doi: 10.37905/jgeosrev.v8i1.33864 ejurnal.ung.ac.id/index.php/jgeosrev

Vol. 8, No. 1, January 2026: 20-29

Jambura Geoscience Review

p-ISSN 2623-0682 | e-ISSN 2656-0380

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Analysis of Community Knowledge, Attitudes, and Behaviors on Urban Heat Island Impacts in Rappocini District, Makassar City

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ARTICLE INFO

Article history:
Received: 11 August 2025
Accepted: 4 December 2025
Published: 15 January 2026

Keywords:
Behavior; Climate Change; Knowledge; Attitude; Urban Heat Island

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ABSTRACT

The phenomenon of Urban Heat Island (UHI) refers to the rise in temperature in urban areas compared to their surrounding rural regions, primarily due to land-use changes, reduced vegetation, and high-density infrastructure. This condition poses health and environmental risks and presents significant challenges for sustainable urban planning. This study aims to: (1) assess the community's level of knowledge regarding climate change and the impacts of UHI; (2) analyze public attitudes and adaptive behaviors in responding to UHI; and (3) determine the influence of knowledge and attitudes on behavior related to mitigating UHI impacts. A quantitative approach was applied using a household survey and structured questionnaires. Data were analyzed using multiple linear regression, including t-tests, F-tests, and the coefficient of determination (R^2), with the aid of SPSS software. The findings show that the community's knowledge and attitudes are generally categorized as good. The F-test yielded a significance value of 0.054, indicating that the model was nearly significant at the 0.05 level. Partially, attitudes had a significant influence on adaptive behavior ($p = 0.030$), whereas knowledge did not show a significant effect ($p = 0.890$). The coefficient of determination (R^2) was 0.083, meaning that knowledge and attitudes collectively explain 8.3% of the variation in community behavior toward UHI mitigation. These findings highlight the need to strengthen public education and promote behavioral adaptation strategies to reduce the environmental impact of urban heat.

How to cite: Maru, R. (2026). Analysis of Community Knowledge, Attitudes, and Behaviors on Urban Heat Island Impacts in Rappocini District, Makassar City. *Jambura Geoscience Review,8*(1), 20-29. https://doi.org/10.37905/jgeosrev.v8i1.33864

1. INTRODUCTION

The Urban Heat Island (UHI) phenomenon is a condition of increasing air temperature in urban areas compared to the surrounding areas, caused by changes in land cover, loss of green open spaces, and the dominance of impermeable surfaces such as concrete and asphalt (Kurnianti & Rahmi, 2019; Maru et al., 2015; Maru, 2017; Maru & Ahmad, 2015a). Several large cities in Indonesia are experiencing rapid growth in the residential and infrastructure sectors; therefore, they have a high potential for increasing UHI intensity, especially in densely populated districts such as Rappocini. Previous research has shown that UHI intensity increases with reduced vegetation and increased built-up areas (Maru et al. 2015; Maru & Ahmad 2014, 2015b). Land use changes that occur in the Rappocini District are recorded as one of the largest contributors to the increase in surface temperature. Every 1 km² reduction in green open space is estimated to increase temperatures by up to 0.068°C, while an increase of 100 residents can increase temperatures by up to 0.10°C (Buyantuyev & Wu, 2010; Li et al., 2013; Santamouris, 2015; Zhou et al., 2016). A

similar study by Rauf (2023) showed an increasing trend in Land Surface Temperature (LST) in Makassar City by almost 39% over the past decade due to land conversion (Syahriani et al., 2022).

Spatially, areas experiencing the highest temperature increases are densely developed areas, such as business centres and densely populated settlements, whereas areas with vegetation cover tend to have lower temperatures (Nasrul et al., 2025; Ruliana et al., 2025; Shashua-Bar et al., 2009; Susiyanti et al., 2025; Zhou et al., 2014). Satellite imagery data show that the average temperature in downtown Makassar reaches 31.29°C during the day and 27.4°C at night. This pattern indicates the need for an environmentally based approach to managing thermal impacts in urban areas.

The impacts of UHI affect not only the physical environment but also exacerbate social and health inequalities (Ali et al., 2025; Maru et al., 2025; Utami et al., 2024). International research shows that poorer areas with limited access to green spaces experience higher heat stress than greener and cooler ones (Arfandi et al., 2024; Enright & Pemberton, 2016; Harlan & Ruddell, 2011; Sartina et al., 2023). These inequalities require community-based adaptation strategies and increased public awareness of the risks associated with UHI.

To date, there has been little local research that comprehensively examines the level of community knowledge, attitudes, and behaviour (KAP) in response to the UHI phenomenon in Makassar. Several interventions, such as tree-planting movements and green open space campaigns, have been implemented, but these have not been fully based on the results of needs analysis and public awareness (Maru et al., 2025; Siqi & Yuhong, 2020). Therefore, this research is important for measuring the level of community knowledge regarding climate change and the UHI phenomenon, analysing community attitudes and adaptive behaviour in response to UHI, and assessing the influence of knowledge and attitudes on community behaviour. The research results are expected to form the basis for more inclusive, participatory, and locally data-driven policymaking for UHI mitigation in the Rappocini District of Makassar City.

2. METHOD

This study was conducted in the Rappocini District of Makassar City. This study used a descriptive quantitative approach to analyse the level of community knowledge, attitudes, and behaviour regarding the impacts of the Urban Heat Island (UHI) phenomenon in Rappocini District, Makassar City. The method used was A household survey was conducted, and data were collected through direct interviews using a validated structured questionnaire.

The data in this study consisted of primary and secondary data. Primary data were obtained through interviews with respondents living in the study area using a questionnaire covering three aspects: (1) community knowledge of UHI, (2) community awareness of environmental issues, and (3) community behaviour in dealing with the impacts of UHI. In addition to the interviews, behavioural data were supported by direct field observations. Secondary data were obtained from previous research, scientific articles, and relevant official reports.

The population in this study consisted of all households residing in the Rappocini District. The sampling frame was obtained from the official household registration data of the district's residents. Respondents were selected using purposive sampling, a non-probability technique, based on pre-established inclusion criteria: (1) adults (18+) who are heads of households or represent decision-makers in the household, and (2) individuals with a level of awareness or direct experience related to environmental conditions or the impacts of urban climate change in their neighbourhood. The exclusion criteria included uninhabited households and individuals unwilling to participate.

As a non-probability method, purposive sampling does not require random selection or probability-based assumptions. Therefore, the sample size in this study was based on practical considerations in the field, ensuring that the number of respondents selected was sufficient to capture relevant information and represent the diversity of environmental experiences in the district, that is, 38 individuals. Therefore, the final sample size reflected methodological suitability and contextual feasibility rather than statistical probability requirements.

Data processing was carried out in several stages, namely: 1. Editing: To ensure the completeness and readability of the questionnaire data, 2. Coding: A numeric code was assigned

to each answer, 3. Entry: entering data into the SPSS program, and 4. Cleaning: Double-checking to ensure that there were no data input errors.

Next, descriptive statistical analyses were conducted, including the calculation of the mean, standard deviation, and frequency distribution. To examine the effects of knowledge (X_1) and attitudes (X_2) on community behaviour (Y), multiple linear regression analysis was employed. Prior to interpreting the regression results, a series of diagnostic tests were performed to ensure that the model met the required statistical assumptions, including tests of residual normality, homoscedasticity, linearity, and multicollinearity (Variance Inflation Factor, VIF). The final regression model reports standardised beta coefficients (β), confidence intervals (CIs), and partial R^2 values to provide a more comprehensive understanding of the contribution of each predictor to the variance explained in community behaviour.

$$Y = \alpha + \beta 1X1 + \beta 2X2 \quad (1)$$

Hypothesis testing was conducted in three stages: 1. A partial t-test (partial) to determine the effect of each independent variable on the dependent variable separately. 2. An F-test (simultaneous) was used to test the effect of both independent variables together on the dependent variable. 3. A coefficient of determination (R^2) was used to determine the contribution of the knowledge and attitude variables in explaining variations in community behaviour.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Public Knowledge Regarding the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

The assessment of the public's level of knowledge regarding the urban heat island phenomenon included 1) the term urban heat island, 2) UHI, which is the increase in temperature in urban areas, 3) the causes of UHI, 4) the impacts of UHI on health, and 5) solutions to the impacts of UHI. For more details, refer to Table 1.

Table 1. Level of public knowledge regarding the urban heat island phenomenon in Rappocini District, Makassar City

Knowledge Indicator	Score	Persentage
The term Urban Heat Island	18	72%
UHI is the increase in temperature in urban areas	20	80%
Causes of UHI	16	64%
Impact of UHI on health	22	88%
UHI impact solutions	24	96%
Total	100	100

Source: Primary Data, 2025

Table 1 shows that of the five existing knowledge indicators, the highest knowledge assessment indicator is for solutions to the impact of the Urban Heat Island (UHI) at 96%, and the impact of the UHI on health at 88%. Meanwhile, the lowest knowledge indicator was for the causes of the UHI, at 64%. Furthermore, to understand the categorisation of each public knowledge indicator, see Table 2.

Table 2 shows that, in general, public knowledge of the Urban Heat Island phenomenon in the Rappocini District of Makassar City is considered good. All knowledge indicators, including understanding the terms, definitions, causes, impacts, and solutions for the UHI, showed high scores, reflecting a relatively good level of public awareness of this urban environmental issue.

Table 2. Categorization of community knowledge regarding climate change and the role of mangrove forests in handling climate change

Knowledge Indicator	Amount		Persentage Score	Category
	(n)	Score		
The term Urban Heat Island	38	137	72,11	Good
UHI is the increase in temperature in urban areas	38	152	79,99	Good
Causes of UHI	38	128	67,37	Good
Impact of UHI on health	38	167	87,72	Good
UHI impact solutions	38	174	91,58	Good

Source: Primary Data, 2025

3.1.2. Public Attitudes Regarding the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

Assessments of public attitudes regarding the impact of the Urban Heat Island (UHI) phenomenon in the Rappocini District of Makassar City include the following indicators: (1) the perceived urgency of the UHI issue; (2) the extent to which the government should take more serious action in mitigating UHI impacts; (3) comfort in living within green open spaces; (4) support for urban greening as a strategy to address UHI; and (5) support for environmentally oriented spatial planning policies.

To improve clarity and consistency, the percentages presented in Table 3 are based on the proportion of each indicator score relative to the total possible score (i.e. the percentage of the maximum score). The percentages in Table 4 represent the proportion of the total score relative to the maximum possible score per indicator across all respondents. This clarification aligns with the interpretation of both tables while maintaining their analytical functions.

Table 3. Public Attitudes Regarding the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

Knowledge Indicator	Score	Persentage
The urgency of Urban Heat Island	18	18%
The government must be more serious about addressing UHI impacts	20	20%
Comfort living in a green space environment	19	19%
Urban greening to address UHI	21	21%
Support for environmentally oriented spatial planning policies	22	22%
Total	100	100

Source: Primary Data, 2025

The results in Table 3 indicate that public attitudes toward the impact of the UHI fall into the "good" category based on their score distribution relative to the maximum score. Indicators related to support for environmentally oriented spatial planning policies (22%) and urban greening (21%) had the highest proportional scores.

Table 4. Categorization of Community Attitudes Regarding the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

Knowledge Indicator	Amount		Persentage Score	Category
	(n)	Score		
The urgency of Urban Heat Island	38	137	90.13	Good
Government must be more serious about handling UHI impacts	38	142	93.42	Good
Comfort living in a green space environment	38	136	89.47	Good
Urban greening to address UHI	38	145	95.39	Good
Support for environmentally oriented spatial planning policies	38	144	94.74	Good

Source: Primary Data, 2025

Table 4 confirms that all attitude indicators fall within the "good" category, with scores exceeding 89%. The highest percentages were recorded for support for urban greening (95.39%) and environmentally oriented spatial planning policies (94.74%). These findings reflect a strong public commitment to environmental sustainability and awareness of the implications of urban climate change.

3.1.3. Community Behavior Related to the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

Table 5. Community Behavior Related to the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

Knowledge Indicator	Score	Persentage
I plant or care for plants in my house/environment	20	20%
I use private vehicles efficiently to reduce heat emissions.	18	18%
I support urban greening activities	21	21%
I avoid littering which can worsen the environmental temperature.	22	22%
I choose to stay or do activities in a shady place when the weather is hot.	19	19%
Total	100	100

Source: Primary Data, 2025

Table 5 shows that community behaviour in responding to the impacts of the Urban Heat Island in the Rappocini District is generally good. The highest scores were for the indicators of avoiding littering (22%) and supporting urban greening (21%), indicating a collective awareness of small but impactful actions that improve urban environmental quality.

Table 6. Categorization of Community Behavior Related to the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

Knowledge Indicator	Amount		Persentage Score	Category
	(n)	Score		
I plant or care for plants in my house/environment	38	152	80.00	Positive
I use private vehicles efficiently to reduce heat emissions	38	150	78.95	Positive
I support urban greening activities	38	155	81.58	Positive
I avoid littering which can worsen the environmental temperature	38	160	84.21	Positive
I choose to stay or do activities in a shady place when the weather is hot	38	149	78.42	Positive

Source: Primary Data, 2025

Table 6 shows that all indicators of community behaviour in responding to the impact of the Urban Heat Island in the Rappocini District are positive. The highest percentage was found for avoiding littering (84.21%), while the indicator with the lowest percentage was engaging in activities in shaded areas during hot weather (78.42%). Overall, this reflects that the community has demonstrated good adaptive behaviour in dealing with the impacts of urban climate change on their health.

3.1.4. Analysis of Community Knowledge, Attitudes, and Behavior Regarding the Impact of the Urban Heat Island Phenomenon in Rappocini District, Makassar City

The F-test or ANOVA test aims to assess the feasibility of the regression model for the independent variables (knowledge and attitude) and knowledge as the dependent variable (behaviour). The results of the F-test are presented in Table 7.

Table 7. Results of the statistical f test (ANOVA test)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	12.853	2	6.426	3.044	0.054[b]
Residual	141.433	67	2.111		
Total	154.286	69			

Source: Primary Data, 2025

Table 7 shows an F-value of 3.044 with a significance level of 0.054, indicating that the value is greater than 0.05. This indicates that the simultaneous knowledge and attitude variables do not significantly influence community behaviour in responding to the Urban Heat Island phenomenon in the Rappocini District. However, because the value is close to the significance limit, there is an indication that the regression model still has a tendency to influence the results, although it is not yet statistically strong.

Multiple regression analysis was conducted to determine the effect of the independent variables (knowledge and attitude) on the dependent variable (behaviour). The results of the regression analysis are presented in Table 8.

Table 8. Results of the statistical f test (ANOVA test)

Unstandardized Coefficients			Standardized Coefficients	t	Sig.
Model	B	Std. Error	Beta		
(Constant)	10.325	0.819		12.608	0.000
X1	-0.012	0.086	-0.019	-0.139	0.890
X2	0.187	0.084	0.297	2.213	0.030

Source: Primary Data, 2025

Table 8 shows that for X1 (Knowledge), the significance value of 0.890 is greater than $\alpha = 0.05$, thus concluding that knowledge does not significantly influence behaviour. The regression coefficient (B) of -0.012 indicates a very weak negative relationship, meaning that a one-unit increase in knowledge is not significantly followed by an increase in community behaviour. For variable X2 (Attitude), the significance value of $0.030 < 0.05$ indicates that attitude significantly influences behaviour. The regression coefficient (B) of 0.187 indicates that a one-unit increase in attitude will increase community behaviour by 0.187 units. Therefore, attitude is a variable that partially contributes significantly to community adaptive behaviour in response to the Urban Heat Island effect in the Rappocini District.

3.2. Discussion

This study shows that, in general, the level of knowledge, attitudes, and behaviour of the Rappocini District community regarding the Urban Heat Island (UHI) phenomenon is good. This is reflected in the high average scores for each indicator measured. The high level of community knowledge reflects that most respondents understood the basic concept of UHI, including its definition, impacts on health, and solutions that can be implemented to overcome it. This finding is in line with previous research showing that public perceptions of increasing temperatures in urban areas tend to be influenced by an understanding of the impacts and relevant adaptations (Harlan & Ruddell, 2011).

One important finding is that the public understands the impacts and solutions to the UHI better than its cause. The indicator for "solutions to the impacts of the UHI" reached the highest percentage, at 96%, whereas understanding the causes only reached 64%. This indicates a gap between conceptual knowledge and the structural understanding of the concept. Various studies have shown that many urban communities do not link dense infrastructure development, reduced vegetation, and human activity as the main causes of increasing surface temperatures (Jabbar et al., 2023; Leal Filho et al., 2018; Lenzholzer et al., 2020; Ramakreshnan et al., 2019).

The public attitudes in this study were also positive. Most respondents agreed on the need for government involvement in mitigating the impacts of the UHI and supported urban greening and environmentally conscious spatial planning policies. This is consistent with findings showing that pro-environmental attitudes, such as support for green open space management, are strongly

associated with the public's intention to take environmental action (Derkzen et al., 2017; Klemm et al., 2017; Sousa-Silva & Zanocco, 2024; Sturiale & Scuderi, 2019).

Regarding behavioural variables, the results show that the public has generally adopted adaptive measures, such as planting crops, using vehicles efficiently, supporting urban greening, and choosing to spend time in the shade during hot weather. High scores on these behavioural indicators reflect that respondents not only possess positive knowledge and attitudes but also implement them in their daily lives. People with an environmentally conscious attitude are more likely to take concrete actions that are both mitigating and adaptive to local climate issues (Lee, 2018).

The statistical results indicate that the knowledge and attitude variables do not significantly influence adaptive behaviour (F-test sig. = 0.054 > 0.05). With a relatively low explanatory power ($R^2 \approx 0.083$), the regression model is limited in its ability to account for variations in adaptive community behaviour. Therefore, any interpretation of the relationships among these variables should be considered tentative and requires further validation.

This low explanatory power suggests the potential influence of theoretically relevant unmeasured factors. For example, grounded in the Theory of Planned Behaviour (TPB), adaptive behaviour is also shaped by subjective norms and perceived behavioural control—constructs not included in the present model. External factors, such as social norms, access to green infrastructure, economic constraints, and environmental support systems, may therefore play a more substantial role in determining community responses to the Urban Heat Island phenomenon. Including these variables in future models may improve their explanatory power and provide a more comprehensive understanding of adaptive behaviour.

In contrast, the results of the partial test (t-test) showed that only attitudes had a significant influence on behaviour, with a sig value of 0.030 (<0.05), while knowledge did not show a significant influence, with a sig value of 0.890 (>0.05). This finding supports the opinion that strong environmental attitudes are often more capable of encouraging real action than knowledge (Hansla et al., 2008). Knowledge that is not accompanied by a strong attitude does not necessarily result in behavioural changes.

This condition is also supported by research which found that people with high levels of knowledge do not necessarily act adaptively if they do not have an attitude of environmental concern or do not see direct benefits from those actions (Derkzen et al., 2017). Therefore, a behaviour change approach in the context of adaptation to the UHI needs to focus on attitude formation through values, beliefs, and concerns, not just cognitive education alone. Furthermore, these results demonstrate the importance of adequate structural support and environmental facilities. It was found that people in dense and poor areas with limited access to green spaces have a limited ability to act, even though they have a good understanding of climate change (Cheng et al., 2024). Therefore, the government's role is crucial in creating an environment that supports adaptive behaviour, such as through green city planning, the provision of open spaces, and strengthening community-based environmental policies.

Overall, fostering adaptive behaviour in the community regarding the Urban Heat Island effect is not sufficient by simply increasing knowledge. Integrated efforts are needed, including value education, attitude change campaigns, and the provision of supporting facilities and policies. With a comprehensive approach, communities can be motivated to adopt behaviours that support sustainable urban climate resilience.

4. CONCLUSIONS

Based on the research results and data analysis, the following conclusions can be drawn: 1. The level of public knowledge of the Urban Heat Island phenomenon in the Rappocini District was generally good, with the highest indicators being solutions and health impacts. 2. Public attitudes demonstrate a high level of concern for environmental protection in mitigating the impacts of urban heat islands, particularly in supporting greening policies and sustainable spatial planning. 3. Public behaviour shows a positive tendency in responding to the Urban Heat Island effect, characterised by active participation in environmental efforts such as tree planting and reducing heat emissions. 4. Simultaneously, knowledge and attitude did not significantly influence behaviour. However, only attitude has been shown to significantly influenced community adaptive behaviour.

5. ACKNOWLEDGMENTS

The author would like to thank Makassar State University and the Institute for Research and Community Service (LPPM) UNM for funding and supporting this research through a PNBP grant from the Majelis Profesor (Professor's Council). Furthermore, the researcher would also like to thank the Head and Lecturers of the Geography Department, Faculty of Mathematics and Natural Sciences, UNM, for their full support in conducting this research.

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