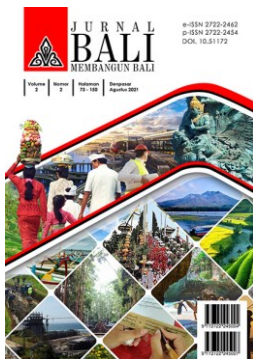




Temperature Comparison of Denpasar City Land Surface before and during the Covid-19 Pandemic

Rizki Cholik Zulkarnain
Dinas Pekerjaan Umum Penataan Ruang, Perumahan, dan Kawasan Permukiman
Email : rizkizack71@gmail.com



Abstrak

Tujuan: Pembatasan kegiatan masyarakat dilakukan oleh Pemerintah Kota Denpasar sebagai upaya untuk menekan angka penyebaran Covid-19. Tujuan dari penelitian ini adalah untuk mengetahui perbandingan *Land Surface Temperature* (LST) di Kota Denpasar sebelum dan selama pandemi Covid-19.

Metode Penelitian: Untuk mengetahui LST digunakan data Citra Landsat 8 yang diolah menggunakan perangkat lunak ArcGIS 10.3.

Hasil dan pembahasan: Penurunan aktivitas antropogenik akibat pembatasan kegiatan masyarakat di masa pandemi Covid-19 mempengaruhi penurunan LST Kota Denpasar. Hal tersebut terbukti dari adanya penurunan rata-rata LST di masa pandemi dibandingkan rata-rata LST sebelum pandemi Covid-19.

Implikasi: Kebijakan pemerintah yang memberlakukan pembatasan kegiatan masyarakat berimplikasi pada penurunan aktivitas antropogenik. Peningkatan maupun penurunan aktivitas antropogenik berpengaruh terhadap peningkatan maupun penurunan LST Kota Denpasar.

Kata Kunci: *Land Surface Temperature*, Covid-19, Citra Landsat 8

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Abstract

Purpose: The purpose of this research was to look at the comparison of Ground Surface Temperature (LST) in Denpasar City before and during the Covid-19 pandemic.

Research methods: To determine the LST used Landsat 8 image data which is processed using ArcGIS 10.3 software.

Results and discussion: Limitation of community activities is carried out by the Denpasar City Government as an effort to reduce the spread of Covid-19. The decrease in anthropogenic activity due to restrictions on community activities during the Covid-19 pandemic affected the decrease in LST in Denpasar City. This is evident from the decrease in the average LST during the pandemic compared to the average LST before the Covid-19 pandemic.

Implication: Government policies that impose restrictions on community activities have implications for decreasing anthropogenic activities. The increase or decrease in anthropogenic activity has an effect on the increase or decrease in LST in Denpasar City.

Keywords: *Land Surface Temperature*, Covid-19, Landsat Imagery 8.

INTRODUCTION

Coronavirus Disease 2019 (Covid-19) is an infectious disease caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). SARS-CoV-2 is a new type of coronavirus that was discovered in Wuhan City, China in December 2019. At least, there are two types of coronavirus that are known to cause diseases that can cause severe symptoms, such as Middle East Respiratory Syndrome (MERS) and

Severe Acute Respiratory Syndrome (MERS). SARS). Common signs and symptoms of Covid-19 infection include symptoms of acute respiratory distress such as fever, cough and shortness of breath. The increase in the number of Covid-19 cases took place quite quickly and spread to various countries, including Indonesia in a relatively short time. On March 11, 2020, WHO finally declared Covid-19 a pandemic.

Since the outbreak of Covid-19 in Indonesia in early 2020, Bali has experienced a fairly severe economic crisis. What happened in Bali tourism due to the pandemic was written for examples in BPS (2020), Yasa (2021), Dewi, et al (2021), Aryawiguna (2021), Puspita, et al (2021), Putra (2021), and Sulistya (2021). Denpasar City is one of the areas with the highest recorded number of corona cases in Bali. It was recorded that the number of Covid-19 cases in Denpasar City as of February 18, 2021 reached 9,632 cases (infocorona.baliprov.go.id, 2021). Reported in denpasar.kompas.com (2020), the Village-based Community Activity Restrictions (PKM) and traditional villages which took effect from May 15, 2020, were taken by the Denpasar City Government as a step to suppress the spread of Covid-19. The implementation of PKM regulates residents' activities such as working, studying, worshiping from home, up to restrictions for residents from outside Denpasar City who will enter urban areas.

On July 9, 2020, the New Normal policy was implemented in Bali to restore the Balinese economy due to the tourism sector which stopped operating (Kristina, 2020). Aly et al. (2020) said the new normal is an adaptation of new habits, which means doing activities by implementing health protocols (wearing masks, implementing a clean and healthy lifestyle, and so on). The implementation of the new normal is carried out by carrying out normal activities but still implementing health protocols to prevent the transmission of Covid-19. Efforts to reduce the spread of the disease are carried out through massive mobility restrictions. As a result of the implementation of mobility restrictions and recommendations not to travel and gather in large numbers, many potential tourists cancel visits to Tourist Attractions (ODTW) (Gunagama et al., 2020).

Hadibasyir et al. (2020) conducted a study on the comparison of Land Surface Temperature (LST) during and before the emergence of Covid-19 using Modis Imagery in Wuhan City, China. The results show that during the emergence of COVID-19 with the implementation of the lockdown policy, namely the end of January 2020 to the beginning of March 2020, the average LST was lower than the average LST for the last three years on the same date. Meanwhile, during the emergence of COVID-19 without a lockdown policy being implemented, i.e. early December 2019 to late January 2020, the average ESG was relatively higher than the LST average for the last three years. According to Yoo, Im, Park, and Cho (2017) and Wang, Zhan, and Ouyang (2017), urbanization, transportation, industry, and settlement are the main activities that have

the potential to increase ESG, all of which are anthropogenic activities. Thus, if an increase in anthropogenic activity will increase ESG, then there is a possibility that a decrease in anthropogenic activity will also cause a decrease in ESG. Regarding the policy of restricting community activities in Denpasar City, this research was conducted to find out the comparison of Denpasar City's LST during and before the Covid-19 pandemic.

RESEARCH METHODS

Land Surface Temperature (LST) is a state controlled by the balance of surface energy, atmosphere, thermal properties of the soil surface and subsurface media (Utomo et al., 2017). Wiguna (2017) reveals that information about ESG is important to know because ESG is a factor that affects the global climate. To find out the comparison of Denpasar City LST before and during the Covid-19 pandemic, Landsat 8 Path 116 Row 66 image data in 2019 and 2020 were used with the minimum level of cloud cover. To represent conditions prior to the Covid-19 pandemic, Landsat 8 imagery data was used September 17, 2019 and Landsat 8 imagery was acquired December 6, 2019. Meanwhile, to represent conditions during the pandemic, Landsat 8 imagery data was used on 11 March 2020 and Landsat 8 imagery dated March 11, 2020. acquisition on May 30, 2020. In addition, the Denpasar City Administrative Boundary Map is used to delineate regional boundaries.

LST is obtained by utilizing the thermal band from Landsat 8 Imagery. The thermal band in Landsat 8 Imagery is found in band 10 and band 11. The LST value is obtained by processing the Digital Number (DN) values of the two using ArcGIS 10.3 software. The processing steps as referred to are described as follows.

1. Convert Digital Numbers to Spectral Radiance

$$L_{\lambda} = M_L \times Q_{CAL} + A_L \quad (1)$$

note:

L_{λ} = Spectral radiance in watts/(m² ster m)

M_L = Band-specific multiplicative rescaling factor

Q_{CAL} = Landsat image pixel value (DN)

A_L = Band-specific additive rescaling factor

2. Convert Spectral Radiance to Brightness Temperature

$$BT = \frac{K_2}{\ln\left[\left(\frac{K_1}{L_{\lambda}}\right) + 1\right]} - 273,15 \quad (2)$$

note:

BT = Temperature of recorded satellite image (oC)

K_1 = Calibration constant

K_2 = Calibration constant

L_λ = Spectral radian in watts/(m² ster m)

3. Calculating the Normalized Difference Vegetation Index (NDVI)

$$NDVI = \frac{NIR-RED}{NIR+RED}$$

note: (3)

NDVI = Vegetation index

NIR = Near infrared band pixel value

RED = Red band pixel value

4. Convert from Brightness Temperature to LST

$$T = BT / \{1 + [(\lambda BT / \rho) \times \ln(e)]\} \quad (4)$$

note:

T = Land Surface Temperature (oC)

BT = Temperature of recorded satellite image (oC)

λ = The wave length of the emitted radiation

$\rho = h \times (c / \sigma) = 1,4388 \times 10^{-2} \text{ m K} = 14.388 \text{ } \mu\text{mK}$

$e = \text{emissivity} = 0,004 \text{ PV} + 0,986$

$PV = [(NDVI - NDVI_{\min}) / (NDVI_{\max} - NDVI_{\min})]^2$

RESULTS AND DISCUSSION

The study area in this research was conducted in Denpasar City, Bali Province, which is geographically located at 8o35'31" – 8o44'49" South Latitude and 115o10'23" – 115o16'27" East Longitude with an area of 127.78 km², 18% of the total area of Bali Province. Denpasar City is the center of the SARBAGITA metropolitan area and the surrounding urban areas have grown and tend to merge with the Badung, Gianyar and Tabanan urban areas. The administrative boundaries of Denpasar City are shown in Figure 1.

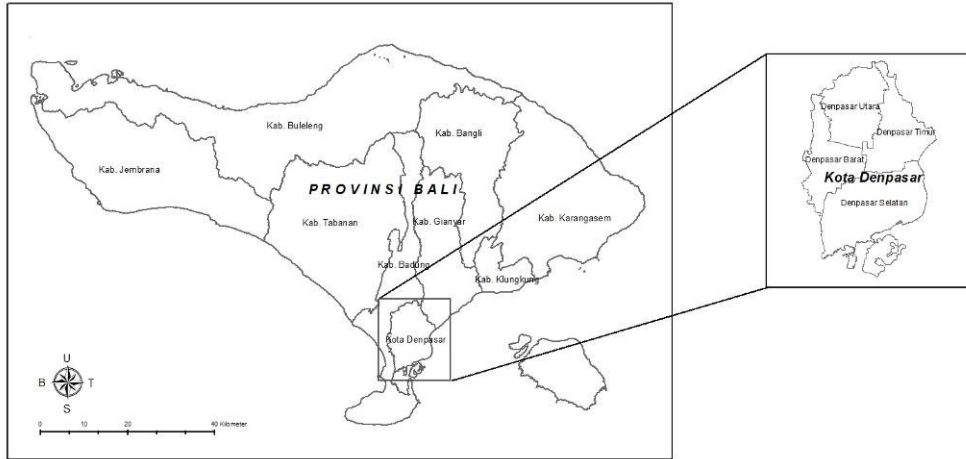


Figure 1. Map of Study Area in Denpasar City, Bali Province

From the results of processing Landsat 8 image data before and during the Covid-19 pandemic in Denpasar City, it was found that the LST trend decreased during the Covid-19 pandemic compared to before the Covid-19 pandemic. The comparison of LST values before and during the Covid-19 pandemic in Denpasar City can be seen in Figure 2.

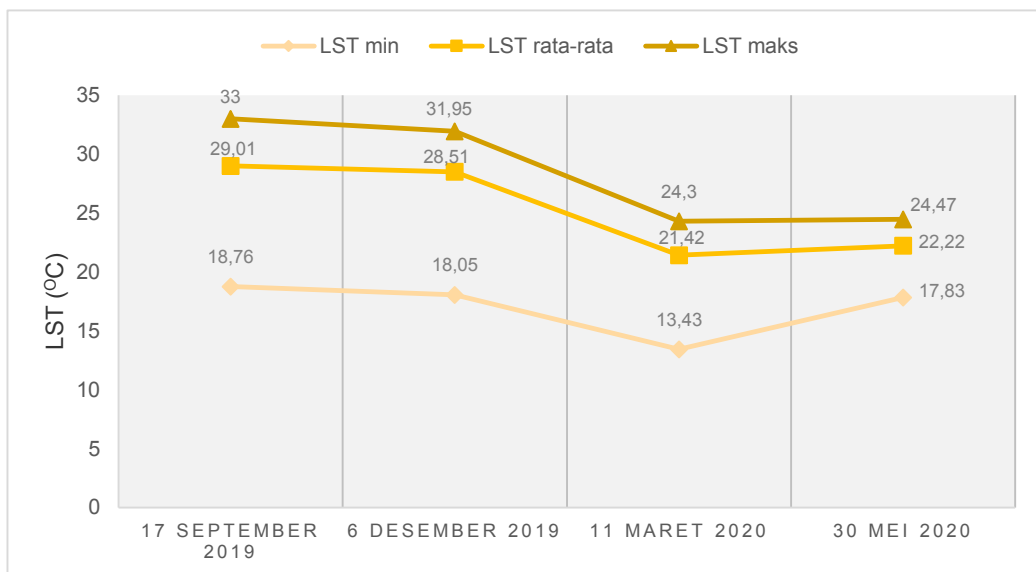


Figure 2. Comparison of ESG Values Before and During the Covid-19 Pandemic in Denpasar City [Source: Author's Analysis, 2021]

Before the Covid-19 pandemic, the average LST obtained from the Landsat image acquisition on September 17, 2019 was 29.01 oC. The LST average that is not much different is obtained from the Landsat image acquired on December 6, 2019, which is 28.51 oC. When compared to during the Covid-19 pandemic, the average LST

obtained has decreased. This is shown by the average LST from the Landsat image acquisition on March 11, 2020, where Covid-19 was announced by the World Health Organization (WHO) as a global pandemic, which was 21.42 oC. The average LST is not much different from the average LST from the image acquisition on May 30, 2020, which is 22.22 oC. Previously, the Denpasar City Government had taken a policy related to the implementation of village-based or village-based and traditional village-based Community Activity Restrictions (PKM) which took effect from 15 May 2020. The policy was implemented to reduce the spread of Covid-19, especially in the Denpasar City area.

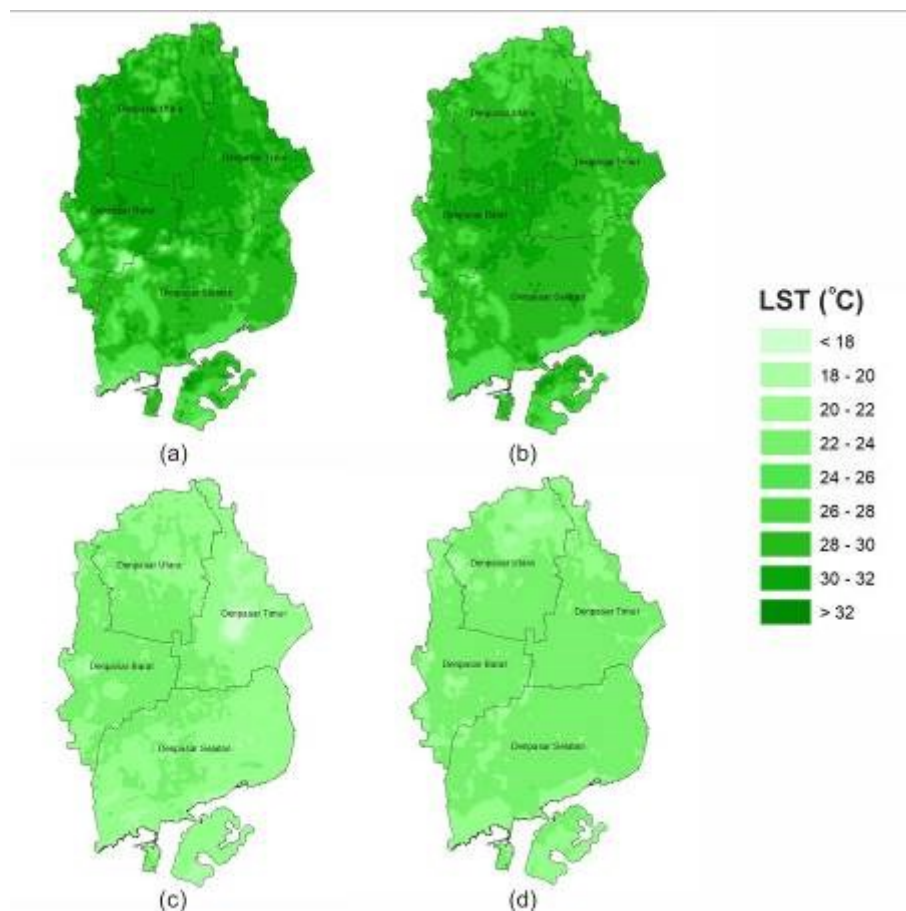


Figure 3. Comparison of LST before and during the Covid-19 pandemic in Denpasar City: (a) acquisition image 17 September 2019; (b) acquisition image 6 December 2019; (c) acquisition image March 11, 2020 (d) image acquisition May 30, 2020

[Source: Author's Analysis, 2021].

Based on Figure 3 above, it can be seen the spatial distribution pattern of Denpasar City LST from each Landsat image recording before and during the Covid-19 pandemic in Denpasar City. Maps (a) and (b) describe the spatial distribution pattern of Denpasar City's LST before the Covid-19 pandemic. While maps (c) and (d) describe

the spatial distribution pattern of Denpasar City LST during the Covid-19 pandemic. When compared, maps (a) and (b) have a darker green distribution pattern than maps (c) and (d) which have a lighter green color distribution pattern. That is, maps (a) and (b) have an ESG distribution pattern with a higher temperature range when compared to maps (c) and (d) which have an ESG distribution with a lower temperature range. The difference in the spatial distribution pattern of LST occurs due to a decrease in anthropogenic activity during the Covid-19 pandemic compared to before the Covid-19 pandemic in Denpasar City. This is inseparable from the policies taken by the government, where restrictions on community activities are carried out as an effort to accelerate the handling of Covid-19.

CONCLUSION

The decrease in anthropogenic activity due to restrictions on community activities during the Covid-19 pandemic affected the decline in Denpasar City's LST. This is shown from the results of the comparison of the average LST processed from Landsat image data, between before and during the Covid-19 pandemic in Denpasar City. The average LST during the pandemic experienced a downward trend when compared to before the Covid-19 pandemic. The implementation of restrictions on community activities during the pandemic is carried out as an effort to accelerate the handling of Covid-19. This policy did not apply before the Covid-19 pandemic. With the implementation of this policy, it has implications for a decrease in anthropogenic activities that affect the decline in Denpasar City's LST during the Covid-19 pandemic.

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