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ESTIMATION OF LAND SURFACE TEMPERATURE IN BUNGO DISTRICT USING THERMAL CHANNELS OF LANDSAT 8 IMAGES

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ABSTRACT: The purpose of this study was to determine the land surface temperature in Bungo Regency using the Landsat 8 image thermal channel by carrying out three stages: (1) Mapping the comparison of vegetation density in 2016 and 2021 using the NDVI (Normalized Difference Vegetation Index) method. (2) Mapping land surface temperatures in 2016 and 2021 using the Land Surface Temperature method. (3) Knowing the relationship between LST and NDVI using the Correlation Person test. The results of the study explain the comparison of vegetation density using the Normalized Difference Vegetation Index (NDVI) method in 2016 and 2021 in Bungo Regency. In 2016 the classification is very dense with an area of 124,871 Ha, the classification dense with an area of 115,732 Ha, the classification medium with an area of 98,536 Ha, the classification is rare with an area of 71,920 Ha, and very rare classification with an area of 54,839 Ha. Whereas in 2021 the very dense classification will decrease to 117,216 Ha, the dense classification will decrease to 112,365 Ha, the moderate classification will decrease to 95,892 Ha, the rare classification will increase to 79,310 Ha, and the very rare classification will increase to 61,084.

Keywords: *Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Correlation Person.*

1. INTRODUCTION

Temperature is a general description of the energy state of an object caused by the level of the object's ability to give or receive heat. Air temperature is the average value of the atmosphere in a place that comes from solar radiation (Handoko, 1994). In general, the highest temperature will be in the city center and decreases gradually towards the outskirts of the city up to the village. It occurs when the air temperature in a city that has many buildings is higher than the air temperature in the surrounding areas that are more open such as suburbs or villages.

Land surface temperature is also one of the main energy balance parameters and climatological variables. The magnitude of the land surface temperature depends on other surface parameter conditions, such as albedo, surface humidity and land cover, and vegetation conditions (Prasasti et al, 2007). Bungo Regency is one of the regencies in Jambi Province which is geographically located between 101°27' to 102°30' East Longitude and between 01°55' South Latitude, which is lowland at an altitude of 0-25 meters above sea level. with an area of 4,659 km2.

Bungo Regency experience settlement development caused by the replacement of vegetation land with built-up land. The influencing factor is the increase in population in Bungo Regency, especially in urban areas which can increase the number of residences so that there are many changes in land use (Iyengar, 2003). As a result of the impact of specialists on the function of vegetation land to become built-up land, land that was originally used by residents for agriculture and animal husbandry can be purchased and converted into non-agricultural or animal husbandry activities such as settlements and industry (Bakker et al., 2015). In addition, the impact of specialists on the function of vegetation land to become built-up land can also be seen in the increasing air temperature and decreasing humidity in the Bungo Regency area.

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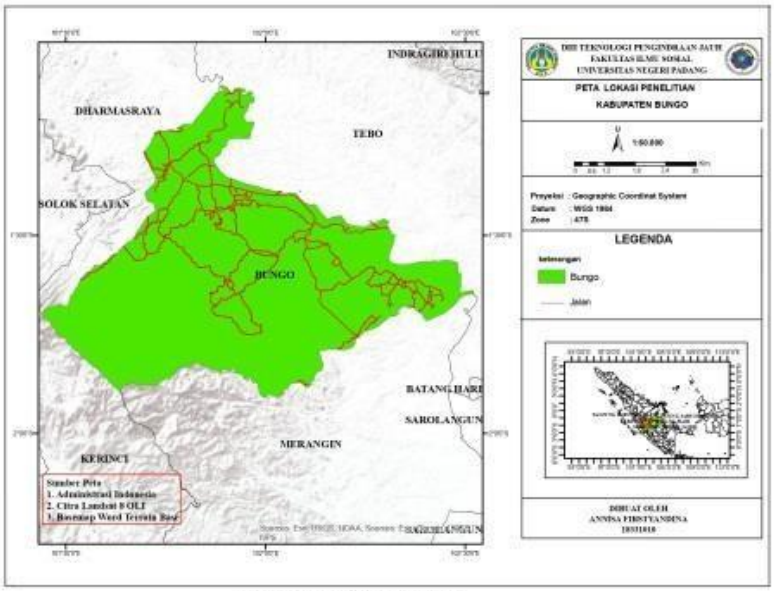
2. METHOD

2.1 Research Form

The research method used in this research is a descriptive research method with a quantitative approach. This research method aims to get a true picture of the subject under study. Most of the data processing is based on



Gambar 3.PETA LOKASI PENELITIAN

Figure 1. Map of The Study Site

2.2 Time & Location of Research

This research is located in Bungo Regency, Jambi Province, which is located between 101o27' to 102o30' East Longitude and between 01o55' South Latitude. Which is a lowland that is at an altitude of 0-25 M above sea level, with an area of 4,659.00 Km2. several conversion stages beforehand for

2.3 Tools & Materials

The tools and materials used in this research are:

Table 3. Tools used in research

No	Tool	Information
1	Hardware	Computers (PC) Acer
2	Software	ArcGIS 10.5
3	Software	Envi 5.3

Table 4. Materials used in the study

No	Data	Keterangan	Format	Sumber Data
1	CITRA	Landsat 8	*.rar	https://www.usgs.dov
2	SHP	Kabupaten Bungo	*.shp	https://www.indonesia-geospasial.com
3	Peta ADM	Kabupaten Bungo	*.shp	BAPPEDA

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2.4 Data Analysis Stage

1. Identification of Land Surface Temperature (LST)

Data on satellite imagery when it is just downloaded is still in the form of a digital number, so it has to go through percentage analysis and trend analysis without relating it to the state of the population where the data was taken (Dharminto, 2007).

Get the actual surface temperature value. What needs to be done is:

a. Changing the Digital Number (DN) value to TOA radiance (radiance value) this correction is made to correct radiometric TOA in Landsat 8 imagery, use the band math tool using the following equation:

$$L\square\ \square\ ML * Qcal + AL$$

$$0.0003342\ X\ Bands\ 10 + 0.1$$

Information :

L□ = TOA radiance (nilai pancaran)

ML = Band-specific multiplicative rescaling factor (in metadata)

AL = Band-specific additive rescaling factor (in metadata)

Qcal = DN at each pixel in the Landsat image band

b. Radiance band conversion to BT (Brightness Temperature)

To get the brightness temperature, a spectral radiance value is needed, by converting the radiance value to a brightness temperature with the following equation:

$$T\ \neg\ K\ 2\ /\{a\ \log(k1/\ L\square\square 1)\}$$

$$(1321.0789/\ Ln\ (774.8853/Rad10+1)-273.15$$

Information :

T = Brightness temperature

L□ □ TOA radians

K1 = thermal constant band 10 or 11 (found in metadata)

K 2 = band 10 or 11 thermal constant (found in metadata)

Bands or channels in the image that can be used for extraction of LST values are bands that have Thermal channels. In Landsat 8 imagery, there are only 2 bands that have Thermal channels, namely Band 10 and band 11. The following is the algorithm for Band 10, then the radiance value will change to brightness temperature with units of degrees Kelvin.

$$(K) : 1321.08/\ alog\ (774.89\ /b1+1)$$

Then convert the brightness temperature into Celsius units

$$(C) : C = K – 273 = b1-273$$

c. Performs NDVI calculations

Aims to compare Near Infrared (band5) Red(band4) data which can be calculated with the following equation:

NDVI = (NIR-RED) (NIR+RED

Float (band5-band4) / Float (band5+band4)

d. Calculation of Vegetation Proportion

$$Pv = (NDVI-NVImin/NDVImax-NDVImin)2$$

$$Pv = (NDVI + 0.256478) / (\ 0.628179 + 0.256478)$$

e. Emissivity Calculation

Emissivity aims to eliminate atmospheric effects which will affect the pixel value received by the image sensor in determining the temperature value. With the following equation:

$$e = 0.004\ PV + 0.986$$

$$e = 0.004\ X\ Pv + 0.986$$

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f. For conversion of satellite temperature to land surface temperature

Then the final calculation is carried out, which is to find the surface temperature value with the LST method which aims to determine the potential surface temperature when the image is recorded. The equation is as follows:

$$T=TB/(1+(\square*TB/C2)*Ln(e))$$

$$TB10/(1+(10.8 \text{ x } TB10/14388)xLn(e))$$

2. Identification of NDVI Vegetation Density

The NDVI value is obtained by calculating Near Infrared (NIR) data with Red data reflected by the appearance of natural plants. To obtain the NDVI value, Band 4 (Red) is used Band 5 (NIR) and classified according to the vegetation density class table (Latif, 2014). The NDVI value is used to compare Near Infrared (band5) and Red data

$$NDVI = (NIR-RED) (NIR+RED)$$

Information :

NIR = Band near infrared RED = Band red

a. Radiometric Correction

First open the Landsat 8 image metadata file with the format (.MTL), On the toolbox menu, then look for Radiometric Calibration then click, select file
.mtl, on the Radiometric Calibration menu you can select the desired calibration type, output interleave, and data type, then save and name the file. Then the results are obtained, where the previous data in the form of DN/Digital number changes to be in the form of radiance.

b. Atmospheric Correction

First, select the toolbox menu, look for Flaash Atmospheric Correction after that click, then select the image that has been carried out by the radiometric calibration process in the previous stage. At the radiometric calibration stage, to be used in the Flash process, it is necessary to use Apply Flash settings on the radiometric calibration menu, on the Radiance Scale Factors menu select use single scale factor for all bands, then completes the sensor parameters type Flight Date, Flight Time, Atmospheric Model, then click apply, and wait until the process is complete.

c. Identification of the relationship between Vegetation Density and Land Surface Temperature

ChangesTo find out how connectionVegetation density to changes in surface temperature of the test field Simple correlation is used to determine the relationship between two variables, and if there is a relationship, how is the direction of the relationship. The closeness of the relationship between one variable and another variable is usually called the Correlation Coefficient which is marked with "r" (Suparto, 2014).

The correlation test is an analytical technique used to measure the strength and weaknesses of the relationship between two variables. This variable consists of independent and dependent variables. The magnitude of the relationship ranges from 0-1. If it is close to 1, it means that the relationship between the two variables is getting stronger, and vice versa, if it is close to 0, it means that the relationship between the two variables is getting weaker. used to determine whether there is a relationship between 2 variables, namely the independent variable and the dependent variable on an interval or ratio (parametric) scale which in SPSS is called a scale. Assumptions in Pearson correlation, data must be normally distributed. Correlation can produce positive (+) and negative (-) numbers. If the correlation number is positive, it means the relationship is unidirectional. Unidirectional means that if the independent variable is large, the dependent variable is getting bigger. If it produces a negative number it means the relationship is not unidirectional. Not unidirectional meaning that if the value of the independent variable is large, the dependent variable is getting smaller. correlation numbers range from 0-1.

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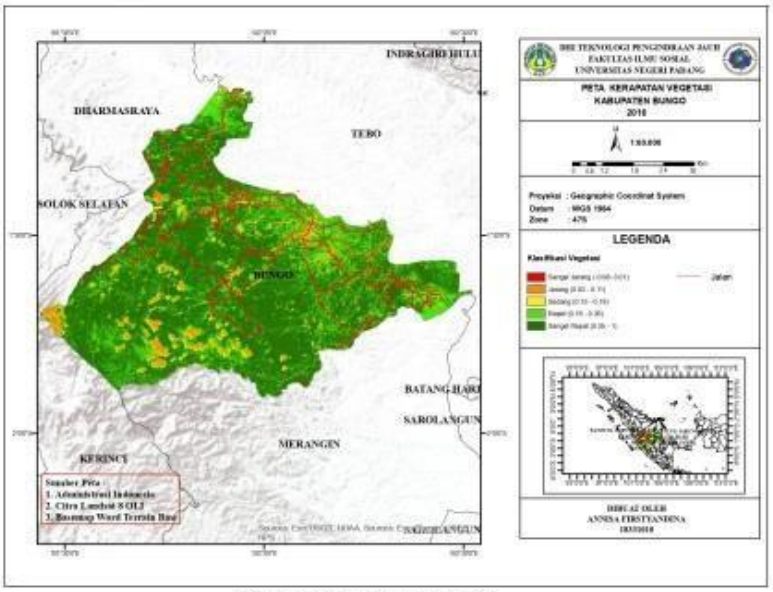
3. DISCUSSION RESULT



Gambar 4. PETA KERAPATAN VEGETASI 2016

Figure 2. Vegetation Density Map 2018

After processing NDVI results in Bungo Regency in 2016, the minimum value was -0.18 and the maximum value was 0.66. In 2021 the minimum value is -0.20 and the maximum value is 0.68. When carrying out the NDVI classification, there were 5 classification classes, namely very rarely shown in red, rarely shown in orange, medium shown in yellow, dense shown in light green, and very dense shown in dark green.

Table 10. Area of Vegetation Density in 2016

Kelas Kerapatan	Luas (Ha) 2016
Sangat Jarang	54.839
Jarang	71.920
Sedang	98.536
Rapat	115.732
Sangat Rapat	124.871
Jumlah	465.898

Source: Results of Data Processing, 2022

Table 11. Area of Vegetation Density Class in 2021

Kelas Kerapatan	Luas (Ha) 2021
Sangat Jarang	61.084
Jarang	79.310
Sedang	95.892
Rapat	112.369
Sangat Rapat	117.216
Jumlah	465.898

Source: Results of Data Processing, 2022

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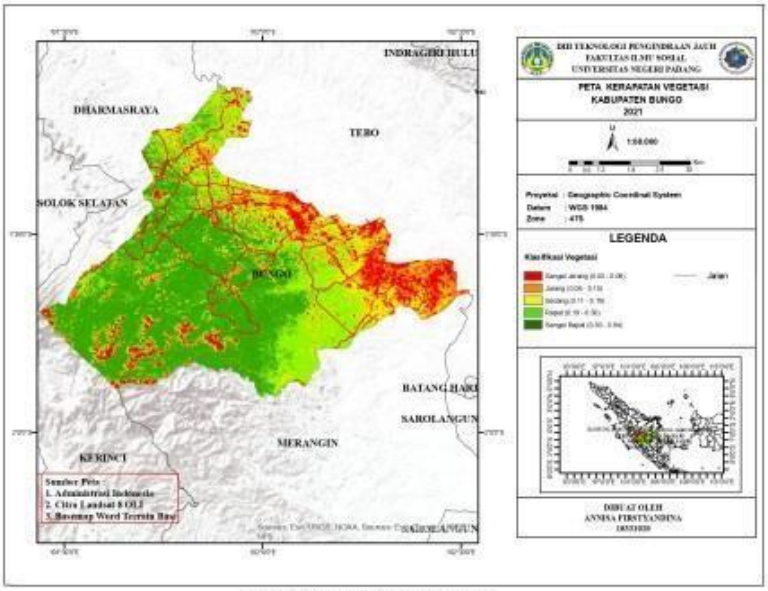

Gambar 5. PETA KERAPATAN VEGETASI 2021

Figure 3. Vegetation Density Map 2022

After the accuracy test was carried out, the results of the spatial data classification of Landsat 8 OLI imagery were obtained, then validation was carried out using the contingency matrix accuracy test or confusion matrix. This is done To see the accuracy of the accuracy, by comparing the results of the classification of satellite image data to the class of vegetation density in the field. The method used in the accuracy test phase is the equalized random sample method.

Random points are distributed automatically with a total of 36 points that have real data references, which are based on image observations on Google Earth. Based on random observations, some points are the same as the real observations and some points are different from the observations. The occurrence of an error is caused by an error when the researcher classifies the image. The error is in the form of the color and hue of a sample land use that has similarities with other land uses. Furthermore, the true and false samples are entered into the error matrix table, this aims to make it easier for researchers to calculate the accuracy test value.

From the processing results of the confusion matrix accuracy test, it can be seen from table 12 that the correct class is shown in white, the number of classes is shown in yellow, the wrong class is shown in red and the processing results are shown in light blue. For the results of the NDVI accuracy test, researchers hope to get 90% accuracy. After the researcher conducted the accuracy test, the researcher got the overall accuracy result with 34 correct classes, divided by the number of 36 classes, and then multiplied by 100, and the researcher got the results for an accuracy of around 94%. Furthermore, the results of the accuracy of the research user get an accuracy value of very rarely 100%, rarely 100%, medium 100%, 90% meeting, and 90% very meeting. And the last result of the accuracy of the researcher is that the accuracy value is very rarely 100%, rarely 100%, medium 100%, meeting 90%, and very meeting 90%.

The results of the Bungo Regency Land Surface Temperature (LST) map are carried out in several steps, the first is to change the Landsat digital number value to a TOA radiance or radian value. Furthermore, the digital number value is converted again to a spectral radian value, then the spectral radian value is converted to a temperature value from the satellite image recording in degrees Kelvin. Furthermore, degrees Kelvin is converted to degrees Celsius using the formula K–273 (273°K is equivalent to 0 °C), after which the land surface temperature results were obtained. Here is a map of the Bungo Regency surface temperature distribution in 2016 and 2021.

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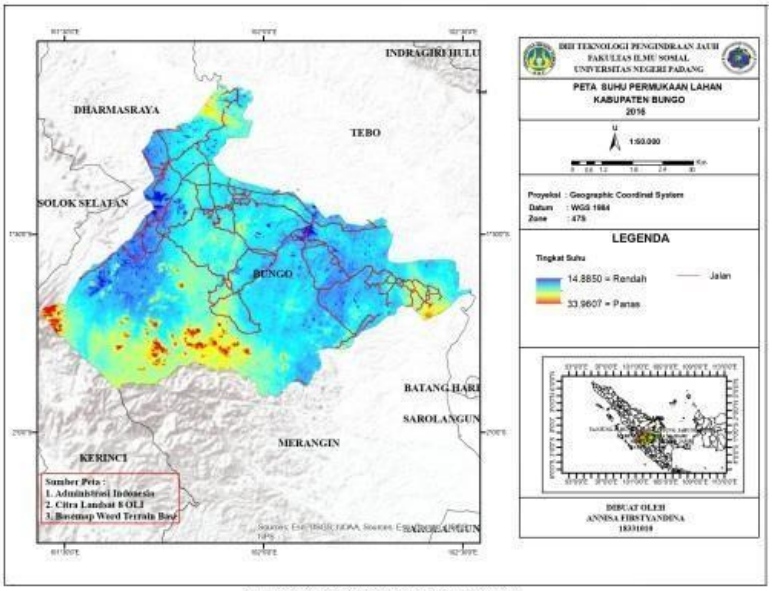
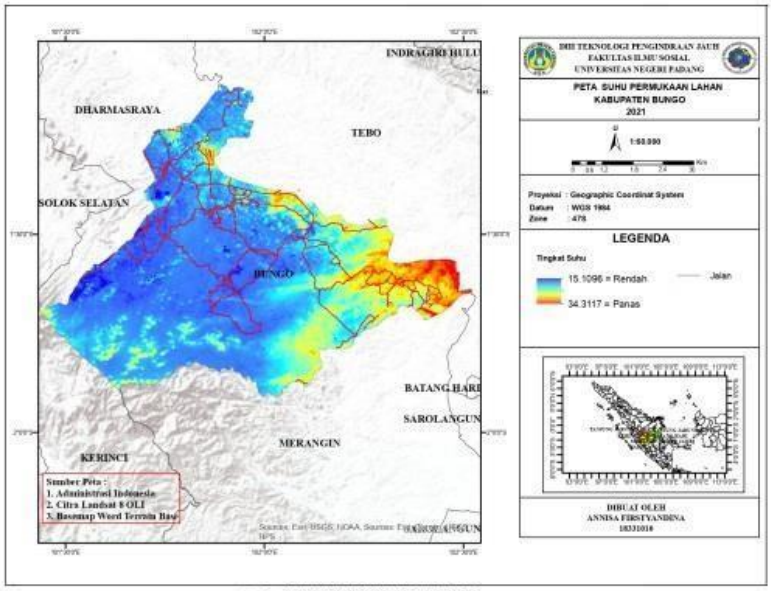


Gambar 6.PETA SUHU PERMUKAAN LAHAN 2016

Figure 4. Land Surface Temperature Map 2016



Gambar 7.SUHU PERMUKAAN LAHAN 2021

Figure 5. Land Surface Temperature Map 2022

In 2016, the minimum temperature on the land surface was 14.8˚C and the maximum temperature was 33.9˚C with an average temperature of 24.7˚C. When identifying the 2021 image, the minimum land surface temperature is 15.1˚C and the maximum temperature is 34.3˚C with an average land surface temperature of 25.6˚C. To determine the relationship between vegetation density (NDVI) and the distribution of land surface temperature in Bungo District, the Pearson correlation test was carried out.

The Pearson correlation test is used to determine whether or not there is a relationship between two variables, namely the independent variable and the dependent variable on an interval or ratio (parametric) scale. Assumptions in Pearson correlation, data must be normally distributed. Correlation can produce positive (+) and negative (-) numbers. If the correlation number is positive, it means the relationship is unidirectional. Unidirectional means that if the independent variable is large, the dependent variable is getting bigger. If it produces a negative number it means the relationship is not unidirectional. Not unidirectional meaning that if the value of the independent variable is large, the dependent variable is getting smaller, or vice versa.

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NDVI & LST Correlation Test Table

correlations		LST	NDVI
LST	Pearsons Corrlation	1	.516**
	Sig. (2-tailed)		001
	N	36	36
NDV I	Pearsons Correlation	.516**	1
	Sig. (2-tailed)	001	
	N	36	36

Analysis of LST and NDVI in the table above, it can be seen that the Pearson correlation coefficient value of LST and NDVI is 0.516, which means that LST and NDVI are strongly correlated because they are in the range of 0.50-0.75 and LST and NDVI have a significant relationship because they have a value of 0.001 (smaller than 0.05)

4. CONCLUSION

Based on the results of research on land surface temperature estimation in Bungo Regency using Landsat 8 image thermal channels, several conclusions can be described as follows:

1. The results of a comparison of the vegetation density maps for 2016 and 2021 can be seen that there has been a change in classification class or a change in the area of vegetation density classes in Bungo Regency in 2016 and 2021. In 2016, the classification was very dense with an area of 124,871 Ha in 2021 reduced to 117,216 Ha. Classification of meetings in 2016, with an area of 115,732 Ha in 2021 reduced to 112,365 Ha. Medium classification in 2016, with an area of 98,536 Ha in 2021 reduced to 95,892 Ha. Rare classification in 2016, with an area of 71,920 Ha in 2021 increasing to 79,310 Ha. And the classification is very rare in 2016, with an area of 54,839 Ha in 2021 increasing to 61,084.
2. The results of the land surface temperature (Land Surface Temperature) of Bungo Regency increased by 0.4°C. in 2016 the highest temperature reached 33.9°C and the lowest temperature reached 14.8°C. The year 2021 has the highest temperature value of 34.3°C and the lowest temperature value of 15.1°C. The highest temperatures are in areas with dense buildings and low vegetation, while the lowest temperatures are in areas around hills and forests with dense vegetation.
3. Produces a Pearson correlation test value of 0.516, which means that it has a strong correlation because it is in the range of 0.50-0.75 and LST with NDVI has a significant relationship because it has a value of 0.001 (smaller than 0.05).

5. SUGGESTION

1. To get maximum results, you should pay more attention to the selection of satellite images that are free from cloud disturbances.
2. Sampling temperature in the field is carried out during the range of satellite image recording in the area and it is attempted when the weather is sunny.
3. Taking the temperature of the sample should be attempted using a thermometer temperature gauge so that the temperature is more in line with the temperature in the field.
4. It is hoped that the government and the community will carry out reforestation in areas with little vegetation, utilize house yards planted with vegetation, and preserve vegetation.

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