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Local Wisdom Approach Model as a Mitigation Effort of Urban Heat Island in Urban Infrastructure Development Case Study: Sorong City

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Abstract

The phenomenon of population growth that is experienced by almost all cities in the world has resulted in an increasing urban population density. This research used mixed methodological method with several stages, analyzing the characteristics of city form and city function in Sorong City related to urban infrastructure development, determining the factors that affect surface temperature seen from the city form and city function caused by urban infrastructure develop-ment and formulating the concept of Mitiasi Urban Heat Island caused by urban infrastructure development with a local wisdom approach. The results of the Urban Heat Island (UHI) analysis, the phenomenon occurs in Sorong City. This was indicated by the lower temperature in the suburbs of Sorong City compared to the urban area. From these results, there is hope that this method can use as an effort to use as a method in analyzing it the occurrence of the UHI phe-nomenon in Sorong City.

Keywords: *Local Wisdom; Urban Infrastructure; Urban Temperature; Urban Heat Island.*

1. Introduction

The increase in urban population coincides with infrastructure development due to urban growth from undeveloped to built-up land, generating large-scale land conversion from vegetation land cover converted into residential, industrial, and commercial buildings such as hotels and shopping centers. The process of land conversion results in changes in the quality of the environment, especially in the microclimate, in which the air temperature in urban areas is higher than in the surrounding [1].

The rapid development of infrastructures causes climate change and makes the local air temperature warmer. It signifies that eliminating the issue of climate change in development can cause greater losses in the future. The idea of linking the climate change agenda as a part of the Sustainable Development Goals (SDGs) is relevant. Since the convention of the United Nations in Rio de Janeiro in 1992 resulted in the United Nations Framework Convention on Climate Change (UNFCCC) to reduce greenhouse gas emissions, various countries have started dialogues to harmonize environmental conservation in global development projects. The effects of global warming will eventually occur on this earth someday [2].

The advanced development of cities affects the quality of the environment, especially the microclimate changes, in which the air temperature conditions in urban areas are higher

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than in the surrounding. This phenomenon is often referred to as Urban Heat Island (UHI). UHI is one of the most critical urban environmental problems and crucial challenges for many cities. Over the last decade, there has been a great deal of research on Urban Heat Island (UHI) in major cities around the world [3]. Several countries experience this, one of which is Malaysia. Therefore, in several research was carried out to determine the factors that could contribute to the formation of urban heat islands [4].

West Papua is designated as a conservation province. Therefore, its developments give attention to environmental regulations and ensure welfare for the community. The use of natural resources according to the rules of indigenous Papuans is substantial. It is because the presence of indigenous peoples and customary land has been recognized by the country while maintaining conservation areas. The facts show many problems faced in urban development, such as a lot of green lands, including conservation lands, have changed their function into built-up lands for urban infrastructure development, especially in cities with a high level of development.

Sorong City is one of the cities with a high level of development on the island of Papua due to its location as the gateway to the island of Papua, especially to the Raja Ampat Regency as a tourist area and to other districts in Sorong Raya. The development of built-up areas in Sorong, especially in urban areas, greatly influences the local air temperature in urban areas. Those areas have hotter air temperatures compared to the suburban areas. As a result, it causes the Urban Heat Islands due to a lack of vegetative cover. The temperature of Sorong City is currently much warmer than in the suburbs, mainly due to the expansion of built-up areas. It can be seen from the increase in temperature that occurred around 1997-2021. In 1997, the temperature in Sorong City was still around 25^0C - 30^0C. Then, it increased in 2006 to 30^0C - 35^0C. In early 2021, it was recorded that several areas had temperatures above 35^0C [5]. The consequences are serious such as high temperatures and heat waves harming human health and killing people, energy consumption due to air conditioning increasing, and productivity falling. Recently, in one of the cities in Qatar, research was carried out on urban heat islands and climate change and their combined impacts resulting from increased demand for cooling over the next few years [6].

Recently, the increase in the intensity of Urban Heat Island (UHI) and extremely high-temperature worldwide have affected the physical and mental health of urban residents and increased heat-related morbidity and mortality [7,8]. The impacts of the Urban Heat Island (UHI) have become a world concern that must be overcome immediately. The more cities experience the UHI, the higher the rate of increase in global warming will be [9]. Factors that affect the difference in temperature between cities and surrounding areas consist of factors that can be controlled by humans, including the design, structure of cities, and population numbers. Meanwhile, factors that are uncontrolled by humans consist of seasons, cloud cover, and atmospheric dynamics. It is mainly due to the development of urban infrastructure.

Furthermore, urban infrastructure development only pays attention to the strength and artistry of a building without paying attention to the nature of the materials used. The choice of concrete and asphalt materials has better strength and absorbs heat. However, concrete and asphalt also trap heat in the environment. These properties, were proven in an experiment that concrete containing fine cement showed better strength and durability, but had a greater tendency to thermal cracking and drying shrinkage [10]. So, the unprofitable application of this material in buildings can hinder air circulation.

Then, the phenomenon of thermal cracking in concrete occurs because concrete has the property of "Poor Thermal Conductivity", so that large volumes of concrete require a relatively longer time to release the heat contained. In the heat release process, the surface of the concrete will release heat more easily than the inside. This results in a temperature difference always occurring between the inner concrete and the surface during the heat release process [11]. Figure 1 shows the phenomenon of the "Poor Thermal Conductivity" properties of concrete materials.

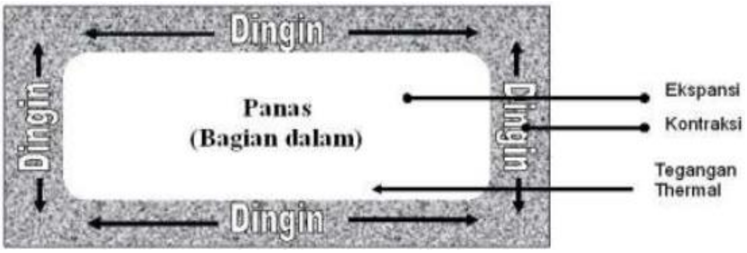
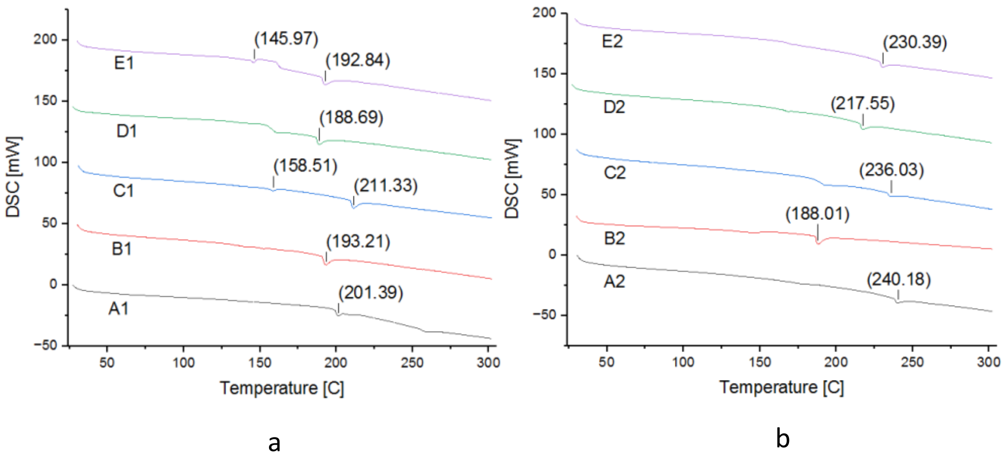


Figure 1. The phenomenon of "Poor Thermal Conductivity"

The values of local wisdom are feasible as solutions in urban development without destroying the value of the social order towards the natural environment. The local culture must be maintained from generation to generation to form behavior that influences the relationship between humans and their environment. This relationship affects humans' outlook on life, understanding the nature of the environment, influence on themselves, and the environment's reaction to their life activities. This view of life accumulates in human behavior and is known as the culture of local communities in urban areas. Local wisdom of the environment can be seen in how humans treat objects, plants, animals, and whatever is around them. This treatment involves the use of the human mind so that the results of our mental activity can be seen. The accumulation of the results of mental activity in addressing and treating the environment is called environmental knowledge or commonly called natural wisdom. Natural wisdom means describing the way humans behave and act to respond to changes that are unique in the scope of the physical environment and human culture itself [12]. Natural local wisdom specifically refers to a limited interaction space with a limited value system. This space has been designed in such a way that involves patterns of relationship between humans and or humans and their physical environment. The interaction pattern that has been designed is called the setting. It is an interaction space in which a person can arrange face-to-face relationships in his environment. The setting of life that has been formed will directly produce values. These values form the basis of relationships or become a reference for humans behavior [13].

In association with thermal comfort, local wisdom creates awareness of values for protecting the environment that can be applied in overcoming the UHI phenomenon in the building system, which includes: materials, ventilation and openings, plans, orientation to sunlight, design of roof, floor, and building environment. Suhendri and Koerniawan (2017) state all traditional building types are thermally comfortable, yet they require passive design interventions to optimize them through shading and vegetation.

Furthermore, to support traditional building types that are thermally comfortable, Several things need to be considered, including the building design, location, and materials used. Local Papuan people, especially in Sorong City, in several areas still maintain local wisdom in building a place to live. The people of Sorong City still use sago fronds as the main material in making dwellings. The properties of sago fronds, which can absorb and release heat well, are often used as the main material in making shelters. However, there are drawbacks to using this material, namely, the duration of use is only seven years. Therefore, additional treatment is needed to increase the duration materials used. Recently, an epoxy resin solution was added to sago fronds to increase the performance of sago fronds in absorbing and releasing heat [14]. Figures 2a and 2b show the results of the DSC test with the addition of NaOH and the resin-catalyst ratio of the composite material, respectively.



Figures 2a and 2b, DSC test results with NaOH addition treatment and resin-catalyst ratio for each composite material.

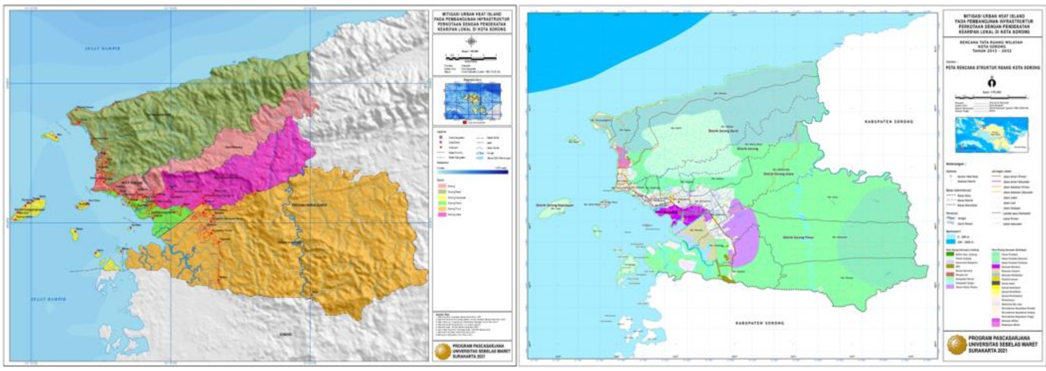
The spread of the Urban Heat Island (UHI) in Sorong City has never been studied. Therefore, it is very essential to conduct research on the UHI in Sorong City and land use at surface temperatures. This study aims to determine the pattern of surface temperature distribution and land use in Sorong City for policy making in planning better urban development. Based on the background above, this study examines the Local Wisdom Approach in Urban Infrastructure Development to Overcome the Effects of Increasing Local Air Temperature in Sorong. The research question is how the concept of local wisdom for mitigation of Urban Head Island generated by development of Insratructure?. The authors expect that the results of this study can be used as material for consideration in policy and prioritization of areas that must be managed properly so that the negative impacts of the UHI in Sorong City do not get worse, especially in the development of urban infrastructure. This study used the local wisdom approach of the Sorong people.

2. Materials and Methods

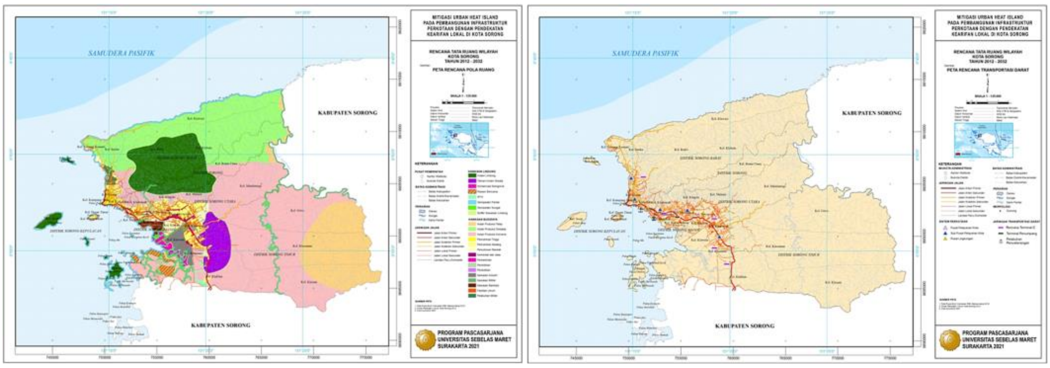
The study was conducted in Sorong City, West Papua Province, which is geograph-ically located below the equator, between 131º-51'E and 0º-54'S. Sorong City is divided into 10 Districts with an area of 1,105 Km2. The City of Sorong has administrative boundaries, as seen in Figure 3. The administrative boundaries of the City of Sorong are as follows:

- West : Dampier Strait Raja Ampat Regency;
- North : Makbon District Sorong Regency and Sagawin Strait Raja Ampat Regency;
- East : Makbon District Sorong Regency; And
- South : Aimas District and Salawati District, Sorong Regency.

The study will use a combination of two methods, namely quantitative and qualita-tive (Mixed Method). A mixed method is a method that combines qualitative and quanti-tative approaches in terms of methodology (As in the data collection stage), and mixed model studies combine the two approaches in all stages of the research process [10]. The mixed methods strategy used in this study is a sequence of quantitative and qualitative analyses. The objective of this strategy is to identify the potential for green infrastructure development through the analysis of quantitative data and then collect qualitative data in order to widen the available information [15]. This study combined the results of GIS analysis, regression, land cover change, and temperature with qualitative data in the form of local wisdom of the Papuans.



(a) Administration Map (b) Spatial Structure Map



(a) Spatial Pattern Map (b) Land Transportation Plan Map

Figure 3. Sorong City Maps of Administrative Boundary, Spatial Structure, Spatial Pattern and Land Transportation Plan

The research design used is an experimental design where image data processing is carried out to obtain vegetation density, building density, and surface temperature. Then, the data taken from the results of image processing and data from field survey results were converted into numbers processed using number processing software, namely SPSS with multiple linear regression methods. Furthermore, an analysis is carried out to determine variations and patterns of land surface temperature. The sample in this study was the condition of the area, which, based on GIS analysis, has a higher temperature than the city's temperature in other parts.

Primary data collection was carried out by observing research sites to validate data obtained from Landsat image processing results, namely land surface temperature (LST), vegetation density (NDVI), and building density (UI). Field observations were conducted by setting sample points. Sample points were determined to obtain variations and patterns of land cover and land surface temperature. Land cover was chosen because it is one of the factors affecting the land surface temperature. The selected land cover is based on a variety of different characteristics in the study area such as:

- The condition of urban infrastructure, including settlements
- Vegetation in the form of urban green infrastructure areas

In addition, interviews were conducted with the community, especially traditional leaders, regarding the local wisdom of the Sorong people, especially in the shape of building houses for the local community. While the secondary data in this study is land cover data obtained through the interpretation of satellite imagery. The secondary data collected in this study are described in Table 1.

Table 1. Secondary Data Collection.

No.	Data	Unit	Data Source
1.	Land Surface Temperature (LST)	Celcius	Citra
2.	Vegetation Density Index (NDVI)		Landsat
3.	Building Density Index		1995
	(Urban Index)		2000
			2005
			2010
			2015
			2019
4.	Sorong City in Figures 2021		BPS
5.	RTRW Sorong City		Bappeda
6.	RPJMD Sorong City		Bappeda

2.1. Data Processing

In the processing process, the image goes through several processes. The first is the data pre-processing process, followed by image processing which includes image sharp-ening and cropping according to the research area. Furthermore, image transformation is performed to obtain vegetation density, building density and surface temperature so that from image data processing, it can obtain vegetation density, building density and land surface temperature values.

Statistical data were processed using number processing software, namely Microsoft Excel and SPPS (Statistical Package for the Social Sciences), with multiple linear regres-sion methods. The data is taken from the results of image processing, namely in the form of vegetation density values and building density values, as well as field survey data in the form of vegetation density and building density which are converted into numbers by classifying their density (rare, medium, and high) and labeling each classification.

2.2. Mapping Surface Temperature in Sorong City

The Landsat program is a program to obtain images of the Earth from outer space. The first Landsat satellite was launched in 1972, and the most recent, Landsat 8, was launched on 11 February 2013. The instruments of Landsat satellites have produced mil-lions of images. The images archived in the United States and Landsat receiving stations worldwide are resources for global change research and its applications to agriculture, geology, forestry, regional planning, education, and national security.

Landsat OLI/TIRS imagery is a remote sensing satellite imagery produced from a passive remote sensing system. Landsat 8 has 11 channels, each using a certain wave-length. The Landsat satellite is a satellite with a sun-synchronous orbit type. It orbits the Earth almost through the poles and intersects the direction of its rotation with an inclina-tion angle of 98.2 degrees and an orbital height of 705 km from the earth's surface. Cover-age area per scene 185 km x 185 km. Landsat has the ability to cover the same area on the earth's surface every 16 days at an orbital altitude of 705 km.

Landsat TM (Landsat 5), ETM+ (Landsat 7), and TIRS (Landsat 8) sensors are capable of recording data on the heat radiation of the earth's surface in the thermal infrared spectrum. The object's surface temperature and emissivity strongly influence the information on the heat radiance in the thermal spectrum. The higher the temperature of an object, the higher the radiation intensity will be. Radiance information is captured by the thermal sensor and stored in the form of a digital number (DN) with a range of 0 to 255 (8 bits) for TM/ETM+ data and 0 to 65536 a. (16 bits) for TIRS data. The following is a list of the 9 bands found on the OLI Sensor.

Table 2. List of 9 Bands OLI Sensor.

Spektral Band	Wavelength	Spasial Resolution
Band 1 – Coastal/Aerosol	0.433 - 0.453 mikrometer	30 Meter
Band 2 – Blue	0.450 – 0.515 mikrometer	30 Meter
Band 3 – Green	0.525 – 0.600 mikrometer	30 Meter
Band 4 – Red	0.630 – 0.680 mikrometer	30 Meter
Band 5 – Near InfraRed	0.845 – 0.885 mikrometer	30 Meter
Band 6 – Short Wavelength InfraRed	1.560 – 1.660 mikrometer	30 Meter
Band 7 – Short Wavelength InfraRed	2.100 – 2.300 mikrometer	30 Meter
Band 8 – Panchromatic	0.500 – 0.680 mikrometer	15 Meter
Band 9 - Cirrus	1.360 – 1.390 mikrometer	30 Meter

As for the TIRS sensor made by NASA Goddard Space Flight Center, there will be two bands in the thermal region with a spatial resolution of 100 meters. In measuring land surface temperature, QGIS software is used, with the following steps:

1. Download Landsat 8 imagery in April 2021 at earthexplorer.usgv.gov
2. Install QGIS software
3. Clip using raster processing, namely the study area Grid A, B, C (which has been cut into 60x60m)
4. Search for NDVI (RTH sensitivity level) with a range of values (-1 to 1)
5. Mapping temperature using band 10 from image data for April 2021, which is able to measure thermal by entering constants or formulations through the "Raster Calculator", with the following steps:

a. Using the constant formula so that there are LST results in radians with a constant

0.0003342*Band10+0.1 (1)

b. Using the constant formula so that there are LST results in Kelvin form

1321.08/Ln(774.89/"Band10Radiance"+1)-272.15 (2)

c. Looking for value "e" from data NDVI

• Count PV (Proportion of Vegetation) by formula:

Pv = (NDVI-NDVImin / NDVImax-NDVImin)2 (3)

• From data used to find the value e

e = 0.004Pv + 0.986 (4)

d. Then the last stage is produced LST Lansat 8 in Celsius form

(using a constant)

LST = BT/1+W*(BT/p)*Ln(e) (5)

Where p = 14380

2.3. Analyzing the Effect of Local Wisdom on Temperature Decline

Local wisdom specifically refers to spaces designed in such a way that involve patterns of relationship between humans and other human beings or humans and their physical environment. These values will form the basis of their relationship or become a reference for human behavior [13]. Hardjasoemantri (2000) describes the development process, and if it is carried out only to achieve high levels of economic growth, it will cause serious environmental damage.

Based on Pamungkas and Ikaputra (2020), there are several factors that affect thermal comfort in traditional buildings:

a. Local wisdom in the traditional building concept considers the thermally comfortable conditions inside the building.

b. The material used, for example, the use of metal materials, will cause high thermal.

c. The design of the roof or building envelope in maintaining the thermal stability of the inner space.

d. Orientation to sunlight.

e. Openings (windows, wall openings) that allow natural or cross-ventilation apart from reducing humidity also promote the thermal comfort of the space.

f. Plans that have an impact on the adequacy of light and humidity in the room.

g. Environmental arrangements (building density, vegetation, surrounding natural conditions) adapted to the surrounding natural conditions. For example, a house by the beach will tend to have higher thermals than those on the mainland.

h. Building floors, for example, a house with a stilt floor can keep the building from getting damp

i. Climatic factors such as temperature, radiation, humidity, and wind speed are the main factors in measuring the thermal comfort of a building.

Based on these factors, the effect on buildings with traditional architecture in lowering the temperature can be analyzed. There are two groups of factors that affect thermal comfort. The first is the local wisdom factor that impacts the building system (materials, ventilation and openings, floor plan, orientation to sunlight, roof design, floors, and building environment), second is the climate factor (temperature, radiation, humidity, and air velocity).

Based on room temperature, buildings with traditional architecture are considered comfortable if the maximum temperature is $27{,}2^0$Cand uncomfortable if the maximum temperature reaches more than $27{,}2^0$C (see Table 5). If it is returned to tropical comfort sizes based on SNI standards $22{,}8^0$C–$25{,}8^0$C. So that the concept of local wisdom in reducing temperature can be analyzed by measuring the room temperature of traditional architecture compared to thermal comfort standards.

Table 3. Variety of Thermal Comfort Sensations.

No	Comfort level	Effective Temperature
1	Uncomfortably cold	< 20^0C
2	Cool-comfortable	20.5^0C–22.8^0C

3	Optimum comfort	22.8^0C–25.8^0C
4	Warm comfortable	22.8^0C–27.2^0C
5	Uncomfortably hot	>27.2^0C

Source: SNI 14-1993-03

Reducing local air temperatures can also be approached using vegetation, both local vegetation (Papuan endemic trees) and non-local vegetation. Local vegetation that can be planted is trees with dense leaves, such as the Matoa tree.

2.4. Formulating UHI Management Concepts in Sorong City

This target is the input from the analysis results on the previous target, namely in the form of a regression model that affects the surface temperature in Sorong City. The modeling results are explained in depth based on theory, best practice, and cases so that important points of the UHI management concept can be obtained by strengthening the results of interpretation of influential factors linked to theory, best practice, and existing conditions, these important points become input which is then structured based on the city management concept.

3. Results and Discussion

In this study, the land surface temperature was analyzed by applying the LST algorithm. The identification map of land surface temperature was conducted through the process of interpretation of image Landsat 8 satellite to observe the change in color as well as the maximum and minimum values of the land surface temperature. LST values obtained from the condition of 1997, 2006 and 2021 were presented in form of a table that includes the maximum and minimum temperatures.

The classification was carried out using a range of temperature assessments to make it easier to see variations in land surface temperature in Sorong City. This image has 11 bands and the bands used are the 2,3,4 band to produce true color displays and 10,11 band to produce LST. The LST values were sorted into temperature classifications of 5 classes, namely:

- Class 1 : < 20°C
- Class 2 : 20-25°C
- Class 3 : 25-30°C
- Class 4 : 30-35°C
- Class 5 : > 35°C

From the results of converting the digital number value of Landsat imagery of Sorong City in 1997, 2006 and 2021 to a land surface temperature value, the study obtained the land surface temperature value to be sorted into a temperature classification. From the results of the classification of land surface temperature values the authors obtained 5 temperature classes. From each of these classes, the authors calculated the area distribution of each class. The results of the classification and calculation of the area are presented in the following tables and figures.

Table 4. Percentage of Land Surface Temperature per District in Sorong City in1997.

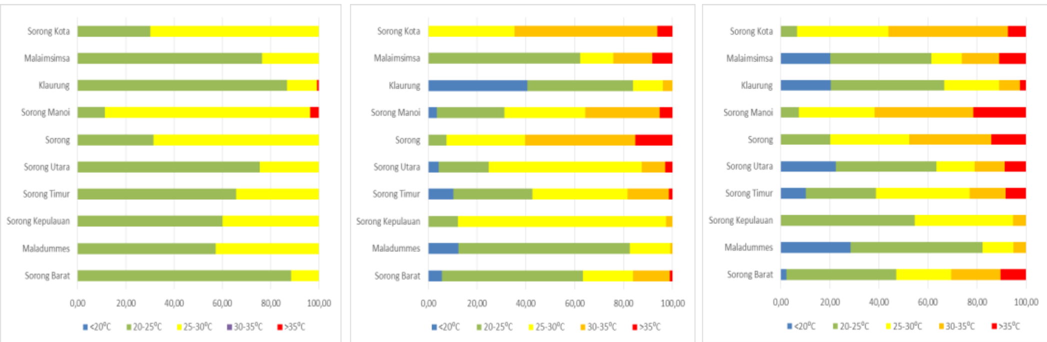
No	Districts	Percentage of Land Surface Temperature				
		Class 1	Kelas 2	Kelas 3	Class 1	Kelas 5
		<20ºC	20-25ºC	25-30ºC	<20ºC	>35º C
1	West Sorong	0,00	88,46	11,54	0,00	0,00
2	Maladummes	0,00	57,28	42,72	0,00	0,00
3	Sorong islands	0,00	60,04	39,96	0,00	0,00
4	East Sorong	0,00	65,79	34,21	0,00	0,00
5	North Sorong	0,00	75,55	24,45	0,00	0,00
6	Sorong	0,00	31,41	68,59	0,00	0,00
7	Manoi Sorong	0,00	11,25	85,22	0,00	3,53
8	Klaurung	0,00	86,79	12,34	0,00	0,87
9	Malaimsimsa	0,00	76,38	23,62	0,00	0,00
10	Sorong City	0,00	30,12	69,88	0,00	0,00
Sorong City		0,00	59,44	40,05	0,00	0,50

Table 5. Percentage of Land Surface Temperature per District in Sorong City in 2016

No	Districts	Percentage of Land Surface Temperature				
		Class 1	Kelas 2	Kelas 3	Class 1	Kelas 5
		<20º C	20-25ºC	25-30ºC	<20º C	>35º C
1	West Sorong	5,63	57,65	20,52	15,18	1,02
2	Maladummes	12,32	70,19	16,65	0,84	0,00
3	Sorong islands	0,00	12,26	85,15	2,59	0,00
4	East Sorong	10,28	32,48	38,91	16,81	1,52
5	North Sorong	4,21	20,56	62,72	9,64	2,87
6	Sorong	0,00	7,45	32,15	45,21	15,19
7	Manoi Sorong	3,49	27,65	33,16	30,52	5,18
8	Klaurung	40,67	43,23	12,24	3,86	0,00
9	Malaimsimsa	0,00	62,16	13,64	15,97	8,23
10	Sorong City	0,00	0,00	35,32	58,45	6,23
Sorong City		6,89	34,29	39,60	16,16	3,06

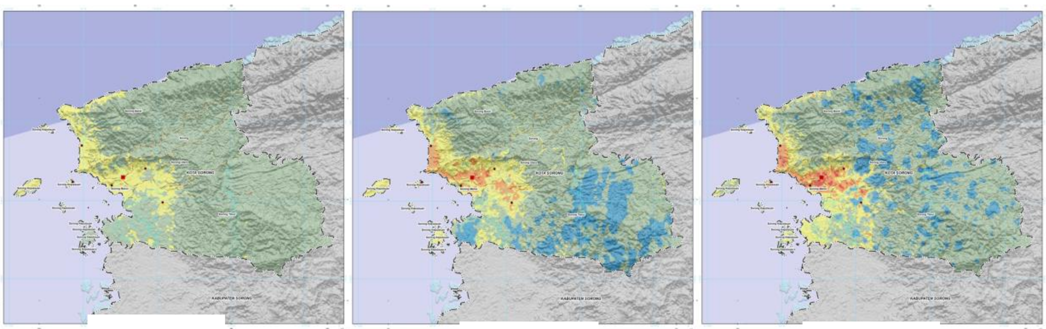
Table 6. Percentage of Land Surface Temperature per District in Sorong City in 2021

No	Districts	Class of Land Surface Temperature				
		Class 1 <20ºC	Kelas 2 20-25ºC	Kelas 3 25-30ºC	Class 1 <20ºC	Kelas 5 >35ºC
1	West Sorong	2,35	44,78	22,38	20,15	10,34
2	Maladumme s	28,47	53,80	12,51	5,22	0,00
3	Sorong islands	0,00	54,57	40,14	5,29	0,00
4	East Sorong	10,22	28,52	38,31	14,61	8,34
5	North Sorong	22,52	40,85	15,68	12,23	8,72
6	Sorong	0,00	20,18	32,15	33,46	14,21
7	Manoi Sorong	0,00	7,46	30,86	40,25	21,43
8	Klaurung	20,29	46,41	22,31	8,47	2,52
9	Malaimsimsa	20,12	41,20	12,44	15,32	10,92
10	Sorong City	0,00	6,67	37,13	48,77	7,43
Sorong City		10,26	37,54	26,29	18,19	7,73



(a) 1997 (b) 2016 (c) 2021

Figure 4. Charts of Land Surface Temperature Percentage per District in Sorong City in 1997, 2016 and 2021



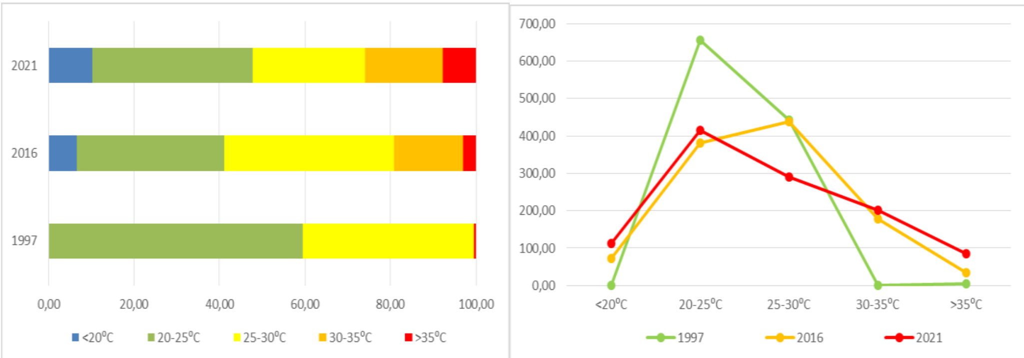
(a) 1997 (b) 2016 (c) 2021

Figure 5. Maps of Sorong City Land Surface Temperature in 1997, 2016 and 2021

During the period of 1997 to 2021, there were significant temperature changes in Sorong City. This was indicated by an increase in land surface temperature in class 4 and class 5. Both classes were in the hot and uncomfortable category based on SNI 14-1993-03 where the standard of thermal comfort is <27.2ºC. In this case, some of the class 3 land surface temperatures were included in the hot and uncomfortable category.

Table 7. Land Surface Temperature Distribution Pattern based on Percentage and Class Area in Sorong City in 1997, 2016 and 2021

Class	Temperature	Year					
		1997		2016		2021	
		%	Area	%	Area	%	Area
1	<20^{0}C	0,00	0,00	6,86	76,13	10,26	113,37
2	20 – 25^{0}C	59,44	656,82	34,29	378,94	37,54	414,82
3	25 – 30^{0}C	40,05	442,60	39,60	437,63	26,29	290,45
4	30 – 35^{0}C	0,00	0,00	16,16	178,54	18,19	200,97
5	>35^{0}C	0,50	5,57	3,06	33,76	7,73	85,39



(a) Percentage (b) Area

Figure 6. Charts of Land Surface Temperature Distribution Patterns based on Percentage and Class Area in Sorong City in 1997, 2016 and 2021

Taking heed of the distribution pattern of land surface temperature in Sorong City in 1997 - 2021, there has been a significant change in surface temperature, which is more visible in Class 4 and 5 temperatures. The temperature included in the hot and uncomfortable category has grown to reach 25.91 % of the total area of Sorong City with distribution in all districts and the location followed the direction of city development, especially around road networks.

3.1. Local Wisdom Approach Model

Local wisdom is a culture owned by certain communities and in certain places that are considered capable of surviving in the face of globalization because local wisdom contains values that can be used as a means of building national characters. Meanwhile, local wisdom is part of a scheme of cultural levels (hierarchical is not based on good and bad). Those wise values are then continuously carried out and have been able to survive until now within the local community. Local wisdom in people's lives has broad dimensions. The referred local wisdom can cover social, cultural, economic and ecological aspects. Types of local wisdom include governance, customary values, as well as procedures and methods, including the use of space.

In an effort to mitigate urban heat island, exploring local wisdom that is owned and operated by a community group is more directed on forms of policy or wisdom covering building layout and environmental planning that are physically ecological in nature. One of the objectives of exploring local wisdom values is for environmental harmony and sustainability.

Efforts to explore local wisdom values in urban heat island mitigation are not limited to exploring ways of 'smart solutions' without being balanced with ways of ‘wise solutions’. Hence, solving problems we face in everyday life does not only get 'smart' answers but also answers that are wise. Thus, it can have an impact on harmony and sustainability for the next generation in the future. Therefore, what is called a 'wise and smart' solution is needed, one of which is obtained from local wisdom values.

Table 8. Sources of Local Wisdom in Indonesia

Basic Elements	Local Wisdom
Empirical Aspects	• Human social interaction
	• Habitats
Cultural Symbols	• Architecture
	• Art
	• Literature
	• Rituals
	• Local Myths
Characteristic	• Logical Perception of
Knowledge	• Non-logical Perception of

This is especially important in today's era, namely the era of information and communication openness which, if not addressed properly, will result in the loss of local wisdom as national identity and identity. Traditional societies in the archipelago have used nature as a guide in developing their environment, both physical and non-physical, for a long time. Some things to note are;

1. Geographical conditions,

2. Humidity,

3. Wind direction,

4. Dry and rainy seasons, and

5. Conditions in areas prone to disasters (earthquakes, rising water levels, wild animals, etc.).

Apart from that, the climate aspect is also an important factor that determines the shape and process of building in a certain area. Saud, et al (2012) described that a fundamental aspect of overcoming urban heat island problems lies in the community's ability to select sites, and materials that suit the local climate, use minimum resources for maximum comfort, and adapt traditional models to climatic conditions.

From the sources of knowledge that exist and have explained the factors that form local wisdom (human, culture and nature), it can be comprehended that humans are elements of actors who form habits and traditions in an effort to interpret the conditions of their natural environment which are established in a form. However, nature still surrounds human existence, culture and architecture.

The main concept of the local wisdom approach model in the development of urban infrastructure is to deal with the urban heat island problem. The main basis of this model is to reduce the land surface temperature through the technical design of the building without destroying the customs of living and the living culture. The consideration for handling the urban heat island problem caused by the development of urban infrastructure is that people's housing are currently causing an increase in temperature, especially in densely populated areas in urban areas.

The diversity of forms and use of building materials is strongly influenced by locus conditions and the provisions of the rules in each ethnic group. Given these conditions, the local wisdom approach model can be applied to buildings of various sizes and shapes as well as available building materials, without forgetting the traditions and culture of the people.

The concept of placing building components with a local wisdom approach can apply the principles of traditional customs that are adhered to. The use of building materials taken from nature and the application of trees around the building function as a wind barrier and cool the temperature which can affect comfort in the building space.

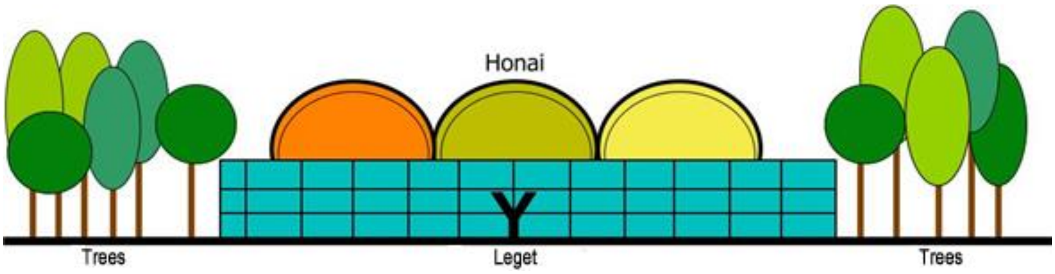


Figure 7. Example of the Implementation of Local Wisdom to Honai House Buildings

Source: Astuti, 1993 as cited in Paryanto et.al, 2018

4. Conclusions

From these results, there is hope that this method can use as an effort to use as a method in analyzing it the occurrence of the UHI phenomenon in Sorong City. This was indicated by the lower temperature in the suburbs of Sorong City compared to the urban area. The suburban area, namely the western part (rural) which had low temperatures then experienced an increase in temperature towards the urban area in the city and then decreases again towards the south of Sorong City (rural). This pattern was repeated every year from 1997, 2016 and 2021. Based on the results of this study, changes in land cover, especially increasing settlements and decreasing vegetation one of the factors in the rise in temperature in Sorong City. With this research, suggestions can be proposed to control the development of residential growth in Sorong City, one of which is with the local wisdom of the local population, especially from the shape of buildings.

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