Trend Analysis of Urban Heat Island Phenomenon in the City of Makassar, South Sulawesi, Indonesia using Landsat

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ABSTRACT---- ***An increase in temperature, in urban areas is a phenomenon which is not uncommon for people in the world, especially for urban communities. Phenomenon is the increase in temperature in the city is one of the micro climate change phenomenon commonly referred to as the urban heat island (UHI). It can be felt is the case the temperature difference between the center, edge and outside the city. Higher temperatures in the city center as a result of the density of the buildings, green areas is reduced, and the high anthropogenic activity in urban centers. This phenomenon also occurs in various major cities in Indonesia including Makassar. This research attempts to provide an overview of the distribution centers of the heat in Makassar using Landsat satellite image 10. The results show the relationship between the distribution of land use with temperatures in the study area. In general, high temperatures occur in residential areas, shopping centers, and office buildings. Meanwhile, a low temperature occurs in green areas, or areas of the building rarely. It is expected to be the initial information in terms of addressing a wide range of urban problems, especially the problem of increasing temperature, which has led to a level of comfort of living in the city on the wane.***

Keywords--- Urban Heat Island, Landsat, Makassar

1. INTRODUCTION

Climate change is a phenomenon that is becoming one of the reviewer's attention to the climate at this time. The high temperature of the earth's surface, especially in the big cities in the world gives an uncomfortable feeling for urban dwellers. Results of preliminary observations indicate that the level of comfort in Makassar has begun to decrease due to high temperatures. This is evidenced by the results of measurements made during the day and night it is known that the average temperature of Makassar is 31.29 ° C during the day and 27.4 ° C at night (Maru and Baharuddin, 2014). The same phenomenon also happens in many big cities in Indonesia such as Jakarta other (Maru and Ahmad, 2014), Jogjakarta, Surabaya, and the others.

In addition, climate change is also characterized by the occurrence of the rainy season and prolonged droughts. Both of these phenomena known as El Nino and La Nina (Seller and Robinson, 1986). Both are frequent disasters, especially El Nino which has several times hit Indonesia in general and South Sulawesi in particular. Extreme events are different from the habit is also suspected as the effect rather than the meteorological situation is not balanced. Unbalanced meteorological conditions should give effect to the increase in temperature causes heat island (HI), especially in areas that experienced a reduction in green area (Efendy, 2007).

Climate change is happening is the result of a meteorological circumstances imbalance. It is a result rather than an increase in greenhouse gases. An increase in these gases, especially CO2 in the atmosphere and the earth's surface led to an increase in temperature and changes in weather patterns (Purnomohadi, 1995). Furthermore, the situation can influence changes in cropping patterns, lower levels of comfort, the emergence of various kinds of diseases, the explosion of various pests, among others locusts wanderer (Maru, 2001: 2009; 2010) and a population explosion of caterpillars, may even lead to global warming so that chunks of polar ice will melt that caused coastal areas and small islands will sink.

2. METHOD

This study uses data Landsat imagery 8. Satellite imagery has also been used by Lu and Weng (2006); Rong-bo, et.al. (2007). Additionally, the software used is ArcGIS. The band is used for the analysis of NDVI 2,3,4,5 band, while the bands 10 and 11 are used to identify the distribution of surface temperature.

Land Surface Temperature (LST) using Landsat 8 in ArcGIS 10.2 software, created with the following steps: 1) Input Band 2,3,4, and 5 Landsat 8 in ArcMap window for analysis of NDVI; 2) composite band and analysis of NDVI on the "composite and NDVI"; 3) staining on the map NDVI analysis results; 4) Input Band 10 and 11 in the ArcMap window; 5) radiometric correction.

Next calculate the LST with the following steps:

1. Calculate the value of Land Surface Emition (LSE)

PV = (NDVI – NDVI min / NDVImax – NDVImin)^2
PV = Proportion of vegetation
e = 0.004 PV + 0.986
2. MenghitungnilaiLand Surface Temperature
Calculating the value of Land Surface Temperature (LST)
LST = BT / 1 + W * (BT / p) * ln (e))
Where:
BT = At satellite temperature
W = Wavelength of emmited radiance (11.5 µm)
P = h * c / s (1.438 * 10 ^-2 m K)
h = Planck's constant (6.626 * 10 ^-34 Js)
s = Boltzman Constant (1.38 * 10 ^-23 J/K)
c = velocity of light (2.998 * 10^8 m/s)
p = 14380

3. RESULTS

1. LST in May 2015

The analysis of Landsat imagery 8 shows that the temperature of Makassar is varied. As shown in Table 1 that the temperature of Makassar consists of 5 (five) levels categories, namely: less than 27 °C (<27 ° C), 27 ° C - 29 ° C,> 29 ° C - 31 ° C,> 31 ° C - 33 ° C and> 33 ° C - 35 ° C with a breadth of each of these categories.

Table 1. Temperature and Land Area in Makassar

No	Temperature (°C)	Broad (Ha)
1	<27	3042.37
2	>27-29	5477.70
3	>29-31	6020.84
4	>31-33	2498.17
5	>33-35	94.89
6	cloud	373.83
Total		**17507.81**

Source: Results of the data analysis in 2015.

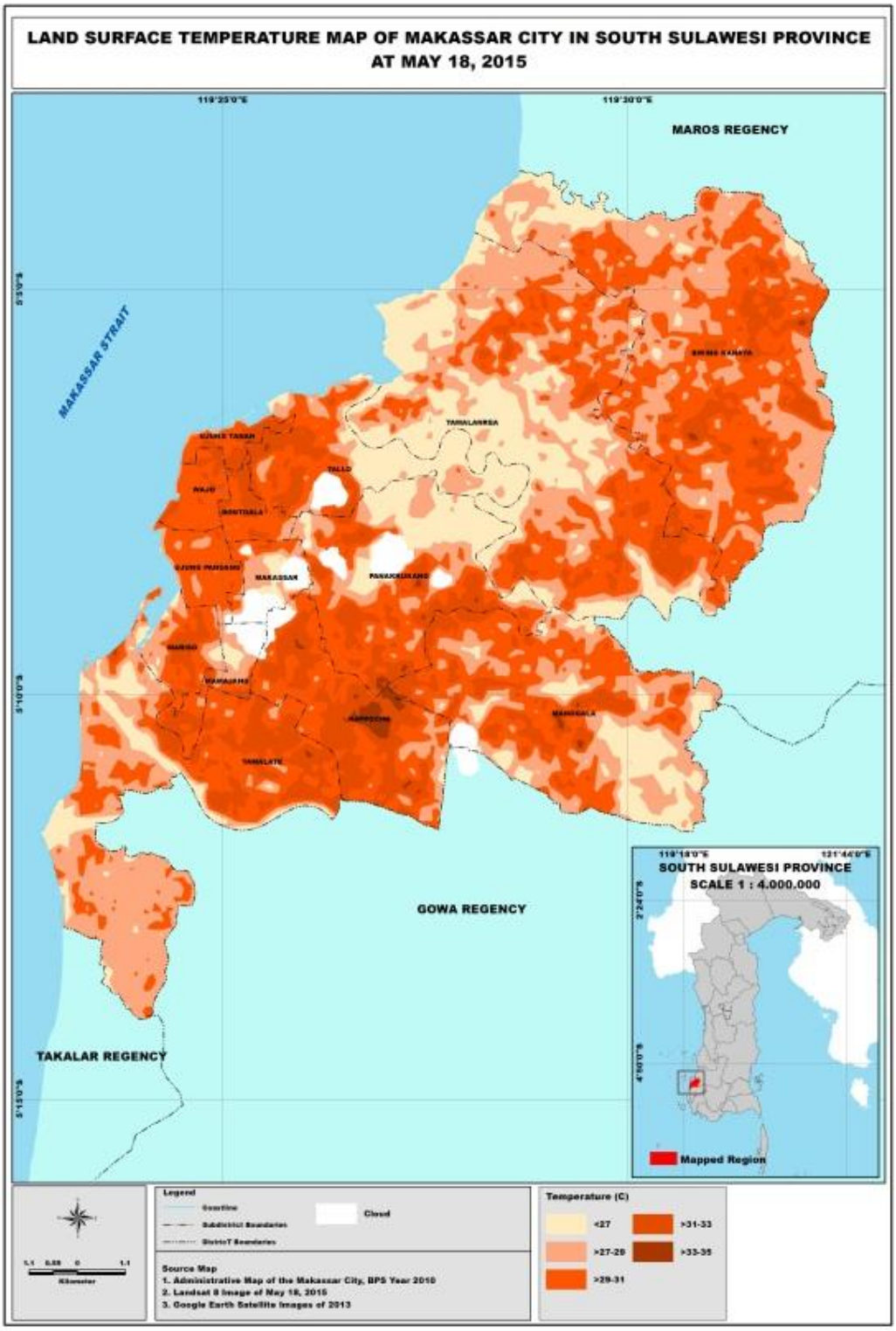

Figure 1. LST month of May 2015

Based on Table 1 and Figure 1 diktahui that the temperature of Makassar dominated by temperatures between 29°C - 31°C with a total area of 6020.84 ha. The temperature of the categories are spread in the area of Panakkukang, Rappocini, Ujungtanah, Ujungpandang, and Bontoala. Meanwhile, a low temperature (<29°C) occur in the area Tamalanrea and Manggala.

2. LST month of July 2015

LST in July also consists of five (5) categories, as contained in May. Moreover, the dominant temperature is> 29 ° C - 31 ° C with a breadth is 7195.40 Ha. This means an increase in the breadth of 1.174.56 Ha. Nevertheless, there is an interesting phenomenon in this month, which is a significant temperature changes. In July a very high temperature or central heat (hot spots) occur in the Region Tallo and Tamalanrea with temperatures between> 33°C-35°C whereas the previous month (May) will be in the low category (<27°C). In addition, hot spots also occur in the region Biringkanaya, exactly on the border Maros and Makassar. Nevertheless, the overall temperature of Makassar City is still dominated by the category of>29°C - 33°C. Central heat phenomenon commonly known as the heat island (HI).

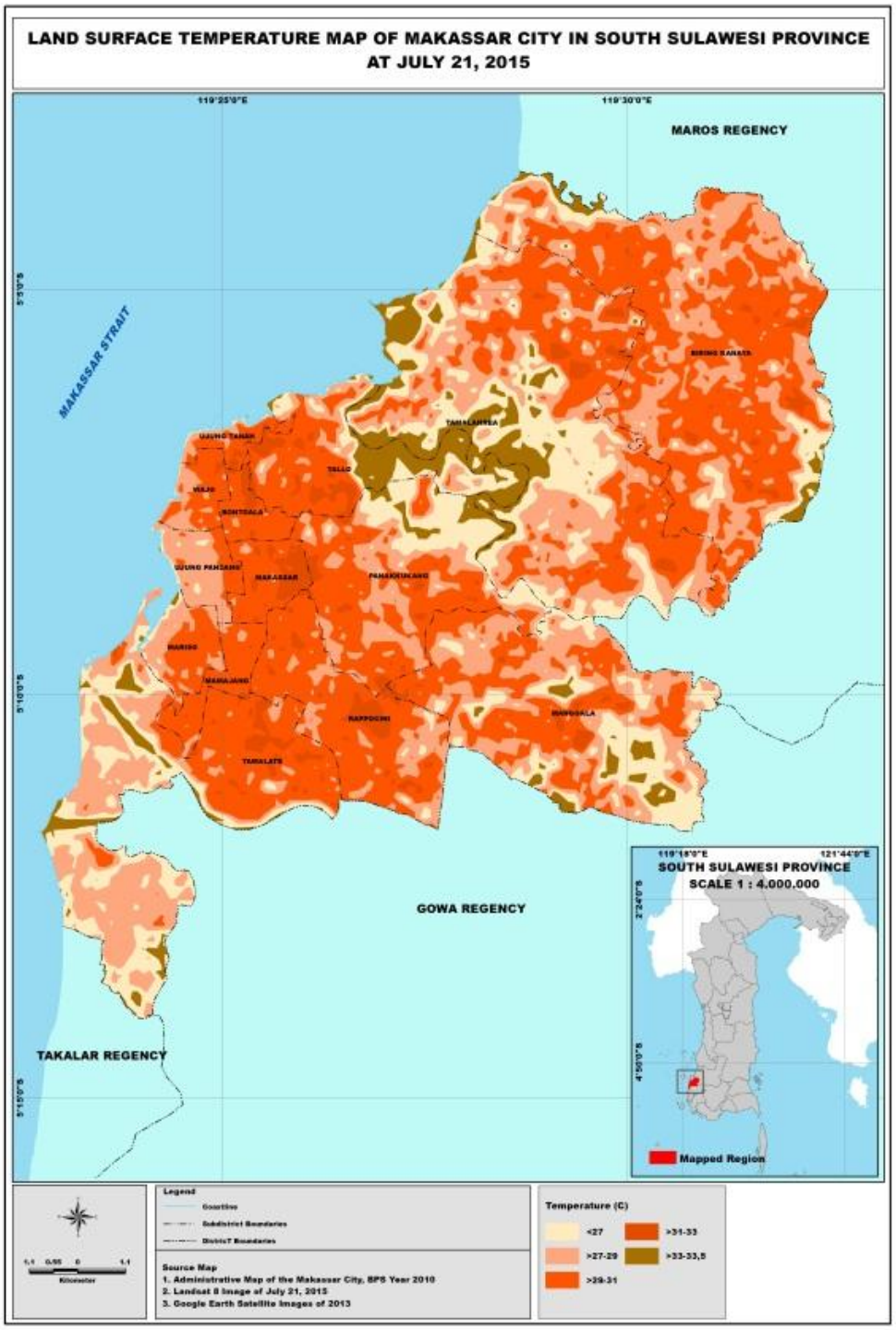

Figure 2. LST in July 2015

If the comparison between the state of the temperature of Makassar in May and July 2015, it is known that an increase in temperature from May to July. This is especially true in the central region to the north or the border city of Maros. Figure 2 and Tabel 2 shows that in July the state of the atmosphere is very bright which is marked by the results of image analysis that is free of distractions clouds. This, in contrast to the month of May, where there are still some areas covered by clouds, so that the area does not seem obvious in reading the images. A similar situation has been found by Aniello, et.al. (1995) in Dallas, Texas. The study results indicate the presence of urban heat islands as a result of the lack of tree cover associated with the newly developed residential neighborhood, parking spaces, business districts, apartment complexes and shopping centers.

Table 2. Temperature and Land Area in July in Makassar

No	**Temperature (**°C)	**Broad (Ha)**
1	<27	2961.09
2	>27-29	5602.75
3	>29-31	7195.40
4	>31-33	666.01
5	>33-33,5	1082.56
	Total	**8943.97**

Source: Results of the data analysis 2015

4. DISCUSSION

The results showed that higher temperatures generally occur in the downtown area. As the studies that have been run by Maru and Ahmad (2014a) in the city of Jakarta, also found that the high temperatures prevailing in the city center. These regions are dense buildings, vehicles, and less trees. One area that has the highest temperature in the month of May 2015 is Rappocini. This area is a residential area, offices, as well as some public universities. and the private sector. Therefore, the region populated mostly by building (Figure 3) and various types of vehicles such as motorcycles and cars. Additionally, kamacetan also often occur in this region, especially in the morning when people go to the office, and in the afternoon, when people come home from work and school. As the studies that have been conducted by Taha (1997) that the city's air pollution levels reached 10 times in clean air.

In addition, this area also includes busnis center, so this area is visited by the public. Antopogenik activity is quite high, accompanied by the use of electricity is high enough, it also causes the temperature of this region is also higher. In accordance study ever conducted in Taiwan which estimates that every increase in temperature by 1 ° C led to increased use of electricity by 6% (Chang, Li & Chang, 2007; Maru& Ahmad, 2014b; 2014c; 2014d).

Increased temperatures occurring from May to July is significant. It is caused by various factors such as clouds. In May appeared several areas covered by clouds, causing the temperature in the region will be lower in comparison with the surrounding area. Meanwhile, in July the state of the atmosphere is very clean so the heat of the sun can get to the surface of the earth.

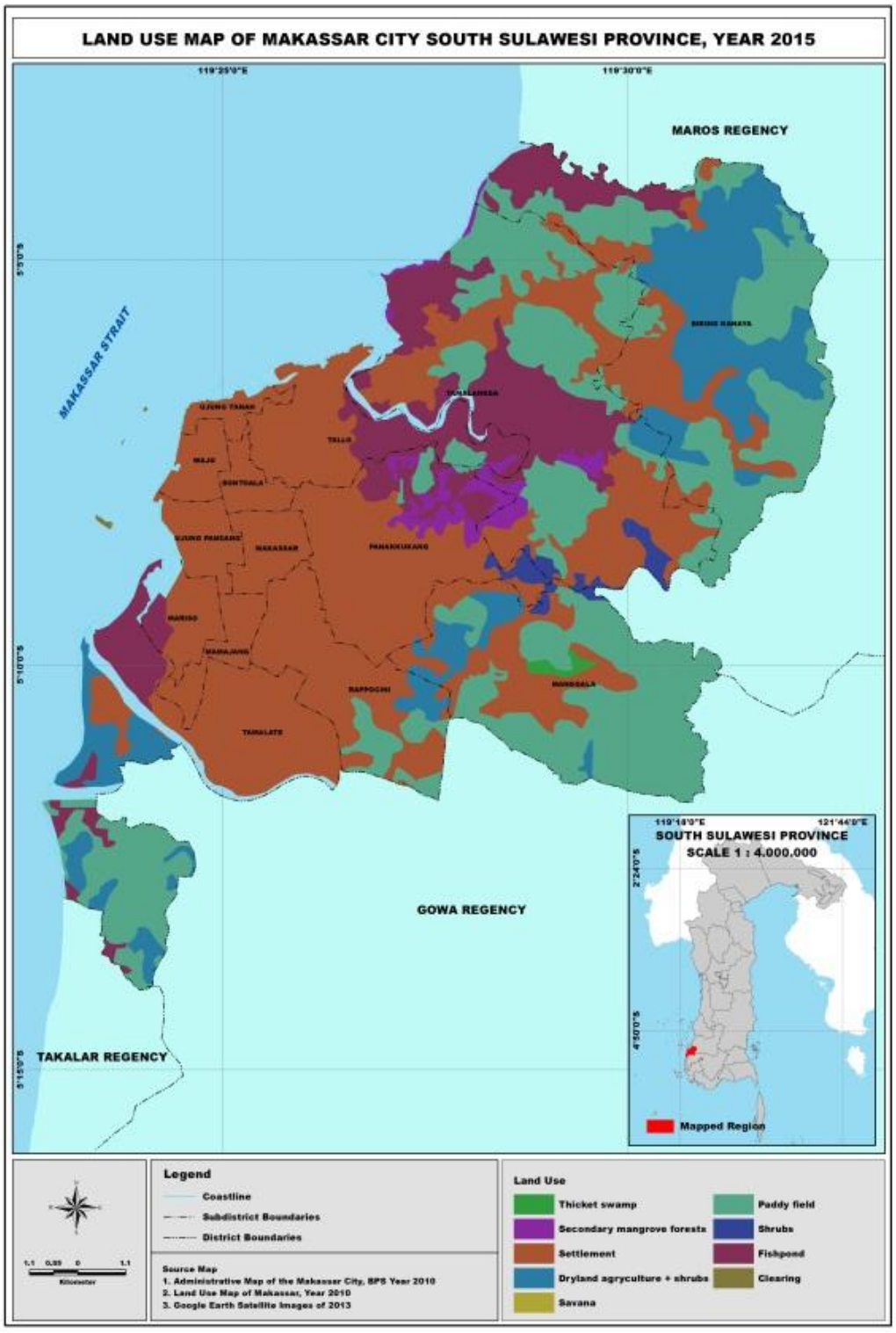

Figure 3. Land Use Map of Makassar

Keep in mind that the presence of clouds can provide two effects, namely withstand the heat of the earth's surface and withstand sunlight that would lead to the earth. Therefore, it can cause the temperature to rise and may also cause the temperature to be lower compared to the surrounding areas.

Makassar temperature is high and it resembles other big cities in Indonesia and the World. Based on the temperature criterion for the population in the tropics (Table 3), the city of Makassar temperature has exceeded the

threshold than the optimum temperature. Therefore, the circumstances cause discomfort to the townspeople, especially temperatures of Makassar. Therefore, it is necessary to seriously handler either by the government, private, and community.

Table 3. Criteria comfort level and effective temperature for tropical regions

Comfort level	Effective temperature (ºC)
Top (rather than accepted) reception	24.5 keatas (76ºF keatas)
Acceptance of the top	22.8–24.5 (73-76ºF)
optimum	20.8 – 22.8 (69 - 73ºF)
Acceptance bottom	18.9 – 20.6 (66 - 69ºF)
Under (rather than accepted) reception	Di bawah 18.9 (di bawah 66ºF)

Source: Wycherley (1967)

5. CONCLUSION

The results showed that in May and July 2015 in the city of Makassar temperature is high enough. and dominated by a temperature> 29 ° C - 31 ° C. In addition, an increase in temperature from May to July, which is characterized by an increase in the breadth of 1.174.56. Ha for temperatures above 33 ° C. Temperature state in Makassar at this time, has exceeded the threshold than the temperature acceptance by humans. Therefore, this UHI phenomenon needs to be addressed seriously and continuously.

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