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Identification of Environmental Changes With NDVI and LST Parameters in Pakpak Bharat Regency by Using Remote Sensing Technique

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ABSTRACT
This research was done using satellite imagery. It was aimed to reduce its sustainable impact on environmental damage. Research method was field survey and the use of landsat 8 OLI satellite data. Data analysis was done by remote sensing techniques. Results showed that a decrease in the greenness of vegetation, and an increase in temperature. The relationship between NDVI and LST is inversely proportional. From the research, it can be concluded that the environmental damage has been identified in Pakpak Bharat.

Keywords: *Pakpak Bharat Regency, Environmental Change, 8 OLI Landsat, Temperature (LST), NDVI.*

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I. INTRODUCTION

Sumatera, Pakpak Bharat regency area consists of 8 subdistricts, they are Salak, Sitellu Tali Urang Jehe, Tinada, Siempat Rube, Sitellu Tali Urang Julu, Pergetteng Getteng Sengkut and Pangindar and 52 villages with total area of 1.218,30 km² (121.830 ha) or about 1,70 % from the total area of North Sumatera province. From that total area, 63.974 ha (52,51%) is the area that has not been optimalized. [2].

North Sumatra is one of 33 provinces in Indonesia, has a total area of 181,860.65 km² consisting of a land area of 71,680.68 km² or 3.73% from the total area of the Republic of Indonesia. Geographically, North Sumatera Province is located at 1 ° - 4 ° North Latitude and 98 ° - 100 ° East Longitude. North Sumatera Province consists of 25 districts and 8 cities, 421 sub districts and 5,828 villages. One of the districts in North Sumatra is Pakpak Bharat [2]

The morphology of Pakpak Bharat Regency consists of flat areas, slopes, and mountains with slopes varying from 0 - 8 °, 8 - 15 ° up to 40 °. Pakpak Bharat Regency has tropical climate influenced by monsoon climate with average rainfall of 2,270 mm / year with 159 rainy days with air temperature ranging from 18 ° C to 28 ° C [3]

The growing of people every year that is always increasing encourages development activities in various sectors as the support capacity for the population's activities. This change occurs because of the need for agricultural land, urban development, deforestation, green alignment for the needs of residential population, etc. These changes have caused such apprehensive effects as rising temperatures, floods, and landslides. These changes need to be identified and mapped to reduce the sustainable impact because if it is not done, it may lead to a decrease in environment quality.

Data used in GIS utilization and remote sensing are spatial data (data represented in map form with digital format), that is satellite imagery. Satellite imagery obtained from the recording by the sensor in the data collection by remote sensing method which is done based on the differences of electromagnetic energy reflectance of each object on the earth surface. Different reflectance power by the sensor will be recorded and defined as different objects presented in an image. The investigation focused on the effects of Vegetation (NDVI) and Surface Temperature (LST) to identify environmental changes.

Remote sensing techniques previously used in research, such as[4] study on the analysis of changes in mangrove land area in Pohuwato, Gorontalo Province, [5] on analysis of vegetation changes in Semarang using the aid of remote sensing technology, [6] about the identification of closing land using SPOT 4 satellite imagery, some studies about vegetation [7], [8], [9], [10], [11]. The influence of vegetation on climate change has attracted much attention, especially since the vegetation index (NDVI) happened since the early 1980s [12], [13]. Surface temperatures (LSTs) have been used to estimate soil moisture, climate, hydrology, ecology, terrestrial ecosystems, and biogeochemistry [14], [15], [16], [17], [18], [19]. [20] on the using of 7 ETM landsat imagery to analyze forest humidity based on drought index value. Correlations between NDVI and LST have been done [21], [22], [23].

Based on the description above, researchers interested in conducting research on the identification of environmental changes in terms of NDVI and LST parameters by utilizing of Remote Sensing 8 OLI Landsat Imagery, Research has never been done in this place and very rarely done in Indonesia. Expected results are maps and values that can provide information. The results of this study will contribute to the government and society so that it can be used to plan development and prevent damage to the environment

II. RESEARCH METHOD

1. Time and Location

Pakpak Bharat Regency, located between the coordinates of 2015'00 "- 3032'00" North Latitude and 960 00 '- 98031' East Longitude. The total area of Pakpak Bharat Regency is 121,830 ha. Research Location has been conducted at some point in 8 Sub-districts for 4 months in February 2016 - May 2016.

2. Tool and Material

2.1. Tool

GPS (Global Position System), a computer device with Arcgis 10.0 software, ENVI 4.7, Garmin DNS, Microsoft office 2013, digital camera, thermometer

2.2. Material

The materials used are spatial data, they are satellite imagery in 2013, 2014, 2015 (USGS., 2014) and attribute data, they are the earth map of North Sumatera and administration map of Nias Island (.shp).

III. Data Analysis

3.1 Making Radiometric Corrections using ENVI Software
3.2 Analyzing data using Arcgis 10
3.3 Conducting correlation analysis of NDVI and LST
3.4 Conducting calculations using Microsoft excel 2013 software

IV. Flowchart

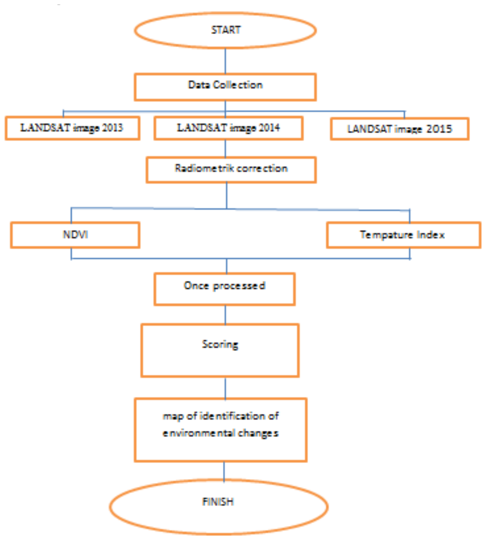

Figure1. Flowchart

4.1.1. Image Processing

Normalized Different Vegetation Indeks **(NDVI)**

NDVI is obtained by inputting band 4 and band 5 from 8 OLI Landsat imagery and using NDVI equation then doing information extraction.

a. Normalized Different Vegetation Indeks (NDVI) of Pakpak Bharat regency in 2013

Minimum, middle, maximum NDVI values can be seen in Table 4.1

Table 4.1. Statistic Value of NDVI in 2013

NDVI min	NDVI max	Mean
-0,152	0,630	0.441

The results of NDVI calculations in 2013 provide an overview of the NDVI Map which can be seen in Figure 4.2

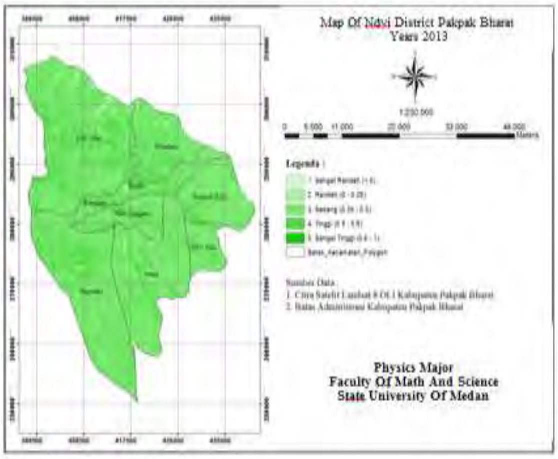

Figure 4.2. NDVI Map of Pakpak Bharat regency in 2013

Then, the attribute values of NDVI calculation results are classified into 5 categories that can be seen in Table 4.2

Table 4.2. NDVI Presentase of Pakpak Bharat regency in 2013

NDVI Classification	Total of Pixel	Width m2	Width ha	Presentase
Very Low (0)	140	126000	12,6	0,0093
Low (0 - 0.25)	37349	33614100	3361,41	2,4773
Medium(0.25 - 0.5)	1180181	1062162900	106216,29	78,2796
High (0.5 - 0.6)	289648	260683200	26068,32	19,2119
Very High (0.6 - 1)	331	297900	29,79	0,022
Total	**1507649**	**1356884100**	**135688,41**	**100**

b. Normalized Different Vegetation Indeks (NDVI) of Pakpak Bharat regency in 2014

Minimum, middle, maximum NDVI values can be seen in Table 4.3

Table 4.3. Statistic Value of NDVI in 2014

NDVI min	NDVI max	Mean
-0.205	0.621	0.386

The results of NDVI calculations in 2014 provide an overview of the NDVI Map which can be seen in Figure 4.3

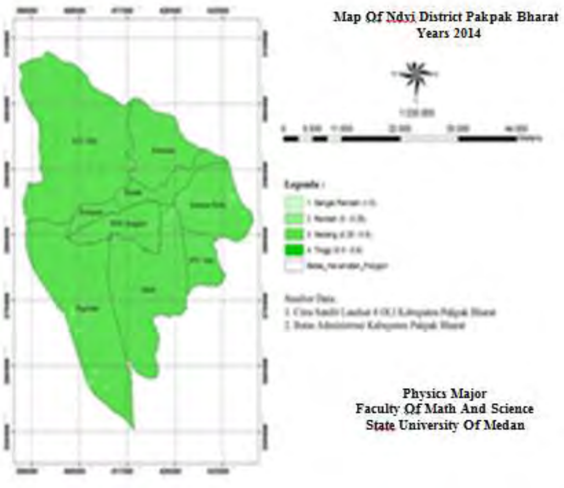

Figure 4.3. NDVI Map of Pakpak Bharat regency in 2014

Then, the attribute values of NDVI calculation results are classified into 5 categories that can be seen in table 4.4

Table 4.4. NDVI Presentase of Pakpak Bharat regency in 2014

NDVI classification	Total of Pixel	Width m2	Width ha	Presentase
Very Low (0)	33	29700	2,97	0,0022
Low (0 - 0.25)	22517	20265300	2026,53	1,4935
Medium (0.25 - 0.5)	1471763	1324586700	132458,67	97,6197
High (0.5 - 0.6)	13336	12002400	1200,24	0,8846
Very High (0.6 - 1)	0	0	0	0
Total	**1507649**	**1356884100**	**135688,41**	**100**

c. Normalized Different Vegetation Indeks (NDVI) of Pakpak Bharat regency in 2015

Minimum, middle, maximum NDVI values can be seen in table 4.5

Tabel 4.5. Statistic Value of NDVI in 2015

NDVI min	NDVI max	Mean
-0,153	0,621	0.232

The results of NDVI calculations in 2015 provide an overview of the NDVI Map which can be seen in Figure 4.4

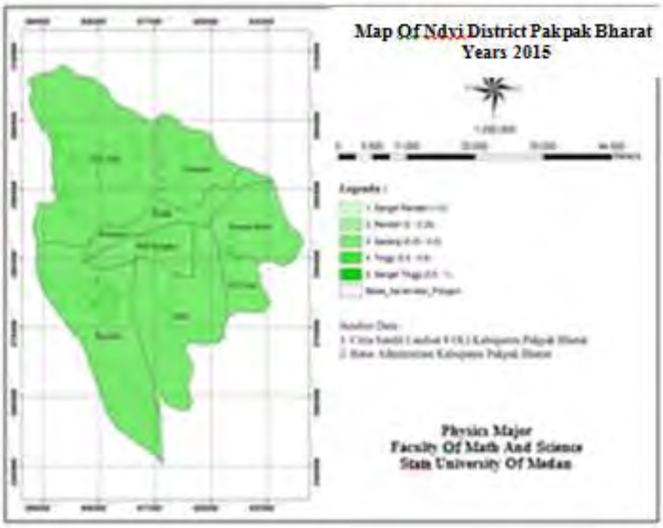

Figure 4.4. NDVI Map of Pakpak Bharat regency in 2015

Then, the attribute values of NDVI calculation results are classified into 5 categories that can be seen in table 4.6

Table 4.6. NDVI Presentase of Pakpak Bharat regency in 2015

NDVI Classification	Total of Pixel	Width m2	Width ha	Presentase
Very Low (0)	158	142200	14,22	0,0105
Low (0 - 0.25)	19705	17734500	1773,45	1,307
Medium (0.25 - 0.5)	1367509	1230758100	123075,81	90,7047
High (0.5 - 0.6)	120265	108238500	10823,85	7,977
Very High (0.6 - 1)	12	10800	1,08	0,0008
Total	**1507649**	**1356884100**	**135688,41**	**100**

4.1.2.Thermal Index (TI)

The Temperature Index (TI), obtained by using the TI calculation formula in equation 2.6 by using Band 10 (Long Wavelength InfraRed). Temperature Index requires correction of radiation first by using Qmax, Qmin, Lmax and Lmin constants (Appendix 1), as follows:

$$L_{\lambda}= ((22.00180-0.10033)/(65535-1))*(Band\ 10-1)+0.10033$$

a. Thermal Index (TI) in 2013

Minimum, middle, maximum of TI can be seen in table 4.7

Table 4.7. Statistic Value of TI in 2013

TI min	TI max	Mean
13.975	31.782	22.611

The results of TI calculation provide an overview of the TI Map which can be seen in Figure 4.5

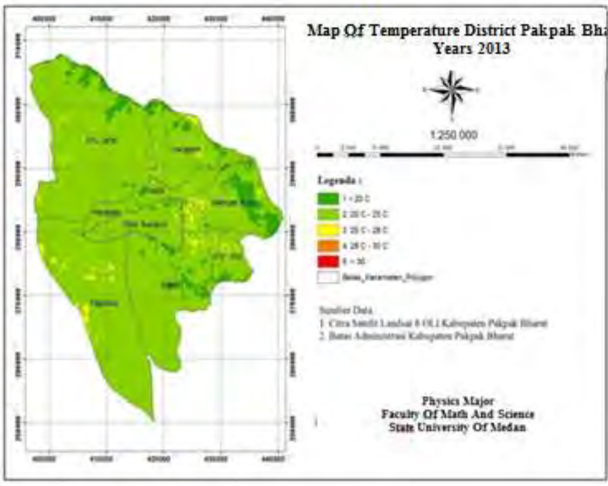

Figure 4.5. TI Map of Pakpak Bharat regency in 2013

Then, the attribute values of TI calculation results are classified into 5 categories that can be seen in table 4.8

Table 4.8. TI Presentase of Pakpak Bharat regency in 2013

TI Classification	Thermal	Total of Pixel	Width m2	Width ha	Presentase
Very Low	< 20 C	106627	95964300	9596,43	7,0724
Low	20 C - 25 C	1362409	1226168100	122616,81	90,3665
Medium	25 C - 28 C	37328	33595200	3359,52	2,4759
High	28 C - 30 C	1170	1053000	105,3	0,0776
Very High	> 30 C	115	103500	10,35	0,0076
Total		**1507649**	**1356884100**	**135688,41**	**100**

b. Thermal Index (TI) in 2014

Minimum, middle, maximum of TI can be seen in table 4.9

Table 4.9. Statistic Value of TI in 2014

TI min	TI max	Mean
16.849	34.561	20.749

The results of TI calculation provide an overview of the TI Map which can be seen in Figure 4.6

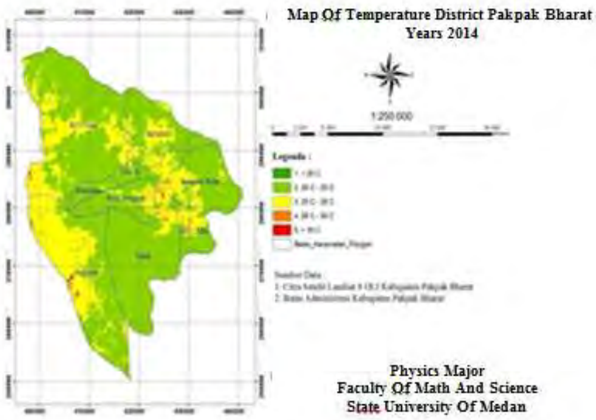

Figure 4.6. TI Map of Pakpak Bharat regency in 2014

Then, the attribute values of TI calculation results are classified into 5 categories that can be seen in table 4.10

Table 4.10. TI Presentase of Pakpak Bharat regency in 2014

TI Classification	Thermal	Total of Pixel	Width m2	Width ha	Presentase
Very Low	< 20 C	780	702000	70,2	0,0517
Low	20 C - 25 C	1056228	950605200	95060,52	70,0579
Medium	25 C - 28 C	433073	389765700	38976,57	28,725

High	28 C - 30 C	15677	14109300	1410,93	1,0398
Very High	> 30 C	1891	1701900	170,19	0,1254
Total		**1507649**	**1356884100**	**135688,41**	**100**

c. Thermal Index (TI) in 2015

Minimum, middle, maximum of TI can be seen in table 4.11

Table 4.11. Statistic Value of TI in 2015

TI min	TI max	Mean
19.148	35.481	25.385

The results of TI calculation provide an overview of the TI Map which can be seen in Figure 4.7

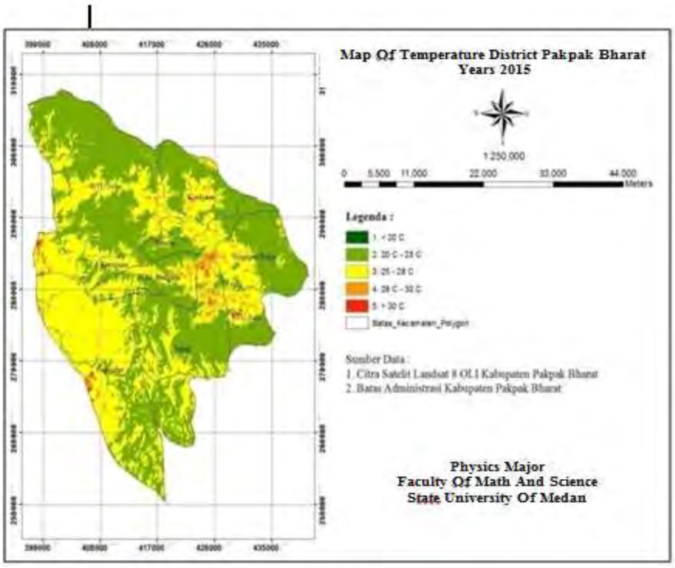

Figure 4.7. TI Map of Pakpak Bharat regency in 2015

Then, the attribute values of TI calculation results are classified into 5 categories that can be seen in table 4.12

Table 4.12. TI Presentase of Pakpak Bharat regency in 2015

TI Classification	Thermal	Total of Pixel	Width m2	Width ha	Presentase
Very Low	< 20 C	51	45900	4,59	0,0034
Low	20 C - 25 C	814730	733257000	73325,7	54,0398
Medium	25 C - 28 C	650260	585234000	58523,4	43,1307
High	28 C - 30 C	36867	33180300	3318,03	2,4453
Very High	> 30 C	5741	5166900	516,69	0,3807
Total		**1507649**	**1356884100**	**135688,41**	**100**

4.1.3. Relation Graphic of NDVI and LST

The relationship between NDVI and LST show that the value of NDVI from 2013 to 2015 decreases, while the value of LST from 2013 to 2015 increases. The values of NDVI and LST can be seen in Table 4.13

Table 4.13. NDVI and LST Value from 2013 to 2015

Year	NDVI	LST
2013	0,630	31,782
2014	0,621	34,561
2015	0,620	35,481

From the table above, the decrease of NDVI value means the decreasing of the density of vegetation causing the rising temperature (LST) in the Pakpak Bharat regency. This is obtained from 50 observation points that can be seen on the relation graphic of NDVI and LST.
The Relation graphic of NDVI and LST from 2013 to 2015 can be seen in Figure 4.8, Figure 4.9, Figure 4.10.

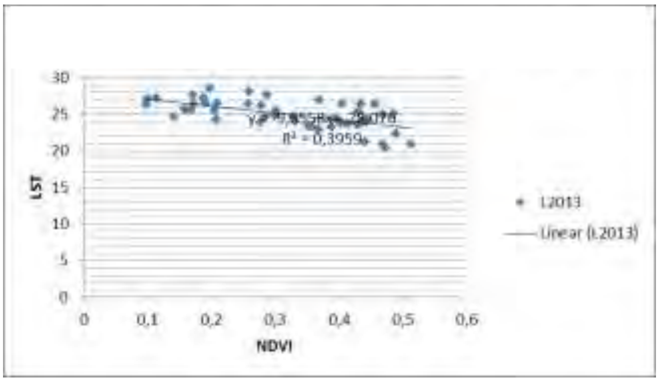

Figure 4.8 Relation Graphic of NDVI and LST in 2013

From Figure 4.11 above, it can be seen for the value of NDVI 0.1 temperature is in the range 250C - 300C and for NDVI with a value of 0.5 the temperature is in the range 200C - 250C. This proves the lower the NDVI value the higher the temperature value, and if the NDVI value is high then the temperature value is low.

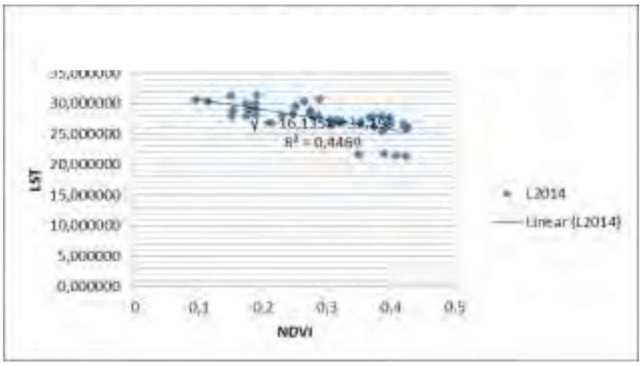

Figure 4.9 Relation Graphic of NDVI and LST in 2014

From figure 4.9 above, it can be seen for the value of NDVI 0.1 temperature is in the range 300C - 350C and for NDVI with value 0.45 the temperature is in the range 250C - 300C. This proves the lower the NDVI value the higher the temperature value, and if the NDVI value is high then the temperature value is low.

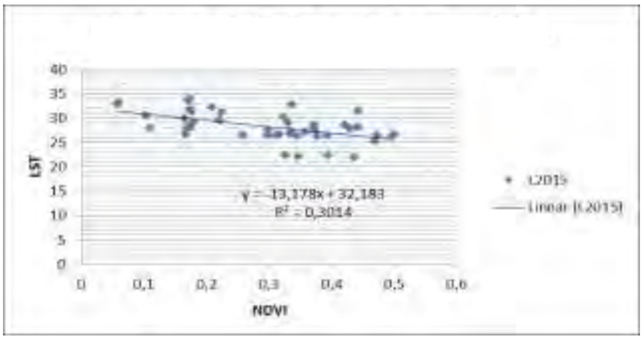

Figure 4.10 Relation Graphic of NDVI and LST in 2015

From Figure 4.10 above, it can be seen for the NDVI value of the range 0 - 0.1 the temperature is in the range 300C - 350C and for the NDVI with a range of values 0.5 to 0.6 the temperature is in the range 250C - 300C. This proves the lower the NDVI value the higher the temperature value, and if the NDVI value is high then the temperature value is low. The result of the NDVI and LST graphics combination from 2013 - 2015 can be seen in Figure 4.11.

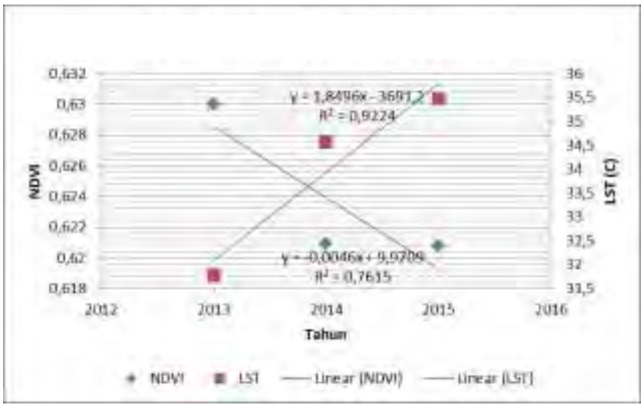

Figure 4.11. Relation Graphic of NDVI and LST

4.2 Discussion

From the NDVI map Figure: 4.2, 4.3, 4.4 it appears that vegetation decreases from 2013 to 2015. It is also supported by tables: 4.2, 4.4, and 4.6. the number of medium and high vegetation pixels has decreased significantly. From the table: 4.1, 4.3 and 4.5 also showed a decline. Thus, it has identified the vegetation. Vegetation density affects the NDVI index where the closer a vegetation is, the higher the NDVI value. The range of NDVI values starts from (-1) to 1. The value (-1) - 0 represents low or nonexistent vegetation (eg water). The values 0 - 0.25 indicate low vegetation such as settlement, vacant area, etc. The values of 0.25 - 0.5 indicate moderate vegetation such as rice fields, fields, etc. A value of 0.5 to 0.65 denotes high vegetation such as plantations. Values above 0.6 represent high vegetation such as forests. This is due to the large number of land conversion from the forest become farming of the community.

From the map figure: 4.5, 4.6, and 4.7, it is clear that there is a increasing temperature from 2013-2015. From the table: 4.7, 4.9 and 4.11 show the temperature attribute value that also shows the rising of temperature. Based on the tables: 4.8, 4.10, and 4.12 also showed a significant rise in temperature. Thus, It has been identified the temperature rise from 2013 to 2015

From the figures: 4.8, 4.9 and 4.10 show the NDVI relationship with LST from 2013 - 2015 indicates a decrease in vegetation level as well as rising surface temperatures. This is related with data of BMKG Sumatra 2015 which states the increasing number of open places in Sumatra cause the region becomes hotter. Currently, there are many open areas in Sumatra caused by high land and forests clearing in that area. Land clearing has prompted the temperature rise in Sumatra much higher than in other regions. The absence of plants and trees makes the area becomes hotter (BMKG, 2015).

Rampant land use also contributes to the increase of carbon emissions, so in the dry season trigger a drastic temperature increasing.

Another factor is the increasingly high urban development that just leaves a little green open space. This causes the phenomenon of urban heat island. Urban heat island is defined as an temperature increasing in the metropolitan areas due to human activities, including development, use of non-environmentally vehicles, and other factors.

V. CONCLUSION

Based on the research results, it can be concluded as follows:

i. The NDVI index from 2013 to 2015 proves the decrease in the value of NDVI which represents a decrease in vegetation. Temperature changes assessed by the TI index from 2013 to 2015 prove an increase in the value of IT that states the increase in temperature.
ii. The relationship between NDVI and LST is inversely proportional; if the NDVI value is high then the LST value goes down and vice versa
iii. With NDVI and LST Parameters, environmental changes can be identified. he results of identification can be used to design sustainable development

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