ICDSOS
The 3rd International Conference on Data Science and Official Statistics
November 27 - 28, 2025
"From Data to Impact: Leveraging Innovation in Data Science and Official Statistics for Data-Driven Policy Making and Global Competitiveness"

Correlation Analysis of Land Surface Temperature (LST) and Vegetation Density Using Landsat 8 and 5 Imagery in Purwakarta Regency

A Ainulmila[1], S Tiana[2], K N Mumtaz[3], D S F Azhari[4], F Ibrahim[5], and T S Anggraini[6]

[1] Geographic Information Sciences, Universitas Pendidikan Indonesia

*Corresponding author's email: taniasepti@upi.edu

Abstract. Urbanization and industrial development in urban areas have led to a decrease in vegetation and an increase in land surface temperature. This phenomenon impacts microclimate change and environmental quality, as seen in Purwakarta Regency. The conversion of vegetated land into industrial and residential areas reduces the vegetation index. This vegetation index can be measured using the Normalized Difference Vegetation Index (NDVI) method. Meanwhile, monitoring the increase in surface temperature can be calculated using the Land Surface Temperature (LST) method, which can indicate physical changes on the Earth's surface. The purpose of this study is to analyze the relationship between vegetation density and the increase in surface temperature using remote sensing and Geographic Information System (GIS) methods. The analysis results show that vegetated land area decreased significantly from 67,564.8 ha (2004) to 44,970 ha (2024), while built-up land increased threefold. In the same period, the average surface temperature increased from 37.31°C to 40.41°C. The correlation analysis shows a strong positive correlation between the decrease in NDVI and the increase in LST, with a correlation coefficient of 0.707 in 2024.

Keywords: Land Surface Temperature (LST), Correlation, vegetated land.

1. Introduction

The growth of an urban area is directly proportional to the development and land use change in the city, accompanied by an increase in population. A city can be defined as the center of economic activity, government, and settlement. The completeness of facilities in urban areas becomes an attraction for the community, which is why urban areas tend to be more densely populated than rural areas. The phenomenon of population migration from rural to urban areas influences the increase in the urban population [1]. As a result of population growth and the massive flow of urbanization, the vegetation index and urban quality decrease, causing an increase in land surface temperature. According to [2], the conversion of vegetated land into built-up land impacts microclimate change in urban areas, thus increasing the surface temperature on Earth. Changes in land cover and the increase in surface temperature certainly cause a domino effect such as land degradation, disruption of ecosystem carrying capacity, threats to animal or plant habitats, and so on [3][4][5]. This study attempts to identify changes in land cover in Purwakarta Regency, Indonesia, and identify its impact on changes in the Earth's surface temperature. The loss of vegetated land and the increase in surface temperature in Purwakarta Regency are still influenced by the rapid growth of the industrial sector. Along with the increasing number of industries, vegetated lands such as forests, agricultural areas, and plantations are being converted into industrial and residential areas. This growth in the industrial sector not only changes the physical landscape of Purwakarta Regency but also directly affects its climate and ecosystems. Therefore, the presence of vegetation is crucial in maintaining ecosystem balance [6].

Purwakarta Regency was chosen as the research location because it has geographical, geological, and ecological characteristics that are very interesting to study in the context of the relationship between vegetation density (NDVI) and surface temperature (LST). Purwakarta Regency also has a variety of landforms, including alluvial, structural, and denudational areas, as well as areas that are lava plugs from past volcanic activity. Purwakarta Regency has a hot climate, which allows for temperature increases that impact environmental quality and food security, especially during El Niño events, which have caused and may continue to cause significant drought in this area, affecting agriculture and vegetation. In recent years, this region has experienced changes in land cover due to development and tourism activities, which have the potential to cause a decrease in vegetation density and an increase in soil surface temperature. To understand this phenomenon, a correlation analysis between NDVI and LST was used, as NDVI is able to describe the level of vegetation density and LST shows the spatial distribution of surface temperature.

This study will utilize geospatial technology, Earth observation satellites, to monitor changes in land cover and their impact on the Earth's surface temperature. Landsat 8 and Landsat 5 imagery have advantages because they can efficiently and effectively observe the Earth's surface regarding surface temperature and vegetation density using predetermined algorithms. This study will integrate land cover models, vegetation index, and surface temperature to see the effect of land cover change on temperature, as well as its relationship with the surrounding vegetation index. Satellite imagery can be used to determine vegetation index and surface temperature values using the Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST) approaches. In addition, this study also conducts correlation analysis between NDVI values and land surface temperature to determine land cover changes from vegetated land to built-up land. This study is expected to provide information and help present data on the extent of the relationship between the two variables in an effort to minimize the negative impacts of global warming.

The Purwakarta Regency Government and the Food and Agriculture Agency explained that the EL Nino phenomenon caused by the dry season has affected 110 hectares of rice fields, causing drought and crop failure in some areas. The increase in air temperature and significant decrease in rainfall have had a direct impact on vegetation and land surface temperature.

In addition to vegetation and surface temperature phenomena, Purwakarta Regency has also experienced land movement that has damaged several areas, such as in Pasirmunjul Village, which indicates environmental vulnerability that needs to be mapped and mitigated.

2. Research Method

2.1. Study Area

This research was conducted in Purwakarta Regency, West Java as can be seen in Figure 1. Purwakarta Regency is located at -6° 33' 24.98" S and 107° 26' 35.99" E. Purwakarta Regency is bordered by several cities/regencies, namely to the north and east by West Bandung Regency and Subang Regency, to the south by Cianjur Regency and still bordered by West Bandung Regency, and to the west by Cianjur Regency, Karawang, and part of Bogor Regency. The total area of Purwakarta Regency is 97,172 ha or 971.72 km².

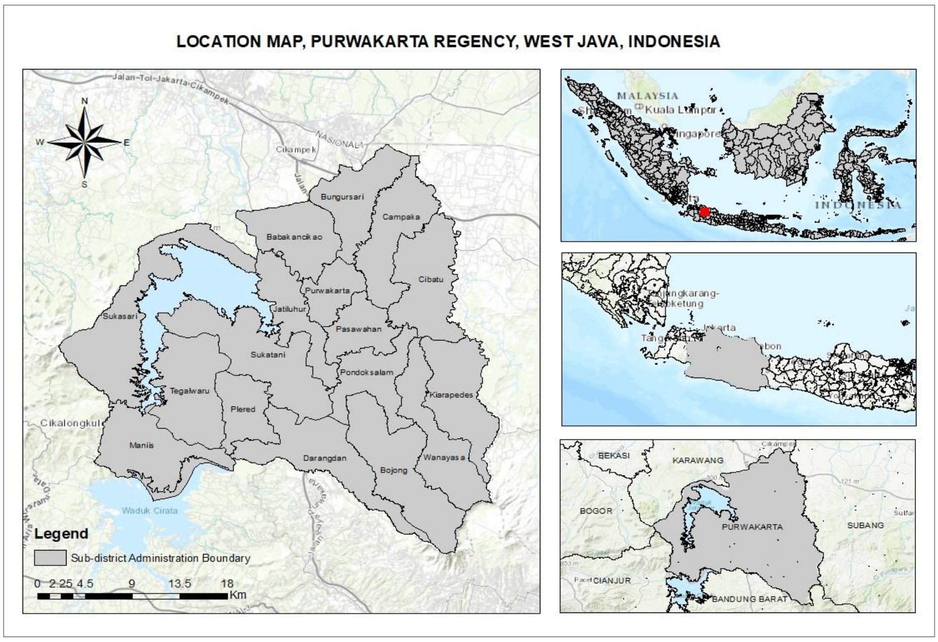

Figure 1. Study area in Purwakarta Regency.

2.2. Data

The data used in this study can be seen in Table 1. The satellite imagery used in this processing is Landsat 5 and Landsat 8 imagery.

***Table 1.** Data used in this study*

No	Data	Purpose of Data	Band	Spatial Resolution	Temporal Resolution	References
1	Landsat 5	LST Calculation	- Band 6 Thermal	120m	2004	[7]
2	Landsat 5	NDVI Calculation	- Band 3 Red - Band 4 Near-Infrared	30m	2004	[7]
3	Landsat 8	LST Calculation	- Band 10 TIRS 1 - Band 11 TIRS 2	100m	- 2014 - 2024	[7]
4	Landsat 8 (NDVI)	NDVI Calculation	- Band 4 Red - Band 5 Near-Infrared	30m	- 2014 - 2024	[7]

2.3. Methodes

The research flowchart can be seen in Figure 2. In general, it can be divided into three processing stages, namely pre-processing such as finding the topic, selecting the location, reviewing literature, and collecting data. The next stage is the processing of NDVI, LST, and land use using Landsat 5 and Landsat 8 imagery. The final stage is correlation analysis, creating time series, and preparing the discussion topic.

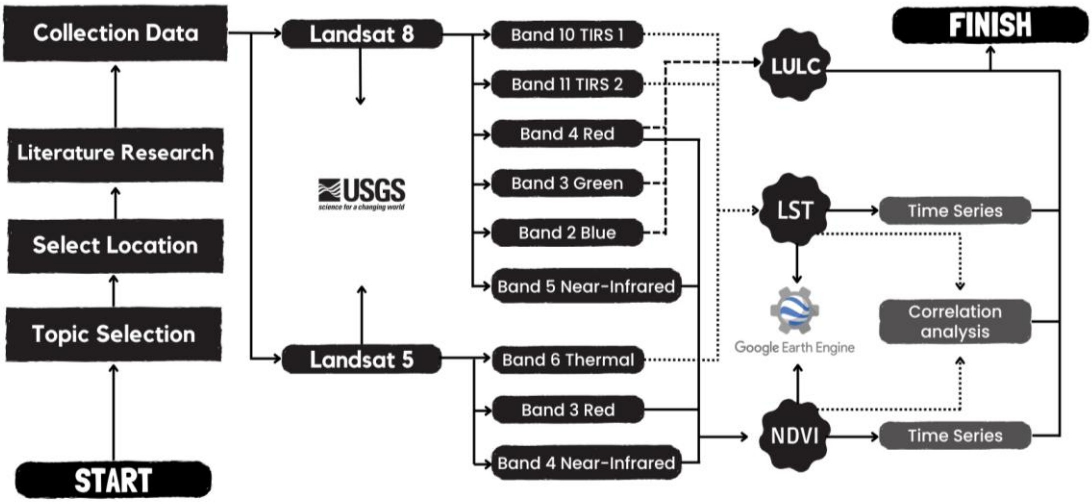

Figure 2. Flowchart in this study

2.3.1. Pre-Processing

This initial processing stage is carried out to ensure that the data used meets the requirements. Data preparation is done by downloading Landsat imagery from the USGS website. Furthermore, the downloaded data is processed to match the study area using the clipping method, which is adjusted based on the boundaries of Purwakarta Regency. Then, a cloud masking stage is carried out to remove cloud interference so that data reading errors can be minimized when processed in Google Earth Engine.

2.3.2. Identification of Land Cover Change

Land use land cover is a research parameter that functions to observe land changes that have occurred in the last twenty years. This land change analysis uses the Supervised Classification method, by taking several samples which are then processed by a computer, resulting in several land cover classes. The land cover types we created include four samples, namely vegetation land, built-up land, bare land, and water bodies.

Changes in land cover occur due to increased community mobility and increasing land demand. Urban activities are usually dynamic but inversely proportional to the available land in urban areas, most of which have undergone land conversion. This can lead to reduced vegetation and trigger an increase in surface temperature [8].

2.3.3. Identification of Vegetation Index Density

Vegetation index density can be calculated using the NDVI (Normalized Difference Vegetation Index) method. The NDVI value is obtained from the numerical processing equation between the near-infrared band and the red band, which can provide information on the vegetation density index [9].

The following is equation (1) to calculate NDVI using the NIR and Red bands:

$$NDVI = \frac{Band\ 5 - Band\ 4}{Band\ 5 + Band\ 4} \tag{1}$$

Description:

NIR: Near Infrared band, Band 5 (Landsat 8) and Band 4 (Landsat 5)

Red: Red band, Band 4 (Landsat 8) and Band 3 (Landsat 5)

According to [10], NDVI classification is divided into 3 categories, namely if the index value <0.2 it is classified as bare land or non-vegetated land, if the index value >0.5 the land can be identified as having high vegetation, and if the index value $0.2 \leq NDVI \leq 0.5$ the index value is in the category of mixed land with high vegetation and bare land.

2.3.4. Calculation of LST with Emissivity

Land Surface Temperature (LST) is a phenomenon of increasing surface temperature that indicates changes in the physical layer of the soil, thereby affecting temperature changes in the surrounding environment [11]. The process of calculating the thermal band for determining the LST value in an image can be done using certain formulas processed in Google Earth Engine. The calculation of the surface temperature increase highly considers the surface emissivity value or the energy emission from an object. In calculating emissivity, the brightness temperature (Tb) is first calculated, then the emissivity (using Pv), and after that the LST calculation stage is performed. The following is the formula for calculating emissivity in LST:

- Calculating emissivity
  To calculate emissivity in LST, the formula presented in Equation 2:

$$EM = (fv \times 0.004) + 0.986 \tag{2}$$

Description:

fv : Fractional vegetation

0.004 : Standard deviation of surface emissivity value

0.986 : Subtraction of vegetation emissivity value

- Calculating Brightness Temperature
  Brightness Temperature is one of the variables in the thermal band related to microwave radiation in the atmospheric layer [12].

  The formula to calculate brightness temperature is presented below in Equation 3:

$$BT = \frac{K_2}{\ln(\frac{K_1}{L_\lambda} + 1)} - 273.15 \quad (3)$$

Description:

BT : Brightness Temperature

L_λ : TOA spectral radiance

K_1, K_2 : Thermal band conversion constant

273.15 : Conversion value from Kelvin to Celsius

- LST Calculation

The Land Surface Temperature (LST) is derived using the following method, with the calculation formula presented in Equation 4.

$$LST = \frac{BT}{1} + w\left(\frac{BT}{\mathcal{P}}\right) ln(e) \quad (4)$$

Description:

BT : Satellite Brightness Temperature

w : Radiation wavelength

$\mathcal{P}$: (h * c / s = 14380)

e : Surface emissivity

2.3.5. Correlation between Vegetation Density and Surface Temperature

Vegetation density has a significant impact on land surface temperature. Dense vegetation can effectively absorb and disperse solar radiation, thereby reducing the amount of radiation that directly reaches the land surface. This process contributes to lowering land surface temperatures in areas with dense vegetation compared to regions with little or no vegetation. In addition, dense vegetation also plays a role in increasing the process of evapotranspiration, which is the evaporation of water from the land surface and the transpiration of water from plants. This mechanism produces a natural cooling effect around vegetated areas because heat energy is used for water evaporation rather than heating the land. This study uses pixel values from the analysis of the Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST) as the main products for statistical analysis.

The research sample was created using a grid technique with the help of the Fishnet tool in GIS software. The pixel values from NDVI and LST were then analyzed using statistical regression to evaluate the relationship and influence between vegetation density and land surface temperature. Dense vegetation functions as a thermal insulator, limiting heat absorption by the land surface. This results in lower land surface temperatures in areas with dense vegetation compared to barren and open areas that are directly exposed to solar radiation. This study utilizes regression analysis to understand the pattern of the relationship between vegetation density and land surface temperature, focusing on data taken from three different periods over 10 years, namely 2004, 2014, and 2024.

This analysis provides an overview of changes in vegetation conditions and land surface temperature over time, as well as the important role of vegetation in regulating the local climate. The regression formula used to support the analysis is shown in Equation 5 below:

$$Y = \beta\sigma + \beta 2X2 + \cdots + \beta nXn + \pounds \quad (5)$$

Description:

$X2, X2 \ldots Xn$: Independent variables

$\beta 1, \beta 2 \ldots \beta n$: Regression coefficients for each independent variable

$\beta\sigma$: When Y and X are zero

Based on the coefficient interval and the level of correlation between vegetation density and surface temperature, there are five classification values, namely very low with a range from 0.00-0.199, low with a range from 0.20-0.399, moderate with a range from 0.40-0.599, strong with a range from 0.60-0.799, and very high with a range from 0.80-1.000 [13].

3. Result and Discussion

3.1. Land Cover Change in Purwakarta Regency

Land use Land Cover is what we commonly know as land use and land cover. According to [14] in Notohadiprawiro (1991), land is defined as the surface of the earth that includes all recognizable features, both relatively permanent and cyclic in nature, from the biosphere, atmosphere, soil, geology, hydrology, and plant and animal populations, as well as human products from the past to the present that influence land use by humans from the past to the present.

Land use change is influenced by several factors, one of which is the increase in surface temperature. According to [15], land use change is the increase in the use of a certain land type for other purposes accompanied by the decrease in the use of other land types over time. This change can occur due to human activities, such as development changes, location changes, and behavioral changes in an area.

Human activities greatly affect climate change in urban areas. Therefore, one of the basic components that can be easily felt to experience changes is temperature. This is because temperature can affect and be affected by human activities and environmental conditions. The increasing demand for land is one of the causes of environmental changes that can lead to rising temperatures in an area, because the loss of vegetated land removes one of the roles of plants as carbon absorbers, resulting in an increase in surface temperature. For example, Figure 3 illustrates the land use changes in Purwakarta Regency.

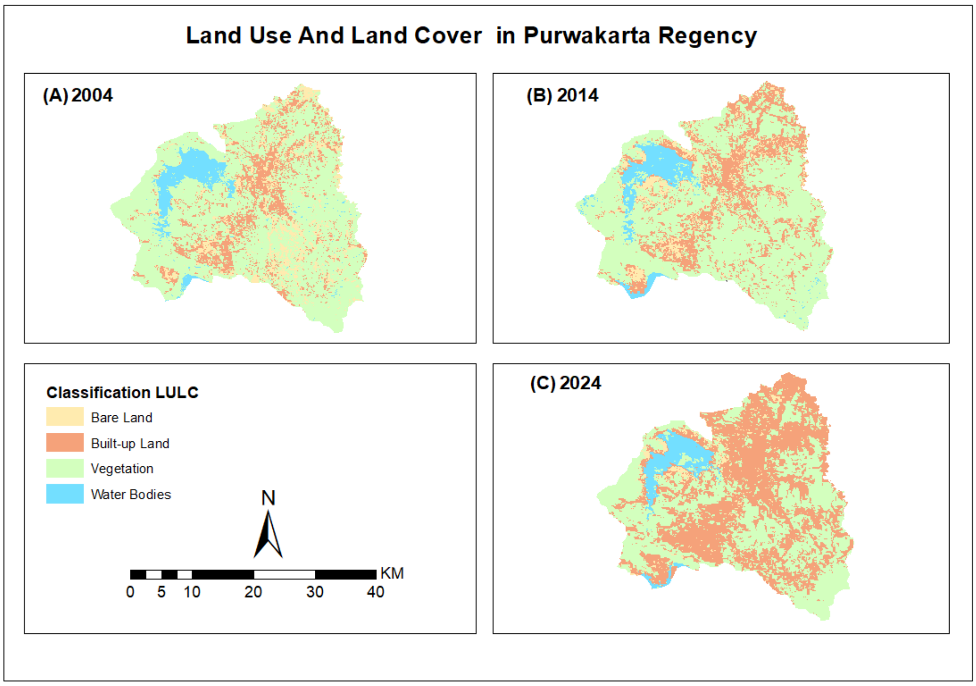

Figure 3. Land use Land cover map of Purwakarta Regency (A) 2004, (B) 2014, (C) 2024

From the processing that has been carried out, four samples of land cover were obtained, including water bodies, land covered by vegetation, vacant land, and built-up land. As seen in Figure 3, it was found that Purwakarta Regency has experienced significant land changes over the past twenty years. The land area that has increased is built-up land, while the land that has decreased is vegetated land. Table 2 shows the details of these land changes:

Table 2. Land Use Change

Landcover	Area (ha)/Year		
	2004	2014	2024
Vegetation	67564.8	64578.3	44970
Water Body	6351.61	6636.23	5495.22
Bare Lands	10447.2	6227.6	2932.5
Built-up Area	15028.8	21943.2	45996.9

3.2. Normalized Difference Vegetation Index (NDVI)

NDVI is an index used in calculating vegetation density. Vegetation is part of the plant community in a landscape. The NDVI method has the principle that green plants can grow effectively because they absorb radiation in the area of visible light spectrum (PAR or Photosynthetically Active Radiation). Because green plants contain chlorophyll, they can reflect radiation from near-infrared. Thus, the increase in surface temperature is directly proportional to the decrease in vegetation density. This indicates an interaction between environmental conditions and climate phenomena [16][17][18].

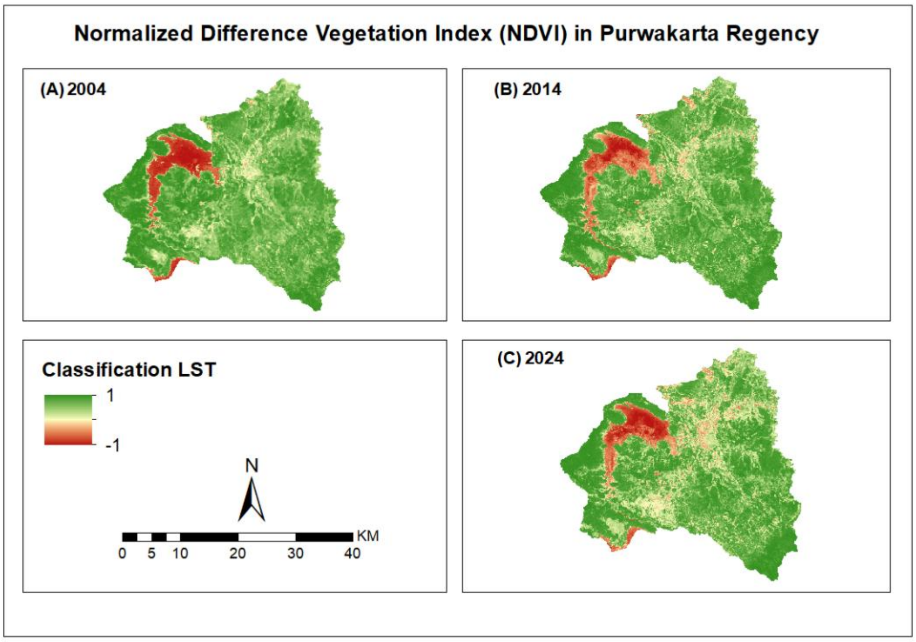

Figure 4. NDVI map of Purwakarta Regency (A) 2004, (B) 2014, (C) 2024

Based on Figure 4, the results show that there is a change in index values from year to year, where greener colors on the map indicate the highest NDVI values, while redder colors indicate lower NDVI values. In 2004, the lowest value was -0.174203 and the highest value was 0.876587. In 2014, the lowest value was -0.371041 and the highest was 0.97332. In 2024, the lowest value was -0.217282 and the highest was 0.986282. This may be caused by several factors, one of which is infrastructure development or land use change from natural vegetation to built-up land, which can cause a decrease in NDVI values.

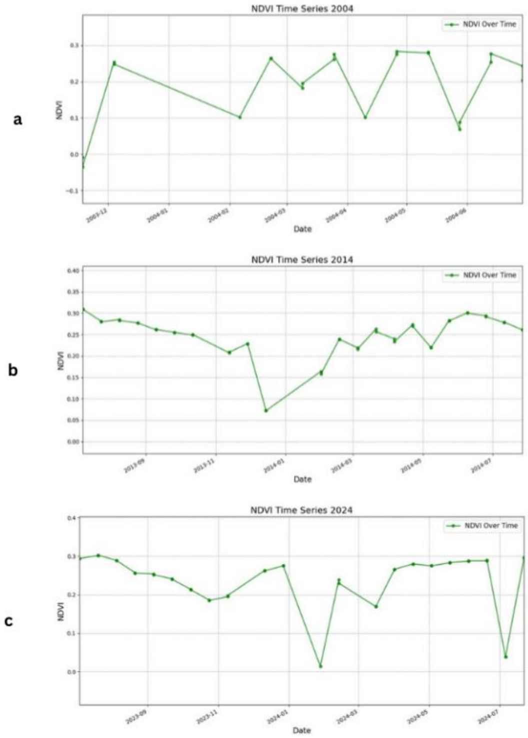

Figure 4. NDVI Time Series (a) 2004, (b) 2014, (c) 2024

In this study, it can be analyzed that Purwakarta Regency has 17 districts spread across the area. Sukasari District, which is adjacent to water bodies, has high vegetation density in 2004, 2014, and 2024. This is because Sukasari District has the smallest population compared to other districts and is not located in the city center but rather at the western tip of Purwakarta Regency, bordering neighboring regencies. In Purwakarta District, Plered District, and Campaka District, it can be seen that in 2014 and 2024, vegetation density decreased, as these three districts are administrative centers and have important roles in governance, which also means they have trade centers and human activities that have increased significantly over the years. Bungursari District and Babakan cikao District still have high vegetation density, but over a 10-year period, they have begun to lose vegetation due to land conversion. Pasawahan District, Sukatani District, Jatiluhur District, Cibatu District, and Cempaka District do not have very high vegetation density, similar to Purwakarta District, as they are still undergoing infrastructure development and are close to the city center, where population and infrastructure have been growing each year. In the eastern area, Darangdan District, Bojong District, Wanayasa District, Pondok Salem District, and Kiara pedes District have relatively high vegetation density because they are not part of the city center and are near the regional border, but the map results show that in 2024, vegetated land has begun to decrease

3.3. Land Surface Temperature (LST)

LST is one of the methods used to determine and map the surface temperature of a land cover by utilizing temperature parameters and vegetation density (NDVI) as a reference to observe the influence of land use. Increasing surface temperature in a region can be influenced by decreasing vegetation density. The higher the surface temperature, the less vegetated land there is. The relationship between land use and surface temperature is clearly illustrated in Figure 6.

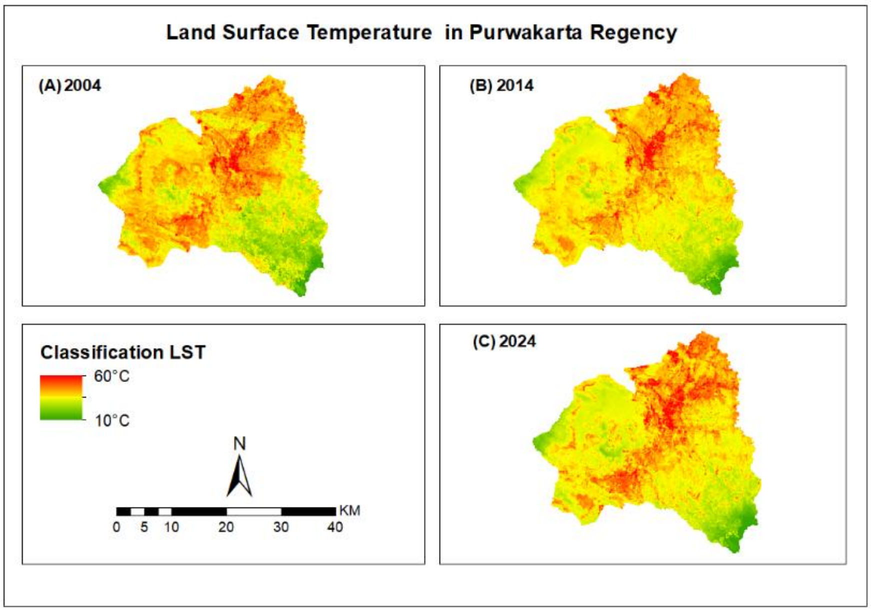

Figure 6. LST map of Purwakarta Regency (A) 2004, (B) 2014, (C) 2024

Based on the results in Figure 5, it was found that monitoring of Land Surface Temperature over the past twenty years shows a continuous increase. In 2004, the LST range was from -10.9903 to 60.0242. In 2014, the range was from 21.3358 to 57.8506. In 2024, the range was from 34.4866 to 59.0997. These results are directly proportional to the land changes that occurred in Purwakarta Regency over twenty years, showing a relationship between temperature increase and land use change. The more built-up land there is, the higher, the likelihood that the temperature in that area will increase due to density factors and the construction materials used, which also contribute to surface temperature rise. In the lower eastern part of the map, surface temperature is low, meaning there is little land use because the area is close to Mount Tangkuban Parahu. In contrast, the central part of the map shows high surface temperatures due to the presence of many residential buildings and industries. In the western part, surface temperature is low because it is a water body area, so there is no land use.

The increase in surface temperature can have significant impacts on the environment and urban life. This includes economic and environmental implications, such as higher cooling and energy costs, thermal comfort, climate change, impacts on urban vegetation, air pollutant concentrations, human quality of life, air quality, and overall climate change. LST data analysis is an important step in understanding environmental and climate changes.

With the reduction of vegetated land, many negative impacts on living organisms can occur. One of the impacts we can feel is surface temperature. Over a 10-year period, there are areas with different surface temperatures. Sukasari District has relatively high surface temperatures, which have increased from 2004 to 2024. Bojong District, Wanayasa District, Kiara Pedes District, and Darangdang District tend to have hotter surface temperatures compared to mountainous areas because the region is relatively flat with varying elevations and mostly lies at 800 meters above sea level. Manis District, Getalwaru District, Jatiluhur District, Sukatani District, Babakancikao District, and Bungursari District have relatively low surface temperatures because they are close to water bodies that help regulate temperature, and their topography is relatively high and close to mountainous areas. Plered District, Purwakarta District, Cempaka District, Cibatu District, and Pasawahan District have relatively low surface temperatures because they are close to mountains and have very high topography.

3.4. Correlation of Normalized Difference Vegetation Index (NDVI) on Land Surface Temperature (LST) in Purwakarta Regency

Based on the research results, an analysis was conducted to identify changes in Land Use Land Cover (LULC) and the correlation between the Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST) in Purwakarta Regency, revealing a close relationship between vegetation density and the increase in land surface temperature. This is inseparable from land use changes and land conversion. Processed data shows that during the 2004–2024 period, the area of vegetation land decreased significantly by 33% due to the conversion of vegetation land into built-up land, while the average surface temperature increased by 3°C.

The processed results indicate that areas with high vegetation density tend to have higher NDVI values, while areas with low vegetation density show lower NDVI values. This finding aligns with the concept that NDVI can be an effective tool to identify and map vegetation density in a region [19].

The analysis using LST revealed that areas with high vegetation density tend to have lower land surface temperatures. Conversely, areas with sparse or low-density vegetation have higher land surface temperatures. This emphasizes the importance of vegetation in regulating surface temperature through the thermal insulation effect produced by dense vegetation. These results reinforce the understanding of the role of vegetation as a key component in mitigating local temperature changes as well as in sustainable ecosystem and environmental management.

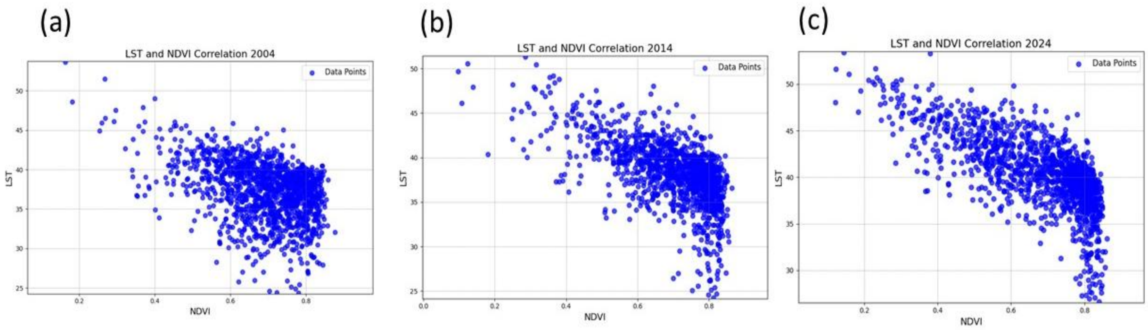

Figure 7. Correlation of LST and NDVI in the years (a) 2004, (b) 2014, and (c) 2024.

The LST and NDVI data obtained were then processed and visualized using a Scatter Plot created in Visual Code with Python programming language, as shown in Figure 6. Sample points were obtained from a grid in the study area using the Fishnet tool, conducted over three time points within a 10-year interval in 2004, 2014, and 2024.

Table 3. Average and Correlation of LST and NDVI

Year	Data	Average Value	LST and NDVI correlation
2024	LST	40.41292	

	NDVI	0.679807	0.7071 High correlation
2014	LST	38.21175	0.6180 High correlation
	NDVI	0.700524	
2004	LST	37.30716	0.4123 Moderate correlation
	NDVI	0.690787	

In Table 3, the processed LST and NDVI results for the years 2004, 2014, and 2024 show a strong correlation in 2024 and 2014 with an interval of 0.60–0.799, and in 2004 a moderate correlation with an interval of 0.40–0.599. The difference between the strong correlations in 2024 and 2014 compared to the moderate correlation in 2004 may be due to differences in the satellite imagery used, namely Landsat 8 and Landsat 5, which have differences in the spectral wavelength ranges of NDVI and LST. Additionally, the radiometric resolution differs, with Landsat 8 having a 12-bit resolution compared to Landsat 5's 8-bit, making Landsat 8 more sensitive to changes in reflectance values. Other factors such as atmospheric effects, including humidity, may also influence LST and NDVI values in the two images.

3.5. Comparative Studies

3.5.1. Comparative Study on Land Cover Change in Purwakarta Regency

The analysis of land cover change in this study shows that the conversion of vegetation land into built-up land increased significantly from 2004 to 2024. This finding is consistent with the study by [8], which showed that urbanization and increased land demand in urban areas trigger land conversion, resulting in a decrease in vegetation. This study also supports previous findings in Bogor Regency, which recorded a significant reduction in vegetation over the past two decades due to land conversion for residential and industrial purposes.

3.5.2. Comparative Study on the Normalized Difference Vegetation Index (NDVI)

The results show a downward trend in the average NDVI value over the past 20 years in Purwakarta Regency, with the highest value reaching 0.876587 in 2004, decreasing to 0.97332 in 2014, and further declining to 0.986282 in 2024. This change reflects significant vegetation degradation, particularly in areas with intense urbanization and infrastructure development. The conversion of vegetation land into built-up areas is the main factor in the decline in NDVI values, as also found in the study by [19], which shows a direct relationship between infrastructure development and reduced vegetation density in the area around Mount Parang, Purwakarta.

3.5.3. Comparative Study on Land Surface Temperature (LST)

The study results show a significant increase in LST in Purwakarta Regency during the 2004–2024 period. In 2004, LST values ranged from -10.9903 to 60.0242, increasing to 34.4866 to 59.0997 in 2024. This increase is closely related to land cover changes, with vegetation land decreasing and built-up land tripling during the period.

This study is consistent with the findings of [12], which showed that converting vegetation land into built-up areas increases surface temperature through the urban heat island (UHI) effect. In this study, areas with high concentrations of built-up land, such as downtown Purwakarta, had higher LST values compared to areas with better vegetation cover, such as Sukasari District.

The results are also in line with[20], who stated that areas with higher development levels also have higher LST values. The increase in surface temperature is particularly evident in areas with building materials with low albedo, such as asphalt and concrete, which reflect less energy compared to vegetation land.

3.5.4. Comparative Study on the Correlation of Normalized Difference Vegetation Index (NDVI) on Land Surface Temperature (LST) in Purwakarta Regency

The correlation analysis between NDVI and LST in Purwakarta Regency shows a consistent pattern with several previous studies, such as the study by [21] in KHDTK Lambung Mangkurat University and the study by [20] in the Wangu Watershed, Southeast Sulawesi. These studies also found a relationship between vegetation density and surface temperature, where areas with dense vegetation had lower land surface temperatures than areas with sparse vegetation. In the study by [21], the correlation coefficient value was 0.6019, indicating a strong correlation between NDVI and LST variables. Furthermore, in the study by [20], the coefficient between NDVI and LST in the analyzed image data was -0.0179, indicating that LST and NDVI in the study area had a negative relationship, meaning that when LST values are high, NDVI values are low, and vice versa. This is consistent with the results in Purwakarta Regency, where strong correlations were found in 2014 and 2024 with values above 0.6180, even reaching 0.7071. The strong correlation indicates the importance of vegetation as a factor in regulating surface temperature. However, the correlation in 2004 (0.4123) was lower than in other years, suggesting an influence from the lower radiometric resolution and quality of Landsat 5 imagery, which affects the accuracy of the results.

In addition, differences in spectral range and temporal resolution can affect NDVI and LST processing results. For example, in the study by [22] in Semarang City, NDVI and LST processing using the Google Earth Engine platform resulted in a more significant correlation because it optimized more accurate radiometric data and used higher quality imagery.

Based on these comparative studies, the results of this research have been indirectly validated by comparing them with relevant literature to strengthen reliability. However, additional studies using direct validation techniques such as field measurements can be conducted to improve accuracy.

3.6. Research Limitations and Future Study Development

This study has several limitations that need to be considered. First, the difference in radiometric resolution between Landsat 5 imagery (8-bit) and Landsat 8 imagery (12-bit) affects data sensitivity to NDVI and LST changes [23] in Polan harjo District, Klaten, Landsat 8 imagery contains a thermal infrared sensor that is very suitable and sensitive for determining surface temperature. In addition to having a good sensor, this imagery indeed has a higher radiometric resolution than Landsat 5, allowing for more detailed and accurate observations. However, this limitation can be minimized by using satellite imagery with consistent radiometric and temporal resolution. Second, atmospheric effects such as humidity and cloud cover can affect LST and NDVI pixel values even after cloud masking. As in the study by [24], which showed comparisons of LST values before and after cloud masking as well as vegetation pixel values before and after cloud masking, the results indicated that LST and NDVI values and visualizations are strongly influenced by atmospheric effects such as clouds and their shadows.

This research can be further developed with more complex approaches to obtain more in-depth results. One such approach is the study by [5] entitled “Addressing the impact of land use land cover changes on land surface temperature using machine learning algorithms,” regarding the temporal effects of LST and NDVI dynamics on LULC, combined with techniques such as machine learning-based image processing to analyze the relationship between NDVI and LST and their effects on LULC in more detail, considering various other influencing factors. Similar studies can also broaden insights into the long-term impacts of land use changes in urban areas such as Purwakarta Regency. Expanding the research area to include larger regions or areas with different land characteristics can verify the consistency of findings on the NDVI-LST relationship across various land cover types. Future studies may also involve more satellite imagery over longer periods to capture more complex change dynamics

4. Conclusion and Recommendations

4.1. Conclusion

This study analyses the relationship between Land Surface Temperature (LST) and the Normalized Difference Vegetation Index (NDVI) in Purwakarta Regency using Landsat 5 and Landsat 8 satellite imagery for the years 2004, 2014, and 2024. The results show a significant decrease in vegetation land area from 67,564.8 ha in 2004 to 44,970 ha in 2024, caused by land conversion for industrial and residential needs. Meanwhile, built-up land increased nearly threefold from 15,028.8 ha in 2004 to 45,996.9 ha in 2024, indicating rapid urbanization and industrial growth affecting natural ecosystems.

The average surface temperature increased significantly from 37.31°C in 2004 to 40.41°C in 2024, with maximum temperature ranges reaching 60°C. Areas with dense vegetation showed lower surface temperatures compared to built-up areas, demonstrating the role of vegetation in reducing temperature through mechanisms such as evapotranspiration and thermal insulation effects.

Correlation analysis showed a strong relationship between declining NDVI and increasing LST in 2024 and 2014. However, in 2004 the relationship was weaker, possibly influenced by the lower radiometric resolution of Landsat 5 imagery. These results confirm that reduced vegetation density directly impacts increased land surface temperature, making vegetation an important factor in mitigating local climate change. The loss of vegetation reduces the environment's ability to absorb carbon and lower local temperatures. This impacts quality of life, increases energy demand for cooling, and worsens urban heat island effects in urban areas.

4.2. Recommendations

1) Strengthening spatial planning policies to protect remaining vegetation land
2) Reforestation and greening efforts in areas with vegetation degradation, especially in industrial and residential areas
3) Establishing protected areas for remaining vegetation, equipped with strict legal regulations
4) Utilizing remote sensing technology regularly to monitor land use changes and their impact on land surface temperature

References

[1] R. Sobirin & Fatimah, "Urban Heat Island Kota Surabaya," *Geoedukasi*, vol. 4, 2015.

[2] A. Y. Pratiwi and L. M. Jaelani, "Analisis Perubahan Distribusi Urban Heat Island (UHI) di Kota Surabaya Menggunakan Citra Satelit Landsat Multitemporal," *J. Tek. ITS*, vol. 9, no. 2, 2021.

[3] R. Virtriana *et al.*, "Developing a spatial-based predictive model for conservation area management prioritization using ecosystem service and site suitability index in Java Island," *Int. J. Appl. Earth Obs. Geoinf.*, vol. 126, no. December 2023, p. 103606, 2024.

[4] A. D. Sakti *et al.*, "Machine learning based urban sprawl assessment using integrated multi-hazard and environmental-economic impact," *Sci. Rep.*, vol. 14, no. 1, pp. 1–16, 2024.

[5] S. Ullah, X. Qiao, and M. Abbas, "Addressing the impact of land use land cover changes on land surface temperature using machine learning algorithms," 2024.

[6] M. H. Rahmawati, S., Irawan, A., Supriyadi, I.H., & Azkab, *Panduan Monitoring Padang Lamun*. Jakarta: Pusat Penelitian Oseanografi Lembaga Ilmu Pengetahuan Indonesia, 2014.

[7] USGS, “EarthExplorer.” [Online]. Available: https://earthexplorer.usgs.gov/

[8] R. Fajarini, B. Barus, and D. R. Panuju, “Dinamika Perubahan Penggunaan Lahan Dan Prediksinya Untuk Tahun 2025 Serta Keterkaitannya Dengan Perencanaan Tata Ruang 2005-2025 Di Kabupaten Bogor,” *J. Ilmu Tanah dan Lingkung.*, vol. 17, no. 1, p. 8, 2015.

[9] L. Ji and A. J. Peters, “Performance evaluation of spectral vegetation indices using a statistical sensitivity function,” *Remote Sens. Environ.*, vol. 106, no. 1, pp. 59–65, 2007.

[10] J. A. Sobrino, J. C. Jiménez-Muñoz, and L. Paolini, “Land surface temperature retrieval from LANDSAT TM 5,” *Remote Sens. Environ.*, vol. 90, no. 4, pp. 434–440, 2004.

[11] F. Dousset, B. & Gourmelon, “Satellite multi-sensor data analysis of urban surface temperatures and landcover,” *ISPRS J. Photogramm. Remote Sens.*, vol. 58, no. 1–2, pp. 43–54, 2003.

[12] D. H. J. Aik, M. H. Ismail, F. M. Muharam, and M. A. Alias, “Evaluating the impacts of land use/land cover changes across topography against land surface temperature in Cameron Highlands,” *PLoS One*, vol. 16, no. 5 May, 2021.

[13] Sugiyono, *Metode penelitian pendidikan : pendekatan kuantitatif, kualitatif, dan R&D*. Bandung: Alpabeta, 2011.

[14] FAO, “A Framework for Land Evaluation,” *Soil Resour. Dev. Conserv. Serv. L. Water Dev. Div.*, pp. 1–79, 1976.

[15] P. L. Martin, *Trade and Migration: NAFTA and Agriculture*. University of California: Institute for International Economics, 1993.

[16] A. W. Kuchler, *Vegetation mapping*. New York: Ronald Press Co, 1967. [Online]. Available: https://catalogue.nla.gov.au/catalog/2047247

[17] Y. Zhang, Xinmin, Ronald C. Estoque, and Murayama, “An urban heat island study in Nanchang City, China based on land surface temperature and social-ecological variables,” *sciencedirect*, vol. 32, pp. 557–568, 2017.

[18] D. Kosasih, I. Nasihin, and E. R. Zulkarnain, “Deteksi Kerapatan Vegetasi dan Suhu Permukaan Tanah Menggunakan Citra Landsat 8 (Studi Kasus : Stasiun Penelitian Pasir Batang Taman Nasional Gunung Ciremai,” *Konserv. untuk Kesejaht. Masy.*, vol. 1, pp. 162–173, 2019.

[19] R. Wigunanti, R. M. R. Rahmansyah P.R, Q. A’yun, A. K. Oktaviana, and H. M. Ihsan, “Pengaruh Kerapatan Vegetasi Terhadap Kenaikan Land Surface Temperature (LST) di Area Gunung Parang, Kecamatan Tegalwaru, Kabupaten Purwakarta,” *El-Jughrafiyah*, vol. 4, no. 1, p. 134, 2024.

[20] V. Fitriani, L. Gandri, L. Indriyani, S. Bana, and L. De Ahmaliun, “Analisis Hubungan Land Surface Temperature (LST) dan Indeks Kerapatan Vegetasi (NDVI) DAS Wanggu, Sulawesi Tenggara,” 2023.

[21] W. Hatipah Yasmine, A. Jauhari, and R. M. N. Pitri, “Correlation Analysis of Normalized Difference Vegetation Index (NDVI) Value with Land Surface Temperature at KHDTK of Lambung Mangkurat University Wilda,” *J. Sylva Sci.*, vol. 05, no. 5, pp. 793–801, 2022.

[22] N. Wachid and W. P. Tyas, “Analisis Transformasi NDVI dan kaitannya dengan LST Menggunakan Platform Berbasis Cloud: Google Earth Engine,” *J. Planol.*, vol. 19, no. 1, p. 60, 2022.

[23] Husna R, “Analisis Hubungan Kerapatan Vegetasi Terhadap Sebaran Suhu Permukaan Lahan Periode Tahun 2015 Dan 2023 Di Kecamatan Polanharjo Kabupaten Klaten,” Universitas Muhammadiyah Surakarta, 2024.

[24] S. Rohma, “Prediksi Urban Heat Island (UHI) Berdasarkan Penginderaan Jauh Satelit Menggunakan Support Vector Regresion,” Universitas Islam Negeri Maulana Malik Ibrahim, 2024.