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The Impact of the COVID-19 Pandemic on Land Surface Temperature Change through Remote Sensing Data Processing

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***Abstract*— Various fields can collaborate in analyzing specific phenomena, such as the impact of the COVID-19 pandemic. Most research tends to focus on one aspect of the discipline, such as economics, health, spread predictions, and the like. Given its impact not only on health but also on other aspects, this study utilizes the processing of spatial data derived from satellite imagery using Geographic Information System (GIS) to observe the impact of the pandemic phenomenon on environmental conditions, i.e., surface temperature warming in the city of Bekasi, Indonesia. This research utilizes GIS tools to convert Landsat 7 and Landsat 8 datasets by extracting thermal sensors (Band 10 and Band 11). The test results show an annual increase in temperature, but a decrease of approximately 10 degrees Celsius during the COVID-19 pandemic. This indicates the possibility of reducing temperature by reducing carbon usage as closely as possible to pandemic conditions.**

Keywords—Landsat, LST, Urban Heat Island, COVID-19, RS-GIS

I. Introduction

Global warming is a natural phenomenon that is currently a serious concern [1]–[4]. This is because this phenomenon has an impact on human life, not just on the environment. Global warming can be mitigated by reducing warming in each region, such as reducing greenhouse gas emissions, improving efficiency, increasing vegetation, and so on.

Research on the COVID-19 phenomenon has been extensively conducted, both in terms of its management [5] and predictive calculations [6]. The COVID-19 pandemic condition has forced people to stay indoors, resulting in reduced emissions from transportation. This phenomenon will be investigated in this research to determine how much the surface temperature decreases when vehicle emissions are reduced. If each region follows the recommendations of this research, it is expected to contribute to mitigating global warming. Several studies have investigated global temperature changes by utilizing existing satellite sensors [7]–[11].

The suburbanization phenomenon appears to area near the central city, with the characteristic of the higher growth of the vicinity then the central city [12]. Bekasi City is a suburbanization area of Jakarta, providing an insight into the changes in Land Surface Temperature (LST) during the COVID-19 pandemic.

Most environmental research is still based on qualitative data in assessing the environment [1], [13]. Some experts advocate for reducing vehicle and industrial emissions, but the actual impact is rarely quantified. The occurrence of COVID-19, aside from affecting all aspects of life, can also serve as a crucial basis for the importance of emission reduction, accompanied by real quantitative data derived from Landsat satellite imagery. With this data, objectivity can be ensured, making it a reference for researchers focused on environmental issues. The obtained data is processed with the assistance of computational tools involving Geographic Information Systems (GIS) and modules available in the application.

After explaining the method used to convert satellite images into LST, where the actual surface temperature is known, the results are analyzed to understand the phenomena that occurred during the pandemic conditions (from 2019 to 2021). The conclusion section then provides insights into the phenomena that occurred during those years.

II. Materials and Methods

A. *Materials*

The current study used Landsat 7 and Landsat 8 satellite images for specific dates. The data were obtained from the United States Geological Survey (USGS) through its official website (https://earthexplorer.usgs.gov/). Four capture dates were selected: August 2010 (Landsat 5), August 2013 (Landsat 8), September 2018 (Landsat 8), and September 2021 (Landsat 8). The selection of these time ranges follows the COVID-19 pandemic conditions, which began in early 2020 and extended into 2021 for the Indonesian region.

Therefore, the year 2021 will demonstrate the effects of the COVID-19 pandemic on land surface temperature.

While Landsat 5 used Band 6, Landsat 8 utilized Band 10 and Band 11 [14]. The downloaded files have a size of approximately 1 gigabyte. We need to sign up on the USGS website first to be able to download available satellite images. It's advisable to choose clear (cloud-free) captures, although with GIS Tools, you can remove clouds during the LST creation process.

Satellites are widely available and can be utilized at no cost. Some satellites offer advantages in terms of resolution, the number of sensors, and other facilities. For this research, Landsat was chosen because it provides broad coverage at the city/district level. Additionally, this satellite is equipped with two bands that function as thermal image capturers of the Earth's surface for both daytime and nighttime conditions.

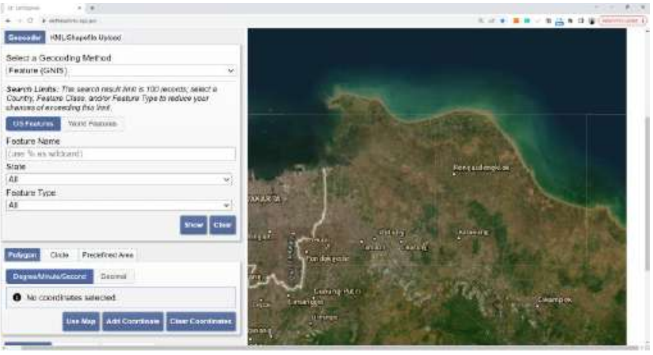


Fig. 1. The region downloaded (Tile) from USGS.

Satellite sensor captures consist of several files that indicate Bands along with important metadata. This metadata serves calibration purposes, such as converting surface temperature to degrees Celsius. Landsat 8 differs from its predecessors (1-7) due to differences in the number of sensors on the launched satellite. In previous Landsat satellites, the thermal sensor was in band 6.

In addition to satellite images in the form of raster data, vector data is needed, which represents the study area, in this case, the city of Bekasi, West Java, Indonesia. This map is used to crop the extensive satellite images that cover the Jakarta Metropolitan Region (JABOTABEK) into the size of the city of Bekasi.

B. Methods

Several GIS tools can be used to create thematic maps of Land Surface Temperature (LST), such as ArcGIS, QGIS, and others. Each tool has its advantages, ease of use, and limitations. However, in principle, they all follow the same process for creating LST maps of an area. Following are the steps to generate LST map.

B.1. Conversion to Top of Atmosphere (TOA) Radiance

In the context of remote sensing and satellite image analysis, the term "radiance" pertains to the transformation process through which the raw sensor data collected by a satellite sensor is converted into radiance values at the top of Earth's atmosphere [15]. This conversion constitutes a crucial step within the data pre-processing workflow for satellite imagery. TOA follows the equation (1):

$$TOA\ (L) = M_L * Q_{CAL} + A_L \qquad (1)$$

Where M_L represents Band-specific multiplicative rescaling factor from the metadata, Q_{CAL} is retrieved from band 10, and A_L is Band-specific additive rescaling factor from the metadata.

B.2. Top of Atmosphere (TOA) to Brightness Temperature conversion

The process of converting TOA Radiance to Brightness Temperature is crucial in remote sensing, particularly in the interpretation of satellite images. A satellite sensor's measurement of brightness temperature determines the surface or object's radiative temperature. The function to change TOA to Brightness Temperature is shown here.

$$BT = (K_2 / (\ln (K_1/L) + 1)) - 273.15 \qquad (2)$$

Where K_1 and K_2 represents Band-specific thermal conversion constant from the metadata.

B.3. Calculate the Normalize Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is a measurement and monitoring tool for the health and density of vegetation in remote sensing and environmental monitoring. The difference between the Earth's surface and plants' ability to absorb IR and visible light is measured by NDVI. The NDVI generates numerical values between -1 and +1, which are typically interpreted as follows:

$$NDVI = (Band\ 5 - Band\ 4) / (Band\ 5 + Band\ 4) \qquad (3)$$

B.4. Calculate the proportion of vegetation P_v

Vegetation proportion to determine emissivity in the study area.

$$P_v = Sqr((NDVI - NDVI_{min})/(NDVI_{max} - NDVI_{min})) \qquad (4)$$

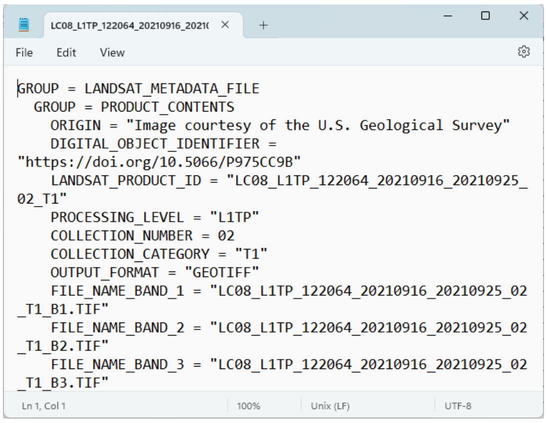
B.5. Calculate Emissivity ε

$$\varepsilon = 0.004 * P_v + 0.986 \qquad (5)$$

B.6. Calculate the Land Surface Temperature

$$LST = (BT/(1 + (0.00115 * BT / 1.4388) * Ln(\varepsilon))) \qquad (6)$$

The surface temperature map can then be obtained by applying the LST equation. The raster calculator can be used to calculate equations 1-6, including calculations involving raster data (Band 10 and the Bands involved in the NDVI composite image). Figure 2 shows the metadata used for these calculations.



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    COLLECTION_NUMBER = 02
    COLLECTION_CATEGORY = "T1"
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_T1_B2.TIF"
    FILE_NAME_BAND_3 = "LC08_L1TP_122064_20210916_20210925_02
_T1_B3.TIF"
```

Fig. 2. Metadata file from downloaded USGS.

In this research, the RS&GIS plugin in Quantum GIS is utilized. This plugin integrates metadata with the required bands (4, 5, 10, and 11). By simply inputting the compressed files downloaded from USGS and the shapefile of the research area, it generates an output consisting of a raster map accompanied by surface temperature ranges.

III. Result and Discussion

Four-time ranges (2010, 2013, 2018, and 2021) were used to create LST maps. ArcGIS was used to obtain LST maps using equations 1 to 6, while QGIS has the RS&GIS plugin that directly converts the downloaded dataset (in tar.gz format). Another option is to specify the folder or file resulting from the extraction of the tar.gz file. We may need to rename the file if the downloaded file is in tar format and not tar.gz.

Thermal bands can be directly used to determine the distribution of surface temperature (Band 6 for Landsat 7 and Band 10 and 11 for Landsat 8); however, to obtain its precise values, calibration with the metadata files accompanying the downloaded satellite images (txt file) is required.

A. Land Surface Tempature Map

Figure 3 illustrates the RS&GIS plugin used for generating LST. The input consists of compressed files from USGS and a shapefile of the study area. Make sure to check the "extra derived output", i.e., LST, at the end. For a visual demonstration of the LST generation process, you can watch it at https://www.youtube.com/watch?v=e_P6UIs4Tv4.

The processed output is a TIF file with standard projection and coordinates. For further processing, it can be integrated with a base map, such as a street map or satellite view, to facilitate the visualization of real locations.

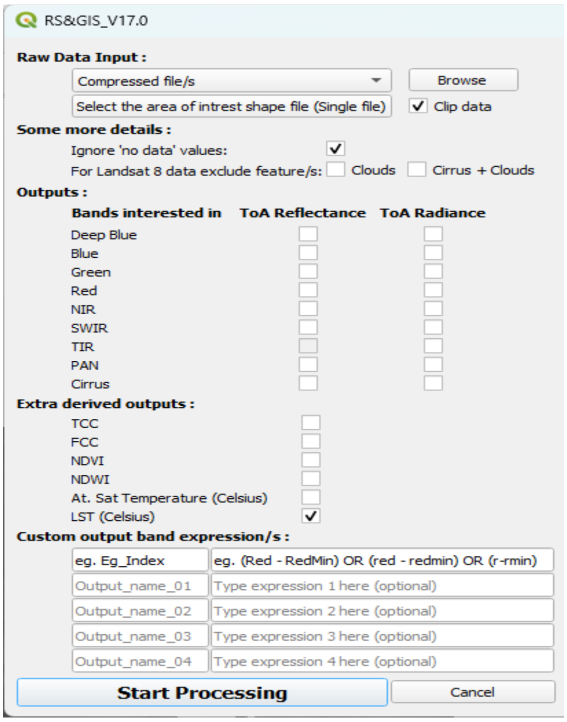

Fig. 3. Metadata file from downloaded USGS.

To remove interference from clouds, specifically for Landsat 8, you can check the "Clouds" and "Cirrus + Clouds" options in the 'For Landsat 8 data exclude feature/s' section. Clouds can affect the accuracy of LST since clouds have the characteristic of low temperature. The cloud issue can be addressed using the features available in the LST module of QGIS for Landsat 8. These features include eliminating 'no data' values as well as excluding clouds and cirrus+clouds.

Figure 4 shows the range of temperature of LST map after calibration using RS&GIS plugin in QGIS. In essence, band 10 and band 11 can be directly used to observe the distribution of heat in an area. However, to determine the exact surface temperature in degrees, calibration following equations 1 to 6 is necessary. In QGIS, these calculations can be performed through the LST module (Figure 3). For other applications, such as ArcGIS, it is necessary to perform this using the raster calculator after reviewing the file metadata (Figure 2).

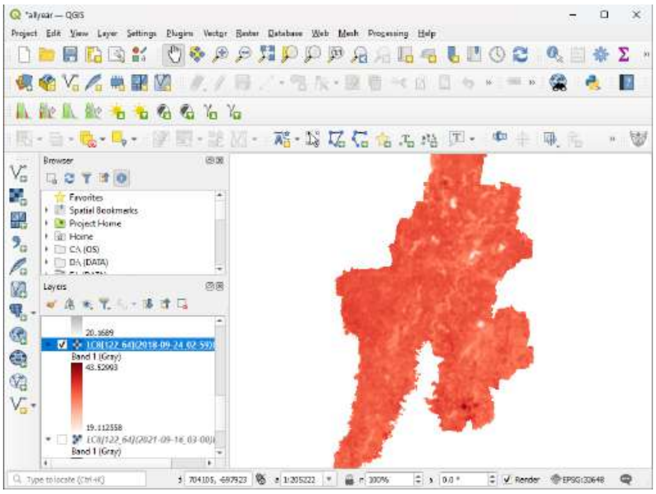

Fig. 4. LST Maps.

Gradually, the pixel colors represent surface temperatures ranging from low temperature (minimum) to high temperature (maximum) from bright red to dark-red colors. Figure 5 shows the temperature graph for four different time ranges of the experimental results. The graph shows a gradual increase in temperature each year, reaching its peak in 2018. It is possible that the temperature continued to rise until the implementation of work from home for workers in Bekasi, including Jakarta, Bogor, and Tangerang. This resulted in a decrease in temperature during the COVID-19 pandemic. Here, the year 2021 is considered when the outbreak began to subside, and some residents were allowed to leave their homes with certain restrictions (PSBB). The experimental results indicate a decrease in temperature of approximately 10 degrees Celsius during the COVID-19 pandemic.

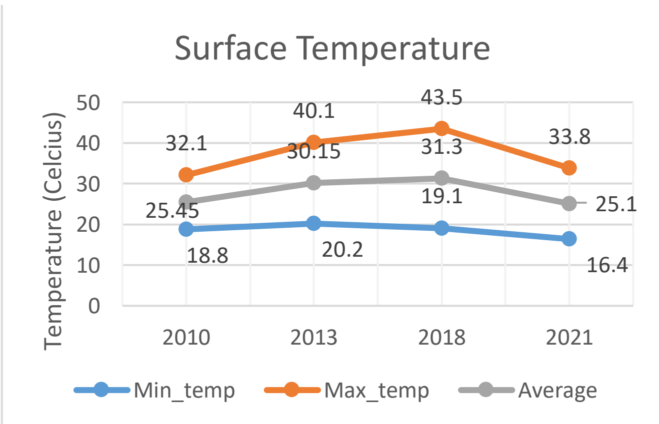

Fig. 5. Daytime Land Surface Temperature

For Landsat 8, Band 10 and Band 11 are used to calculate land surface temperature [16]. Whereas Band 10 is used for calculating daytime temperature, Band 11 is used to measure surface temperature at night with a longer infrared wavelength compared to Band 10. For the year 2010, considering the use of Landsat 5, only one band was used, which is Band 6, primarily used for capturing daytime imagery [10].

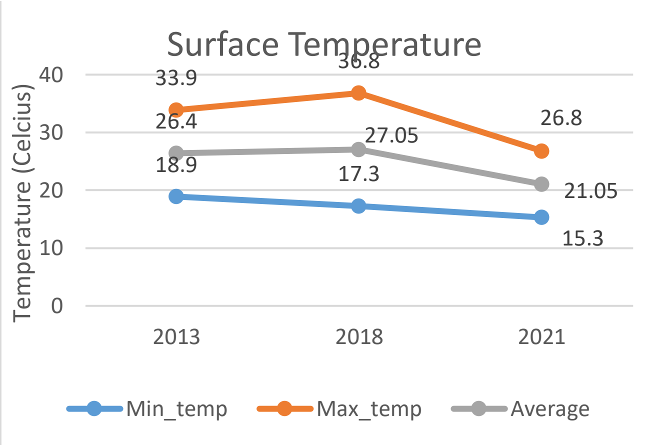

Fig. 6. Nighttime Land Surface Temperature

Figure 6 shows nighttime temperatures for the years 2013, 2018, and 2021. The sensor used here is Band 11. The year 2010 is not included because only Band 6 with daytime wavelength data was available. The temperature difference between day and night is approximately 7 degrees Celsius.

To facilitate users in determining the real location, the use of a base map is essential. Figure 7 demonstrates the use of Open Street Map (OSM) as a base map.

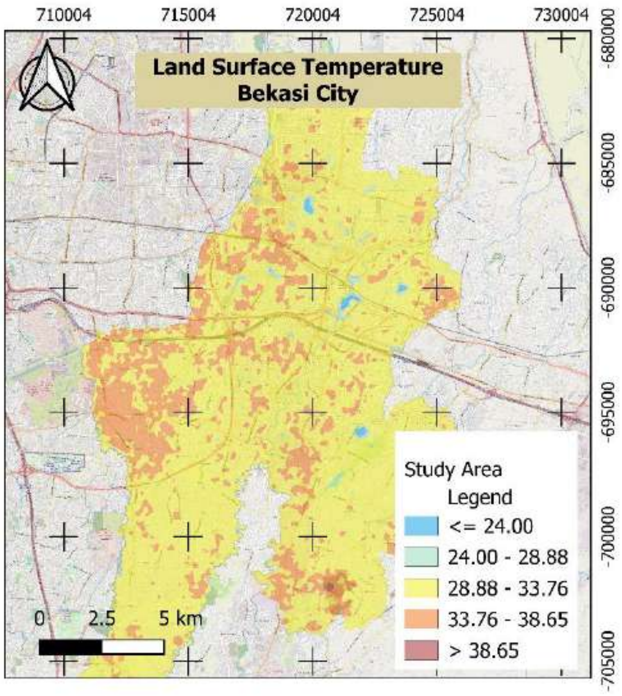

Fig. 7. Land Surface Temperature with OSM Base Map

Figure 7 shows the hottest conditions in the city of Bekasi before the COVID-19 pandemic, specifically in the year 2018. Some locations with surface temperatures are visible on the Land Surface Temperature (LST) map, including the border with Jakarta, industrial areas in the east, and the Bantargebang landfill in the southern part. Some locations indicate lower temperatures, such as along the rivers and reservoirs/lakes. Most Bekasi City experiences temperatures ranging from 29 to 34 degrees Celsius.

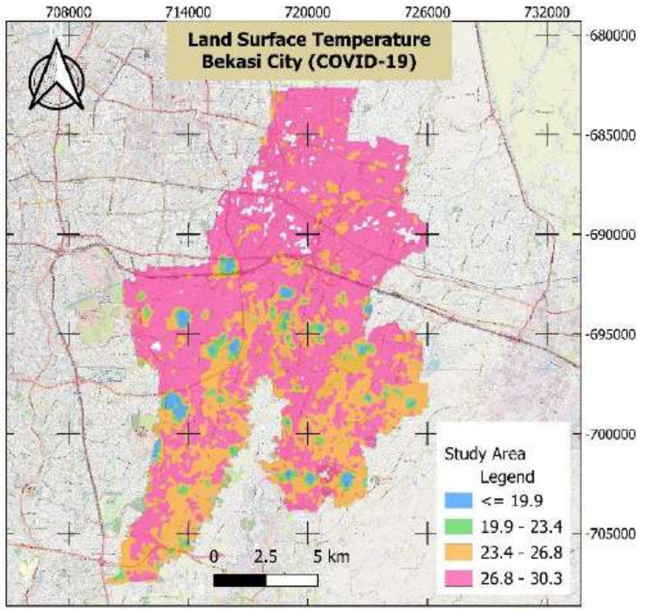

Fig. 8. Land Surface Temperature with OSM Base Map (COVID-19 Pandemic)

The COVID-19 pandemic conditions show a decrease in temperature, both maximum and minimum temperatures. Figure 8 depicts the average temperature during COVID-19 ranging from 26.8 to 30.3 degrees Celsius, or a decrease of 3 to 4 degrees Celsius. The World Health Organization (WHO) officially announced that the COVID-19 pandemic ended in 2022 [19]. Therefore, it is likely that surface temperatures will increase again to pre-COVID-19 levels.

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COVID-19, which resulted in the implementation of work from home, has a direct impact on the decrease in land surface temperature (LST). Several industries that rely on fossil fuel combustion, as well as vehicles traveling on the roads in Bekasi, have been shown to raise land surface temperatures, in addition to air pollution that poses a threat to human health.

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Bekasi City, which has a low slope (approximately 0 to 2 percent).[21].

IV. Conclusions

This study discusses the phenomenon of a decrease in surface temperature under specific conditions, in this case, COVID-19. Using Landsat data from the USGS, precise temperature data for the years 2010, 2013, 2018, and 2021 were obtained. The results prove a decrease of approximately 10 degrees during COVID-19 both for daytime and nighttime. This provides input to the government to reduce vehicle exhaust emissions in order to lower surface temperatures due to the greenhouse effect.

Acknowledgment

The authors thank to Universitas Bhayangkara Jakarta Raya for funding this research, Universitas Islam 45 Bekasi, and reviewers for suggestion and comments.

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The Impact of the COVID-19 Pandemic on Land Surface Temperature Change through Remote Sensing Data Processing

by Herlawati Herlawati

The Impact of the COVID-19 Pandemic on Land Surface Temperature Change through Remote Sensing Data Processing

***Abstract*— Various fields can collaborate in analyzing specific phenomena, such as the impact of the COVID-19 pandemic. Most research tends to focus on one aspect of the discipline, such as economics, health, spread predictions, and the like. Given its impact not only on health but also on other aspects, this study utilizes the processing of spatial data derived from satellite imagery using Geographic Information System (GIS) to observe the impact of the pandemic phenomenon on environmental conditions, i.e., surface temperature warming in the city of Bekasi, Indonesia. This research utilizes GIS tools to convert Landsat 7 and Landsat 8 datasets by extracting thermal sensors (Band 10 and Band 11). The test results show an annual increase in temperature, but a decrease of approximately 10 degrees Celsius during the COVID-19 pandemic. This indicates the possibility of reducing temperature by reducing carbon usage as closely as possible to pandemic conditions.**

Keywords—Landsat, LST, Urban Heat Island, COVID-19, RS-GIS

I. Introduction

Global warming is a natural phenomenon that is currently a serious concern [1]–[4]. This is because this phenomenon has an impact on human life, not just on the environment. Global warming can be mitigated by reducing warming in each region, such as reducing greenhouse gas emissions, improving efficiency, increasing vegetation, and so on.

Research on the COVID-19 phenomenon has been extensively conducted, both in terms of its management [5] and predictive calculations [6]. The COVID-19 pandemic condition has forced people to stay indoors, resulting in reduced emissions from transportation. This phenomenon will be investigated in this research to determine how much the surface temperature decreases when vehicle emissions are reduced. If each region follows the recommendations of this research, it is expected to contribute to mitigating global warming. Several studies have investigated global temperature changes by utilizing existing satellite sensors [7]–[11].

The suburbanization phenomenon appears to area near the central city, with the characteristic of the higher growth of the vicinity then the central city [12]. Bekasi City is suburbanization area of Jakarta, providing an insight into the changes in Land Surface Temperature (LST) during the COVID-19 pandemic.

Most environmental research is still based on qualitative data in assessing the environment [1], [13]. Some experts advocate for reducing vehicle and industrial emissions, but the actual impact is rarely quantified. The occurrence of COVID-19, aside from affecting all aspects of life, can also serve as a crucial basis for the importance of emission reduction, accompanied by real quantitative data derived from Landsat satellite imagery. With this data, objectivity can be ensured, making it a reference for researchers focused on environmental issues. The obtained data is processed with the assistance of computational tools involving Geographic Information Systems (GIS) and modules available in the application.

After explaining the method used to convert satellite images into LST, where the actual surface temperature is known, the results are analyzed to understand the phenomena that occurred during the pandemic conditions (from 2019 to 2021). The conclusion section then provides insights into the phenomena that occurred during those years.

II. Materials and Methods

A. Materials

The current study used Landsat 7 and Landsat 8 satellite images for specific dates. The data were obtained from the United States Geological Survey (USGS) through its official website (https://earthexplorer.usgs.gov/). Four capture dates were selected: August 2010 (Landsat 5), August 2013 (Landsat 8), September 2018 (Landsat 8), and September 2021 (Landsat 8). The selection of these time ranges follows the COVID-19 pandemic conditions, which began in early 2020 and extended into 2021 for the Indonesian region. Therefore, the year 2021 will demonstrate the effects of the COVID-19 pandemic on land surface temperature.

While Landsat 5 used Band 6, Landsat 8 utilized Band 10 and Band 11 [14]. The downloaded files have a size of approximately 1 gigabyte. We need to sign up on the USGS website first to be able to download available satellite images. It's advisable to choose clear (cloud-free) captures, although with GIS Tools, you can remove clouds during the LST creation process.

Satellites are widely available and can be utilized at no cost. Some satellites offer advantages in terms of resolution, the number of sensors, and other facilities. For this research, Landsat was chosen because it provides broad coverage at the city/district level. Additionally, this satellite is equipped with two bands that function as thermal image capturers of the Earth's surface for both daytime and nighttime conditions.

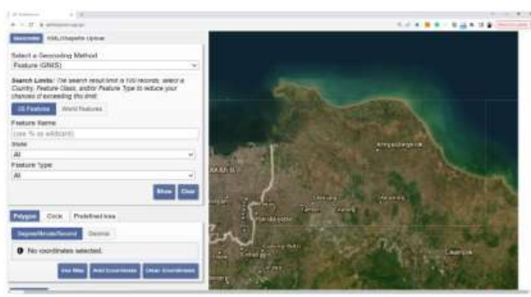


Fig. 1. The region downloaded (Tile) from USGS.

Satellite sensor captures consist of several files that indicate Bands along with important metadata. This metadata serves calibration purposes, such as converting surface temperature to degrees Celsius. Landsat 8 differs from its predecessors (1-7) due to differences in the number of sensors on the launched satellite. In previous Landsat satellites, the thermal sensor was in band 6.

In addition to satellite images in the form of raster data, vector data is needed, which represents the study area, in this case, the city of Bekasi, West Java, Indonesia. This map is used to crop the extensive satellite images that cover the Jakarta Metropolitan Region (JABOTABEK) into the size of the city of Bekasi.

B. Methods

Several GIS tools can be used to create thematic maps of Land Surface Temperature (LST), such as ArcGIS, QGIS, and others. Each tool has its advantages, ease of use, and limitations. However, in principle, they all follow the same process for creating LST maps of an area. Following are the steps to generate LST map.

B.1. Conversion to Top of Atmosphere (TOA) Radiance

In the context of remote sensing and satellite image analysis, the term "radiance" pertains to the transformation process through which the raw sensor data collected by a satellite sensor is converted into radiance values at the top of Earth's atmosphere [15]. This conversion constitutes a crucial step within the data pre-processing workflow for satellite imagery. TOA follows the equation (1):

$$TOA\ (L) = M_L * Q_{CAL} + A_L \quad (1)$$

Where M_L represents Band-specific multiplicative rescaling factor from the metadata, Q_{CAL} is retrieved from band 10, and A_L is Band-specific additive rescaling factor from the metadata.

B.2. Top of Atmosphere (TOA) to Brightness Temperature conversion

The process of converting TOA Radiance to Brightness Temperature is crucial in remote sensing, particularly in the interpretation of satellite images. A satellite sensor's measurement of brightness temperature determines the surface or object's radiative temperature. The function to change TOA to Brightness Temperature is shown here.

$$BT = (K_2 / (\ln (K_1/L) + 1)) - 273.15 \quad (2)$$

Where K_1 and K_2 represents Band-specific thermal conversion constant from the metadata.

B.3. Calculate the Normalize Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is a measurement and monitoring tool for the health and density of vegetation in remote sensing and environmental monitoring. The difference between the Earth's surface and plants' ability to absorb IR and visible light is measured by NDVI. The NDVI generates numerical values between -1 and +1, which are typically interpreted as follows:

$$NDVI = (Band\ 5 - Band\ 4) / (Band\ 5 + Band\ 4) \quad (3)$$

B.4. Calculate the proportion of vegetation P_v

Vegetation proportion to determine emissivity in the study area.

$$P_v = Sqr((NDVI\text{-}NDVI_{min})/(NDVI_{max}\text{-}NDVI_{min})) \quad (4)$$

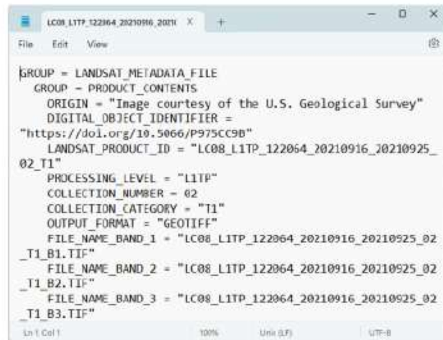
B.5. Calculate Emissivity ε

$$\varepsilon = 0.004 * P_v + 0.986 \quad (5)$$

B.6. Calculate the Land Surface Temperature

$$LST = (BT/(1 + (0.00115 * BT / 1.4388) * Ln(\varepsilon))) \quad (6)$$

The surface temperature map can then be obtained by applying the LST equation. The raster calculator can be used to calculate equations 1-6, including calculations involving raster data (Band 10 and the Bands involved in the NDVI composite image). Figure 2 shows the metadata used for these calculations.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"https://doi.org/10.5066/P975CC9B"
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    COLLECTION_NUMBER = 02
    COLLECTION_CATEGORY = "T1"
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_T1_B3.TIF"
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Fig. 2. Metadata file from downloaded USGS.

In this research, the RS&GIS plugin in Quantum GIS is utilized. This plugin integrates metadata with the required bands (4, 5, 10, and 11). By simply inputting the compressed files downloaded from USGS and the shapefile of the research area, it generates an output consisting of a raster map accompanied by surface temperature ranges.

III. Result and Discussion

Four-time ranges (2010, 2013, 2018, and 2021) were used to create LST maps. ArcGIS was used to obtain LST maps using equations 1 to 6, while QGIS has the RS&GIS plugin that directly converts the downloaded dataset (in tar.gz format). Another option is to specify the folder or file resulting from the extraction of the tar.gz file. We may need to rename the file if the downloaded file is in tar format and not tar.gz.

Thermal bands can be directly used to determine the distribution of surface temperature (Band 6 for Landsat 7 and Band 10 and 11 for Landsat 8); however, to obtain its precise values, calibration with the metadata files accompanying the downloaded satellite images (txt file) is required.

A. Land Surface Tempature Map

Figure 3 illustrates the RS&GIS plugin used for generating LST. The input consists of compressed files from USGS and a shapefile of the study area. Make sure to check the "extra derived output", i.e., LST, at the end. For a visual demonstration of the LST generation process, you can watch it at https://www.youtube.com/watch?v=e_P6UIs4Tv4.

The processed output is a TIF file with standard projection and coordinates. For further processing, it can be integrated with a base map, such as a street map or satellite view, to facilitate the visualization of real locations.

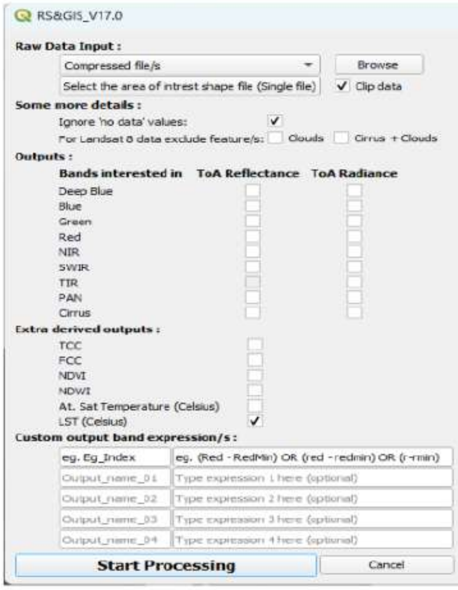


Fig. 3. Metadata file from downloaded USGS.

To remove interference from clouds, specifically for Landsat 8, you can check the "Clouds" and "Cirrus + Clouds" options in the 'For Landsat 8 data exclude feature/s' section. Clouds can affect the accuracy of LST since clouds have the characteristic of low temperature. The cloud issue can be addressed using the features available in the LST module of QGIS for Landsat 8. These features include eliminating 'no data' values as well as excluding clouds and cirrus+clouds.

Figure 4 shows the range of temperature of LST map after calibration using RS&GIS plugin in QGIS. In essence, band 10 and band 11 can be directly used to observe the distribution of heat in an area. However, to determine the exact surface temperature in degrees, calibration following equations 1 to 6 is necessary. In QGIS, these calculations can be performed through the LST module (Figure 3). For other applications, such as ArcGIS, it is necessary to perform this using the raster calculator after reviewing the file metadata (Figure 2).

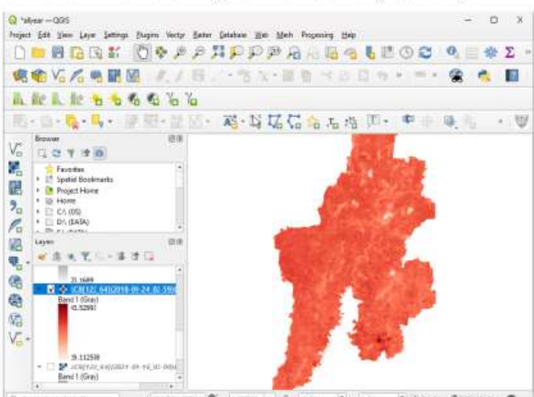


Fig. 4. LST Maps.

Gradually, the pixel colors represent surface temperatures ranging from low temperature (minimum) to high temperature (maximum) from bright red to dark-red colors. Figure 5 shows the temperature graph for four different time ranges of the experimental results. The graph shows a gradual increase in temperature each year, reaching its peak in 2018. It is possible that the temperature continued to rise until the implementation of work from home for workers in Bekasi, including Jakarta, Bogor, and Tangerang. This resulted in a decrease in temperature during the COVID-19 pandemic. Here, the year 2021 is considered when the outbreak began to subside, and some residents were allowed to leave their homes with certain restrictions (PSBB). The experimental results indicate a decrease in temperature of approximately 10 degrees Celsius during the COVID-19 pandemic.

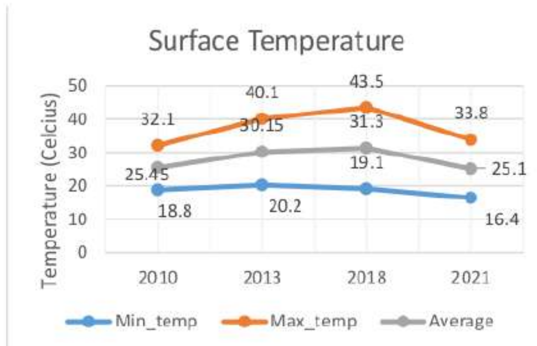


Fig. 5. Daytime Land Surface Temperature

For Landsat 8, Band 10 and Band 11 are used to calculate land surface temperature [16]. Whereas Band 10 is used for calculating daytime temperature, Band 11 is used to measure surface temperature at night with a longer infrared wavelength compared to Band 10. For the year 2010, considering the use of Landsat 5, only one band was used, which is Band 6, primarily used for capturing daytime imagery [10].

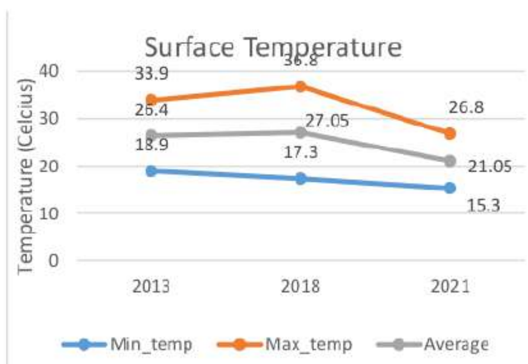


Fig. 6. Nighttime Land Surface Temperature

Figure 6 shows nighttime temperatures for the years 2013, 2018, and 2021. The sensor used here is Band 11. The year 2010 is not included because only Band 6 with daytime wavelength data was available. The temperature difference between day and night is approximately 7 degrees Celsius.

To facilitate users in determining the real location, the use of a base map is essential. Figure 7 demonstrates the use of Open Street Map (OSM) as a base map.

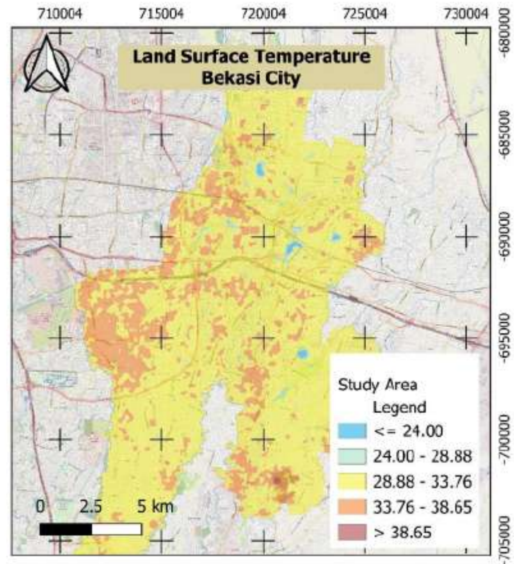
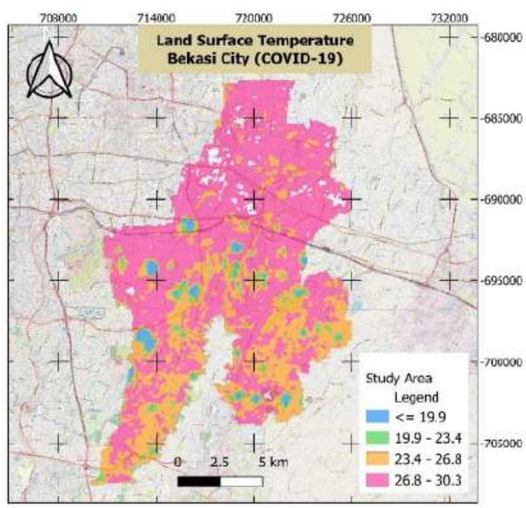


Fig. 7. Land Surface Temperature with OSM Base Map

Figure 7 shows the hottest conditions in the city of Bekasi before the COVID-19 pandemic, specifically in the year 2018. Some locations with surface temperatures are visible on the Land Surface Temperature (LST) map, including the border with Jakarta, industrial areas in the east, and the Bantargebang landfill in the southern part. Some locations indicate lower temperatures, such as along the rivers and reservoirs/lakes. Most Bekasi City experiences temperatures ranging from 29 to 34 degrees Celsius.



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The Impact of the COVID-19 Pandemic on Land Surface Temperature Change through Remote Sensing Data Processing

for his/her participation as Best Paper in The 9th International Conference on Computing, Engineering and Design (ICCED 2023) at International Islamic University Malaysia

Kuala Lumpur, 7 - 8th November 2023

ICED 2023

Prof. Ir. Teddy Mantoro, M.Sc., PhD., SMIEEE
General Chair ICCED 2023

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PAPER: 407

Reviewer Response

REVIEWER 1

The review identifies several areas for improvement in the paper. First, the background lacks depth, with no explanation for the choice of Bekasi as the study area or the selected research methodology. Second, issues with image clarity, notably in Figures 1 and 3, where numbers overlap and are unclear, need attention. Lastly, there's an inconsistency in temperature comparisons: while the discussion mentions a 7-degree difference between day and night temperatures, the LST map comparison reports a 3–4-degree difference between 2018 and 2021. Clarity is needed regarding whether the 7-degree difference pertains to diurnal variations or yearly changes during the COVID-19 period. These suggestions aim to enhance the paper's overall quality and coherence.

Author’s Response

Thank you for the suggestion and correction. We have made the Figure 1 and 3 clearer as well as the inconsistency of the temperature comparison as follows, “The results prove a decrease of approximately 10 degrees during COVID-19 both for daytime and night-time”, in conclusions as well as abstract.

REVIEWER 2

Abstract/ Introduction: The author can give short reasons of choosing Bekasi area in research.
Literature Review: Methods, references and previous research have been explained well, clearly and coherently between one paragraph and the next.
Conclusion: The author can give more description of the results.

Author’s Response

Thank you for the comment. We have made the conclusion more descriptive similar to Reviewer 1 suggestion.

REVIEWER 3

Major revisions
1.the background of the research written is not so easy to identify. Please write in more detail the background, objectives and issues raised.
2. The research theme cannot be identified as to its novelty and urgency. Please explain it!

Author’s Response

Thank you for the suggestions. We have added the explanation as follows, “Most environmental research is still based on qualitative data in assessing the environment [1], [13]. Some experts advocate for reducing vehicle and industrial emissions, but the actual impact is rarely quantified. The occurrence of COVID-19, aside from affecting all aspects of life, can also serve as a crucial basis for the importance of emission reduction, accompanied by real quantitative data ..” to show the contribution as well as easy to identify the background.

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SURAT TUGAS
Nomor: ST/1181/XI/2023/FASILKOM-UBJ

Pertimbangan : Dalam rangka mewujudkan Tri Dharma Perguruan Tinggi untuk Dosen di Universitas Bhayangkara Jakarta Raya maka dihimbau untuk melakukan penelitian.

Dasar :
1. Kalender Akademik Universitas Bhayangkara Jakarta Raya Tahun Akademik 2023/2024;
2. Rencana Kerja dan Anggaran Pembelanjaan Universitas Bhayangkara Jakarta Raya Tahun 2023.

DITUGASKAN

Kepada : Personil yang namanya tercantum dalam Surat Tugas ini.

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Untuk :
1. Membuat Artikel Ilmiah dengan judul ***"The Impact of the COVID-19 Pandemic on Land Surface Temperature Change through Remote Sensing Data Processing"*** dalam kegiatan *The 9th International Conference on Computing, Engineering and Design (ICCED 2023) at International Islamic University Malaysia.*
2. Yang dilaksanakan pada:
   Hari : Selasa s.d Rabu
   Tanggal : 07 November 2023 s.d 08 November 2023
   Melalui : *Hybrid* (*Offline* dan *Online*)
   Penyelenggara : *International Conference on Computing, Engineering, and Design* (ICCED) 2023
3. Melaporkan hasil pelaksanaan kepada Dekan Fakultas Ilmu Komputer Universitas Bhayangkara Jakarta Raya.
4. Melaksanakan tugas ini dengan penuh tanggung jawab.

Jakarta, 02 November 2023
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