing, and residential development (BPS, 2020).

The results of the classification and calculation of the area of land-use change are based on visual interpretation using the Arcgis 10.7 application. To increase the credibility and validity of the data, land validation surveys were conducted. The surveys were conducted by randomly determining 10 sampling points with open land, low-density vegetation, and medium-density vegetation. The application used during the survey on the field is the Avanza Map. Through this application, the position of the sample points that have been determined based on the coordinates can be located and also able to add images of land conditions directly at each point.

Table 3. Field Observation on 30 Sampling Points.

No.	Coordinate Points	Locations Description	Accuracy
1.	-4°54.858’. 105°15.763’	Villager home	Accurate
2.	-4°55.968’. 105°12.418’	Irrigation	Accurate
3.	-4°54.148’. 105°12.853’	Villager home	Accurate
4.	-4°54.495’. 105°10.988’	Yard	Accurate
5.	-4°52.443’. 1059.892’	Villager home	Accurate
6.	-4°54.148’. 105°12.853	Villager home	Accurate
7.	-4°52.203’. 105°16.973’	Intersection	Accurate
8.	-4°48.338’. 105°9.025’	Villager home	Accurate
9.	-4°47.993’. 105°7.445’	Villager home	Accurate
10.	-4°49.082’. 105°7.805’	Villager home yard	Accurate
11.	-4°50.970’. 105°17.092’	Cassava field	Accurate
12.	-4°49.842’. 105°14.698’	Post-harvest cassava field	Accurate
13.	-4°49.359’. 105°14.583’	Cassava field	Accurate
14.	-4°47.923’. 105°16.257’	Post-harvest paddy field	Accurate
15.	-4°51.170’. 105°15.903’	Cassava field	Accurate
16.	-4°48.332’. 105°7.182’	Empty field	Not accurate
17.	-4°47.923’. 105°16.257’	Post-harvest cassava field	Accurate

18.	-4°50.453'. 105°8.465'	Cassava field	Accurate
19.	-4°51.497'. 105°7.362'	Cassava field	Accurate
20.	-4°51.705'. 105°12.360'	Cassava field	Accurate
21.	-4°54.853'. 105°16.555'	Bush and shrubbery	Accurate
22.	-4°54.567'. 105°11.597'	Sugarcane field	Accurate
23.	-4°52.822'. 105°10.567'	Forest	Accurate
24.	-4°48.523'. 105°16.810'	Bush and shrubbery	Accurate
25.	-4°48.930'. 105°12.992'	Sugarcane field	Accurate
26.	-4°47.798'. 105°9.607'	Plantation land	Accurate
27.	-4°47.857'. 105°8.590'	Bush and shrubbery	Accurate
28.	-4°51.493'. 105°7.878'	Rubber plantations	Accurate
29.	-4°51.493'. 105°7.878'	Cassava field	Not accurate
30.	-4°45.740'. 105°15.460'	Oil palm field	Accurate

In the survey of 10 points for each class classification, in the open area, villager houses, road junctions, and residents' houses yards can be found. In the low vegetation area, it was found that the land was planted with cassava, and also a post-harvest paddy field can be seen. Whereas in the medium-vegetation area, it is found that the land is vegetated by bush, rubber, oil palm, and sugar cane.

Table 4. Result of the Land Validation Survey to Validate the Data Classification

Land Validation / Land Classification	Number of Sampling Points	Not Matched	Matched	Accuracy %
Open field/building	10	0	10	100
Low vegetation	10	1	9	90
Medium vegetation	10	1	9	90
Total	30	2	28	93,3%

The percentage accuracy of land-use classification is calculated based on the matched results from the survey sample divided by the number of samples taken. The accuracy of each type of land use is shown in table 4 of the total 30 sample points surveyed in the field, 3 of them did not match. This could be caused by several changes in land functions in the area. The points that are not matched are two points on low-density vegetation and one point on medium-density vegetation. This brings the total level of data accuracy to 90%. With this relatively high accuracy value, the results of the land-use classification can be used for further analysis.

Analysis of Land Use Change in Terbanggi Besar Subdistrict

Land-use in Terbanggi Besar Subdistrict in 2000 and 2020, which have been validated by land survey, is then calculated to find the total area for each type of land-use using Arcgis 10.7 application with the Calculator Geometry feature, which has previously been converted from raster data into polygon data. Land-use change statistics show the dynamics of existing land use (Wijaya and Susetyo, 2017). This is due to the causal factors that affect each type of land use, mainly due to land conversion in the Terbanggi Besar Subdistrict. The following is the statistical area of land use in the Terbanggi Besar Subdistrict based on calculations using the Arcgis 10.7 application from 2000 to 2020.

Table 5. Statistics of land-use area in Terbanggi Besar Subdistrict

No	Land -use	Wide (ha)	
		2000	2020
1.	Open area/building	9.359	11.983
2.	Low vegetation	9.608	27.151
3.	Medium vegetation	55.176	33.171

The result of the analysis from the land-use calculation in Terbanggi Besar Subdistrict in 2000 and 2020 presented in Table 3 shows that land-use dynamics in Terbanggi Besar Subdistrict tend to fluctuate for 20 years. In table 3, it can be seen that the open land increased to around 4.1%. In 2000, open area land had around 9,359 ha and increased to 11,983 ha in 2020. For the area of low-density vegetation, the percentage has increased by 25%. In 2000 the area was around 9,608 ha, while in 2020, it increased to 27,151 ha. And lastly, the area of medium vegetation decreased by 26%, from 55,176 ha to 33,171 ha.

CONCLUSIONS

Based on the research results, the following conclusions can be drawn: Terbanggi Besar Subdistrict has had a large land-use change from 2000 to 2020 in both the industrial and infrastructure sectors. The largest land-use change in Terbanggi Besar Subdistrict from 2000 to 2020 is 26% medium density vegetation with an area of 21,465 Ha. the second largest in the Low-density vegetation area of 25%, around 17,453 Ha and 4.1% open land with an area of 2,624 Ha. As a recommendation, land use management is needed, such as controlling the development of built-in land, and others, such as limiting the conversion of land functions into settlements and industry..

ACKNOWLEDGMENT

Gratitude to both of the writers' parents who have provided motivation and prayer in the completion of this research. To the lecturers of the soil surveying class, for their guidance in this research. Thanks to Ade Rio Saputra as a colleague who accompanied the writer during the validation survey in the field.

REFERENCES

Badan Pusat Statistika. (2020). *Kabupaten Lampung Tengah dalam Angka*. Badan Pusat Statistik. Lampung Tengah.

Cahyono, B, E., Febriawan, E, B., & Nugroho, A, T. (2019). Analisis tutupan lahan menggunakan metode klasifikasi tidak terbimbing citra landsat di Sawahlunto, Sumatera Barat. *TEKNOTAN*. 13(1), 8-14.

Hung, T. (2000). MODIS Application in Monitoring Surface Parameters. Institute of Industrial Science. Tokyo: University of Tokyo.

Lufilah, S, N., Makalew, Afra, D, N., & Sulistyantara. 2017. Pemanfaatan citra landsat 8 untuk analisis indeks vegetasi di DKI Jakarta. *Jurnal Lanskap Indonesia*. 9 (1), 73-80.

Indarto, K. D. & Rahayu, S. (2015). Dampak pembangunan perumahan terhadap kondisi lingkungan, sosial dan ekonomi masyarakat sekitar di kelurahan sambiroto, kecamatan tembalang. *Jurnal Tenik PWK*, 4(3), 428-439.

Januar, D., Suprayogi, A., & Prasetyo. (2016). Analisis penggunaan ndvi dan bsi untuk identifikasi tutupan lahan pada citra landsat 8 (studi kasus : wilayah kota Semarang, Jawa Tengah). *Jurnal Geodesi Undip*. 5 (1), 135-144 .

Niagara, Y., Ernawati., & Purwandari, E, P. (2020). Pemanfaatan citra penginderaan jauh untuk pemetaan klasifikasi tutupan lahan menggunakan metode unsupervised *k-means* berbasis web gis (studi kasus sub-das bengkulu hilir). *Jurnal Rekursif*. 8 (1), 100-110.

Nuraeni, R., Sitorus, S, R, P., & Panuju, D, R. (2017). Analisis perubahan penggunaan lahan dan arahan penggunaan lahan wilayah di Kabupaten Bandung. *Buletin Tanah dan Lahan*. 1 (1), 79-85.

Parwati, Zubaidah, A., Vetrita, Y., Yulianto, F., Ayu, K. & Khomarudin. M.R. (2012). Kapasitas indeks lahan terbakar normalized burn ratio (nbr) dan normalized difference vegetation index (ndvi) dalam mengidentifikasi bekas lahan terbakar berdasarkan data spot-4. *Jurnal Ilmiah Geomatika*. 18(1), 29-41.

Philiani, I., Saputra, L., Harvianto, L., & Muzaki, A, A. (2016). Pemetaan vegetasi hutan mangrove menggunakan metode *normalized difference vegetation index* (ndvi) di Desa arakan, Minahasa Selatan, Sulawesi Utara. *Journal of Technology*. 1 (2), 211-222.

Wahyuni, S., Guchi, H., & Hidayat, B. (2014). Analisis perubahan penggunaan lahan dan penutupan lahan tahun 2003 dan 2013 di Kabupaten Dairi. *Jurnal Online Agroekoteknologi*. 2 (4), 1310-1315.

Wijaya, A., & Susetyo, C. (2016). Analisis perubahan penggunaan lahan di kota pekalongan tahun 2003, 2009, dan 2016. *Jurnal Teknik ITS*. 6 (2) : 414-420.

Yudistira, R., Meha, A, I., & Prasetyo, S, Y. (2019). Perubahan konversi lahan menggunakan ndvi, evi, savi dan pca pada citra landsat 8 (studi kasus : kota Salatiga). *Indonesian Journal of Modeling and Computing* 1 : 25-30.