

# URBAN HEAT ISLAND ON THE BAGHDAD AIRPORT STREET ARE DECREES 16% DUE TO ASPHALT CONCRETE AND STREET TREES

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**Abstract** ---The Urban Heat Island (UHI) is a phenomenon that affects many millions of people worldwide, Especially in Iraq, this phenomenon intensified after the Western invasion of the State of Iraq, which was more concentrated in its capital, Baghdad, This increase in temperature is caused by the reflection of heat from the surface of the asphalt concrete, which negatively affected people's health and lives, This rise is caused by the movement of vehicles and machinery used in industry, and also from the reflection of the surface temperature of asphalt concrete, Especially in this article, we talked about the resulting reflection of asphalt concrete, This is what led us to the fact that increased urbanization is the cause of urban heat islands, UHI effect It also leads to increased energy needs which further contribute to the heating of our urban landscape, and Associated environmental and public health consequences, Roads and surfaces that reflect heat, In this research, we made a practical experiment on the Baghdad airport street after It was paved with asphalt concrete and trees were planted on it, Asphalt Concrete is one of the most popular types used in paving and roads, which helps reduce UHI, Densely graded AC has low albedo and high volumetric heat capacity, which results in surface temperatures reaching upwards of 60°C on hot summer days, Cooling the surface of asphalt concrete by cold mixing is one solution that helps reduce thermal reflections, Therefore, we conducted a study on the Baghdad Airport road, along one kilometer, in which cold asphalt was used and the road was planted to reduce surface reflections and mitigate heat islands on this road, Which resulted in a significant decrease in temperature equivalent between – 3.000 to 5.000oC of the natural temperature before paving it with cold asphalt and street trees.

**Keywords:** *Urban heat island, Asphalt concrete, street trees, Baghdad airport street.*

## I. INTRODUCTION

A city is a place that has a function as a center of human activity. The development of various fields in urban areas is very rapid compared to other areas. This is closely related to the characteristics of urban areas which have functioned as the center of government, economic activity, tourism, and a vehicle for improving the quality of life. It is a great opportunity to improve the quality of life, making urban areas more crowded by people from suburban areas and people from villages trying their luck in the city. The development of a centralized region in Indonesia causes the rate of urbanization in many big cities in Indonesia to increase every year. With the increase in urbanization every year, activities that occur in the city center as a center of economic and other anthropological activities are also centralized. As a

result of the concentration of this activity, there is an increase in temperature in the area of the City center. This phenomenon is known as Urban Heat Island (UHI)., UHI is part of the phenomenon of rising temperatures in urban areas, caused by isolated locations (different conditions) that have a higher surface/air temperature than the surrounding area on institute measurements (American Meteorological Society, 2014). UHI has a negative impact because it causes changes in air quality, affects human health, 2 energy use, and climate change (Lai and Cheng, 2009; Ng and Ren, 2017; Road et al., 2010; Skelhorn et al., 2016; Stone et al., 2010; Tan et al., 2010).

Urban Heat Island (UHI) is a phenomenon that has occurred a lot but not much research has been done related to UHI in Baghdad City. This phenomenon generally occurs in urban areas as the center of community economic activity. According to Kurnianti

(2020), UHI is a phenomenon where urban areas have higher temperatures than rural areas. This occurs due to the sun's heat trapped in urban areas due to green open land that has been transformed into built-up land, even though vegetation has an important role in reducing surface temperature. UHI has a negative impact in the form of a decrease in the quality of health and the environment, energy resources, and climate dynamics that will affect the activities of urban areas, it needs to be overcome (Hu & Jia, 2010; Tran et al., 2006; Jin et al., 2005; Tayanc & Toros, 1997).

Baghdad is the capital of Iraq which continues to develop, both in terms of physical development and population growth. This happened after the western attack on Iraq. As the most important regional economic center in the Middle East region, with very high oil revenues, Baghdad was able to attract many people to live and carry out economic activities, both in industry and trade and services. Associated with the existence of the largest oil company in Iraq, will also affect the development of the city of Baghdad. This will certainly increase the potential for urbanization, increasing population density and its activities, thereby increasing the potential for UHI.

Many studies related to urban heat islands (UHI) have been carried out by various researchers around the world, especially using remote sensing imagery. Aslan & San (2016) conducted research in Antalya City, Turkey using Landsat 7 ETM+ and Landsat 8 OLI/TIRS images to detect UHI potential and relate it to land use with an increase in UHI intensity of 1.2°C from 2001 to 2014. which is almost the same as done by Bahi et al. (2016), but this study has not shown the intensity of UHI that occurs, only the visualization of land surface temperature (LST) which is associated with the UHI phenomenon and the dynamics of land cover/use. A more specific study was conducted by Du et al. (2019) in the Yangtze River Delta by connecting the combination of surface urban heat island effects, landscape composition, and configuration. The research is interesting, but the intensity of SUHI which is the main focus of the research has not been explained how to obtain it, while in tabular visualization it still uses the value of land surface temperature (LST).

The utilization of remote sensing for the study of urban heat island phenomena needs to be maximized considering its ability to extract land surface temperature (LST) data in a short time and with a wide coverage (Schwarz et al., 2011; Voogt & Oke, 2003). This study seeks to integrate cloud computing techniques and methods that have been widely used in surface urban heat island (SUHI) analysis by prioritizing the main focus in the form of the spatial distribution of the SUHI intensity that occurs so that it is not only the visualization of land surface

temperature (LST) which is associated with the SUHI phenomenon.

## II. METHODOLOGY

The population of the city of Baghdad in 2022 was about 8,780,422, while the population of the city of Baghdad in 2015 reached 8.5 million people. This change in the population of the city of Baghdad contributed to the use of larger areas and lands than it was in 2015, and it is one of the factors that increase the temperature of urban heat islands.

In this study, we took the temperature of 5 points from the length of the Baghdad airport road, which is one kilometer, and compared it to the temperature of this road before the process of paving it with cold asphalt and afforestation of the road by the Baghdad government, The variables in this research are the change in the urban island temperature in Baghdad Airport Street in 2015 and its comparison with the street temperature in 2022.

The research location is in the city of Baghdad, the capital of Iraq, with an area of 204.2. The months with the most precipitation intensity are January, February, and April with 236 mm precipitation intensity. Most precipitation intensity occurs in January with an average rainfall of 88 mm.

The annual amount of precipitation intensity in Baghdad is 450 mm. The average annual temperature is 24°C in Baghdad. The warmest month of the year is July, with an average temperature: of 36°C. Usually, January is the coldest month in Baghdad, with an average temperature of 9°C. The difference between the hottest month: July and the coldest month: January: is 27°C. The difference between the highest precipitation (January) and the lowest precipitation (July) is 88mm. km<sup>2</sup> (City of Baghdad, 2017). The city of Baghdad was chosen as the research location because it is one of the big cities that are quite dense, continues to grow, considering that the city of Baghdad is the capital of Iraq, and is very close to oil companies so there is a need for effective and efficient monitoring mechanisms and techniques in the context of mitigating the SUHI phenomenon that occurred. in Baghdad City. Research related to the SUHI phenomenon in the city of Baghdad using remote sensing imagery has also not been widely carried out.

### 1. Cool Pavements

Cool pavements do not have a standard definition. The United States Environmental Protection Authority (USEPA) defines cool pavements as “paving materials that...have been otherwise modified to remain cooler than conventional pavements” (Qin 2015a). Many studies interpret an element of this definition to mean that a cool pavement must be able to suppress its daily

maximum surface temperature relative to AC (Qin 2015a; Zheng, Han, Wang, Mi, Li and He 2015; Toraldo, Mariani, Alberti and Crispino 2015; Jiang, Sha, Xiao, Wang and Apeageyi 2016; Higashiyama, Sano, Nakanishi, Takahashi and Tsukuma 2016).

Qin (2015a) derives the following mathematical equation for the daily maximum surface temperature ( $T_{max}$ ) of a pavement:  $T = \frac{(*+R)10}{P\sqrt{\omega}} T4$

Based on Equation 1, suppressing the daily maximum surface temperature of pavement can be achieved by increasing the albedo, reducing the percentage of thermal absorption to thermal conduction, or increasing the thermal inertia of the pavement.

Defining a cool pavement by its ability to suppress its daily maximum surface temperature is limited because it does not account for temperature fluctuations across the time of day, season, or other environmental conditions. For example, increasing the thermal inertia of pavement may result in a lower daily maximum surface temperature; however, more heat will be released in the early evening and night-time (Qin and Hiller 2014). Another limitation of this definition is the assumption that lowering the surface temperature of a structure will contribute to the mitigation of UHI effects, which is not always the case. Nevertheless, reducing the daily maximum surface temperature of pavement remains a key element within the literature on cool pavements.

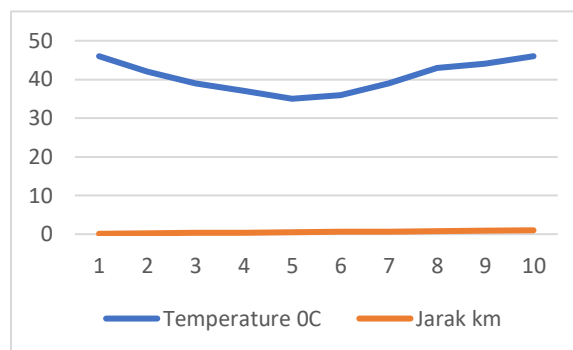
## 2. Making the environment green.

One of the easy solutions that help reduce the temperature is planting trees, as they not only provide people with shade but to reduce the heat of the atmosphere, resulting from the roofs of houses and concrete structures, which contribute significantly to heat islands. (Oke 1982; Akbari, Pomerantz and Taha 2001; Stone and Norman 2006; Stone, Hess and Frumkin 2010). More trees not only provide shade for buildings and people, but also reduce the wind speed under the canopies, and cool the air through evapotranspiration (Akbari, Pomerantz and Taha 2001; Santamouris 2015b). The heat of the roofs and the heat of the air resulting from the green spaces help greatly reduce the urban heat islands. Even if these green spaces are relatively small (Doick, Peace and Hutchings 2014; Tan, Wong, Tan, Jusuf and Chiam 2015). This cooling effect extends its benefits to the surrounding cityscape.

Land Surface Temperature (LST) The formula used for converting the TOA spectral radiance value to land surface temperature (LST) utilizes the formula published by USGS (2016) as in Equation 4. This formula is used to convert the TOA spectral radiance value into brightness temperature in units of Kelvin

(K). This brightness temperature is then converted into units of degrees Celsius ( $^{\circ}\text{C}$ ) to facilitate analysis with the formula in Equation 5.

$$T_{celcius} = T - 273.15$$



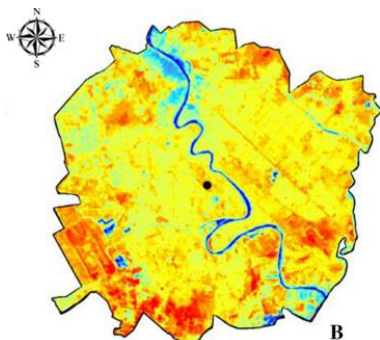
The last stage in the extraction of surface temperature data is carried out by utilizing the emissivity value in equation (3) and the brightness temperature which has been calculated in Equation 4 and converted into Celsius units in Equation 5. The formula used refers to Stathopoulou and Cartalis (2007) in Salih et al. (2018) as in Equation 6

$$T_{rad} = \frac{T_{rad}}{(1 + \left(\frac{T_{rad}}{p}\right) \ln \ln \epsilon)}$$

## Results

The spatial distribution of land surface temperature (LST) in the City of Baghdad which is quite high is relatively distributed in clusters around the center of Samarinda city at a buffer radius of 1 km with a temperature range of 40-48 $^{\circ}\text{C}$ , administratively, the temperature range is quite high spread over the Baghdad City airport road Baghdad. The temperature of other waypoints on the outskirts of the Baghdad airport has relatively lower temperatures, such as points 0.1 and 0.9. This indicates that at the 0.5 km point it has the lowest slope so that it has a minimum surface urban heat island effect.

land Surface Temperature Average by 0.1 km Airport Street in Baghdad



Map of the Distribution of Land Surface Temperature (LST) in the City of Baghdad

The identification of the SUHI phenomenon was also carried out statistically using the statistical dataset of the thermal image used. Statistical analysis used in the form of an overview of the central tendency and taking the average value of land surface temperature (LST) in each sub-district in the city of Baghdad. The average land surface temperature value is then plotted on a line graph to see the pattern and potential for SUHI which is derived from the land surface temperature (LST) value.

## Discussion

In this study, we obtained that cold asphalt and afforestation of cities or roads is one of the solutions that help reduce the temperature of urban islands, especially on the Baghdad airport road, where we obtained a decrease in road temperature. The highest intensity of Surface Urban Heat Island (SUHI) is distributed in a buffer radius of 1 km from the beginning of the Baghdad airport international road with an intensity value of 6,001-8,000°C and the intensity of SUHI decreases as the buffer radius is further away from the beginning of the road. Administratively, the highest SUHI intensity distribution is at 0.1 out of 1 kilometer specified, and the distance is 0.9 with a SUHI intensity range of

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6,5001-8,000°C, while the lowest SUHI intensity is at a distance of 0.5 kilometers with a SUHI intensity range of - 5,000-2,500 °C.

Even though the surface temperature is very dynamic even in a matter of seconds. Ideally, the accuracy test is carried out at the same time as the satellite is recording the area, but this is very difficult to do. The option exists to perform a comparison on two thermal infrared sensors recording the same area, but due to limited data sources, this is also difficult to do. The study of the surface temperature accuracy test needs to be reviewed related to the extraction process. The accuracy test on remote sensing images is carried out only on the results of both visual and digital interpretations, for example on the interpretation of land cover/use. Land cover/use is a hybrid variety that needs to be tested, while the biophysical variables that make up the hybrid variable are a collection of pixel values that do not need to be tested (Danoedoro, 2012).

The researchers suggest that a global city needs to implement solutions at scale to enable researchers to better measure the effects of UHI. Various studies on UHI are well developed but also experience inconsistencies in experimental and analytical methods. This calls into question the accuracy of the results and conclusions and makes comparisons between studies difficult. Diverse monitoring techniques, measurement equipment, study duration, variables considered, and rural reference locations all contribute to this problem. In addition, a methodology for measuring UHI intensity has not been agreed upon (Santamouris 2015a).

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