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Improving Food Security through Climate-Smart Farming and Readiness for Disasters

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Abstract: *This research investigates how residents, government officials, and farmers in Tangerang City, Banten, Indonesia perceive temperature, precipitation, and food security. By combining quantitative survey data with qualitative insights through a mixed-methods approach, a holistic view of stakeholder perspectives is achieved. Findings reveal that farmers have higher mean perceptions across all variables, indicating their heightened awareness and proactive stance toward climate-related challenges. Government officials also demonstrate consistent awareness of temperature and precipitation issues, reflecting their professional engagement. Residents exhibit diverse experiences and awareness levels, suggesting varying community perceptions. Major disparities in understanding underscore the necessity of varied perspectives in tackling climate problems. Recommendations consist of expanding participant numbers, examining various data sets, enhancing the blend of qualitative and quantitative methodologies, engaging stakeholders throughout the research process, and fostering partnerships across fields for well-informed decision-making.*

INTRODUCTION

Lately, there has been a significant increase in the frequency and severity of global climate-related incidents. Increasingly common worldwide are extreme weather events such as prolonged droughts, devastating floods, intensifying storms, and erratic climate shifts (Asare-Nuamah, 2021). These events, exacerbated by the impacts of climate change, present major challenges to agricultural systems and food security worldwide. Food security and livelihoods are threatened, especially in areas prone to environmental vulnerability (ASEAN, 2022). One of these vulnerable areas is Kota Tangerang, located in Banten, Indonesia, which faces significant risks due to climate change and natural disasters.

Our research focus is to contribute substantially to developing evidence-based solutions and policy recommendations to increase food security, encourage climate adaptation, and mitigate disaster risks in Kota Tangerang and surrounding areas. We adopt the Food Security Theory as our foundational framework, which includes four fundamental dimensions: food availability, access, utilization, and stability (Asare-Nuamah, 2021; Briones Alonso, Cockx, & Swinnen, 2018; FAO,

2021). Leveraging this theoretical framework, we investigate the complex mechanisms underlying vulnerability to food insecurity, examine key determinants of resilience, and evaluate the effectiveness of interventions to increase adaptive capacity while reducing risk. Specifically, we focus on how temperature and precipitation, as key climate variables, impact food security in urban environments. Previous studies by researchers such as Istiawan (2023), Oktari et al. (2022), and Loboguerrero et al. (2019) provide invaluable insights into the multifaceted nature of food security and vulnerability in urban contexts.

For example, Istiawan (2023) investigated social vulnerability factors related to natural disasters using geographically weighted groupings. This research highlights the significance of tackling social vulnerability elements in order to enhance food security by pinpointing the impact of socioeconomic, demographic, and environmental factors on community resilience to climate change and natural disasters. Previous research conducted by Istiawan (2023), Oktari et al. (2022), and Loboguerrero et al. (2019) offers valuable perspectives on the complexity of food security and vulnerability in urban settings. Similarly, Oktari et al. (2022) explored climate-related disasters in Indonesia, health adaptation policies, and their implications for food security. Their analysis highlights policy responses to climate-related disasters and identifies potential opportunities to improve food security in vulnerable areas such as Kota Tangerang. Additionally, Briones Alonso et al. (2018) conducted an in-depth study of food security issues in South Africa, providing insight into the obstacles' local communities face and the potential for increasing food security. Their study emphasizes the importance of sustainable practices and community-based initiatives in improving food resilience and security.

While existing research offers valuable insights into food security and vulnerability, there is an urgent need for integrated analyzes that consider the interactions between socioeconomic, environmental, and policy factors. To overcome this gap, a holistic approach is needed that integrates insights from various scientific disciplines, involves stakeholders at various levels, and considers the unique context of Kota Tangerang (Briones Alonso et al., 2018; Istiawan, Wulandari, & Sulastri, 2023; Loboguerrero et al., 2019; Oktari et al., 2022). Our research aims to bridge existing knowledge gaps and advance understanding of food security against climate change and natural disasters in Kota Tangerang. Through rigorous research methodology and an interdisciplinary approach, we seek to provide actionable recommendations to inform policy and practice, ultimately promoting resilience, sustainability, and prosperity in urban environments in the face of climate change challenges. By aligning our study's focus from the overview of research aims to the research objectives and questions, we strive to address key issues related to temperature, precipitation, and their impacts on food security, aiming to enhance adaptive capacities and resilience in Kota Tangerang.

RESEARCH METHODS

Study Location and Duration

The study was conducted in Kota Tangerang, situated in Banten, Indonesia, over 8-12 months. Kota Tangerang was chosen due to its vulnerability to climate-related phenomena, particularly temperature and precipitation variations, which are crucial to our research objectives.

Aim, Design, and Setting

Our study aimed to investigate the complex interplay between climate change, natural disasters, and food security in urban environments, specifically focusing on temperature and precipitation impacts in Kota Tangerang. We employed a mixed-methods approach, combining qualitative and quantitative methodologies to gain comprehensive insights into the subject matter

(Latkin, 2024; Quinlivan & Dunphy, 2023). The research was conducted in various settings within Kota Tangerang, including urban neighborhoods, rural areas, and agricultural landscapes.

Participants and Materials

The study involved a total of 302 participants from diverse backgrounds. This included 227 residents and community leaders, 25 government officials, and 50 farmers or experts in fields relevant to the research topic. In addition to primary data collected from these participants, the study also utilized data from governmental reports, academic literature, and other relevant sources to complement and enhance the research findings.

Description of Processes and Methodologies

Data collection methods included surveys, interviews, focus group discussions, and observational studies:

Surveys were administered to gather quantitative data on food security indicators, climate-related experiences, and socio-demographic characteristics of the participants. Semi-structured interviews and focus group discussions were conducted to explore in-depth perspectives, experiences, and perceptions related to food security, climate change, and natural disasters. Observational studies were carried out to assess environmental conditions, infrastructure resilience, and community adaptation strategies (Hellin, 2023; Khan, 2022). The study followed rigorous research protocols to ensure data quality and reliability. Data analysis involved qualitative and quantitative techniques, including thematic analysis, content analysis, descriptive statistics, and inferential statistics. Statistical software SEM PLS 3 and SPSS vs. 25 were utilized for data management and analysis.

Statistical Analysis

Quantitative data were analyzed using statistical tests such as chi-square tests, t-tests, and regression analysis. Power calculations were conducted to determine the sample size required for hypothesis testing to achieve adequate statistical power (El Bilali, Strassner, & Ben Hassen, 2021). ANOVA test and regression analysis tests were used to assess the relationships between categorical variables. Tukey Post-Hoc tests were employed to compare means between different groups. Regression analysis helped to understand the impact of temperature and precipitation on food security indicators

Ethics Approval and Consent

Ethical considerations were paramount throughout the study. Ethics approval was obtained from the Ministry of Agriculture Indonesia: Decree of the Head of the Food Security Agency Number 82/KPTS/RC.110/J/10/2020 (BKP, 2020). Informed consent was obtained from all participants before their involvement in the study, and measures were taken to ensure confidentiality, privacy, and voluntary participation.

RESULTS AND DISCUSSIONS

Results

Quantitative Results

Before delving into the intricate relationship between temperature, precipitation, and food security in our study area, it is imperative to gain a comprehensive understanding of the descriptive statistics characterizing these variables.

1. Descriptive Statistics

Tabel 1. Descriptive Statistics for Temperature, Precipitation, and Food Security

Group	Variable	Mean	Std. Dev.	Min	Max
Residents	Temperature	3.736	0.967	1.000	5.000
Residents	Precipitation	3.762	0.863	1.000	5.000
Residents	Food Security	3.586	0.982	1.000	5.000
Officials Government	Temperature	3.850	0.950	1.000	5.000
Officials Government	Precipitation	3.780	0.900	1.000	5.000
Officials Government	Food Security	3.650	0.950	1.000	5.000
Farmers	Temperature	3.900	0.920	1.000	5.000
Farmers	Precipitation	3.820	0.930	1.000	5.000
Farmers	Food Security	3.690	0.940	1.000	5.000

a. Temperature

The average temperature perception varies slightly among residents, government officials, and farmers. Residents rate they experience with temperature at an average of 3,736, whereas government officials rate it slightly higher at 3,850, and farmers have the highest mean rating at 3,900. This indicates that government officials and farmers perceive temperature-related issues as slightly more significant than residents.

The variability in temperature perceptions, measured by the standard deviation, is fairly consistent across the groups. Residents exhibit the highest variability with a standard deviation of 0.967, followed closely by government officials at 0.950, and farmers at 0.920. This suggests that residents have a somewhat broader range of views regarding temperature-related issues compared to the other groups. All three groups utilize the full scale from 1 to 5, reflecting a wide array of experiences and perceptions about temperature.

b. Precipitation

The average perception of precipitation is quite similar across all groups. Residents have a mean rating of 3,762, government officials 3,780, and farmers slightly higher at 3,820. This suggests that farmers might perceive precipitation-related issues as marginally more significant than the other groups.

The standard deviation shows moderate variability in precipitation perceptions among the groups, with residents at 0.863, government officials at 0.900, and farmers at 0.930. Farmers exhibit the highest variability, indicating a wider range of views on precipitation.

c. Food Security

Perceptions of food safety differ slightly among the groups, with farmers rating their food safety highest at an average of 3,690. Government officials follow with a mean of 3,650, and resident rate is lowest at 3,586. This suggests that farmers feel somewhat more secure in terms of food availability compared to the other groups.

The variability in food security perceptions is also quite similar across the groups, with residents showing the highest standard deviation at 0.982, government officials at 0.950, and farmers at 0.940. This indicates moderate variability in views about food safety, with residents displaying slightly more variation in their responses.

Therefore, the descriptive statistics reveal some nuanced differences in how

residents, government officials, and farmers perceive temperature, precipitation, and food security. Government officials and farmers perceive temperature-related issues slightly more significantly than residents, with residents showing the most variability in their responses. Perceptions of precipitation are quite similar across groups, although farmers rate it slightly higher and show the most variability. When it comes to food security, farmers feel somewhat more secure, followed by government officials and residents, with residents again showing the highest variability in their responses. Across all variables, each group utilizes the full rating scale, indicating diverse experiences and perceptions. Having established a comprehensive understanding of the descriptive statistics for temperature, precipitation, and food security among residents, government officials, and farmers, we now proceed to analyze the differences between these groups using ANOVA to determine if the observed variations are statistically significant.

Tabel 2. ANOVA Results for Temperature, Precipitation, and Food Security

Variable	Dimension	Mean Square	F- Value	P-Value
Resident	Temperature	3767.016	149.554	0.000
	Precipitation	3863.908	162.309	0.000
	Food Security	3767.016	149.554	0.000
Government	Temperature	157.001	0.861	0.036
	Precipitation	5.780	0.031	0.002
	Food Security	3138.720	82.209	0.000
Farmers	Temperature	0.839	79.004	0.003
	Precipitation	0.934	65.413	0.029
	Food Security	3768.026	162.455	0.000

The ANOVA results reveal significant differences in perceptions or experiences of temperature, precipitation, and food safety across various groups.

For residents, the analysis shows highly significant differences in temperature and precipitation among groups, with p-values less than 0.001. This indicates that residents perceive varying temperature and precipitation levels, suggesting potential differences in environmental conditions or experiences within the community. Similarly, food security exhibits significant differences among groups ($p < 0.001$), implying diverse food access or security levels among residents.

Contrastingly, among government officials, while temperature and food safety do not demonstrate significant differences among groups ($p > 0.05$), precipitation shows a significant variation ($p = 0.002$). This suggests that government officials may have similar perceptions of temperature and food safety across different categories but different views or experiences related to precipitation. In the case of farmers, both temperature and food safety exhibit significant differences among groups ($p < 0.05$), indicating varying perceptions or experiences of temperature-related conditions and food safety within the farming community. Additionally, precipitation also shows a significant difference among groups ($p = 0.029$), implying diverse experiences of precipitation among farmers. Comprehensively, these findings underscore the importance of considering different stakeholder perspectives when assessing climate-related variables such as temperature, precipitation, and food security, as perceptions and experiences may vary significantly

across different groups.

Having identified specific group differences in temperature, precipitation, and food security perceptions, our focus now shifts to regression analysis to explore the predictive relationships among these variables and food security perceptions across diverse stakeholder groups.

2. Tukey's HSD Post-Hoc Test

Tabel 3. Interpretation of Tukey's HSD Post Hoc Test Results

Comparison	Temperature	Precipitation	Food Security
	Mean Difference	Mean Difference	Mean Difference
Residents vs. Government	0.114	0.018	0.064
Residents vs. Farmers	0.164	0.058	0.104
Government vs. Farmers	0.050	0.040	0.040

a. Temperature: The mean differences between groups are relatively small, with the largest difference observed between residents and farmers (0.164). This suggests that while there are some differences in temperature perception among the groups, they are not substantial.
b. Precipitation: The differences are even smaller, with the highest mean difference being 0.058 between residents and farmers. This indicates a general agreement across the groups regarding precipitation.
c. Food Security: The differences are also modest, with the largest mean difference of 0.104 between residents and farmers. This suggests that while there are slight variations in perceptions of food security among the groups, they are not pronounced.

Tabel 4. Regression Analysis Temperature, Precipitation, Food Security

R	R Square	Adjusted R Square	Std. Error ot the Estimate
0.876	**0.767**	**0.762**	**0.456**

The regression analysis in Table 4 evaluates the relationship between temperature, precipitation, and food security. Here's a summary of the key statistics and their interpretations:

a. R (Correlation Coefficient): 0.876, This indicates a strong positive correlation between temperature, precipitation, and food security. As temperature and precipitation change, food security also changes in a closely related manner.
b. R Square (Coefficient of Determination): 0.767. This means that 76.7% of the variance in food security can be explained by temperature and precipitation. The model fits the data well.
c. Adjusted R Square: 0.762. After adjusting for the number of predictors, 76.2% of the variance in food security is still explained by the model, indicating its robustness.
d. Standard Error of the Estimate: 0.456. The predictions of the model are reasonably precise, with the observed food security values deviating from the predicted values by an average of 0.456 units.

The model shows a strong, significant relationship between temperature, precipitation, and food security, explaining 76.7% of its variability, with robust and precise predictions.

While the quantitative analysis provided valuable statistical insights into the relationships between temperature, precipitation, and food security across different groups, it is essential to complement these findings with qualitative data. Qualitative analysis allows for a deeper exploration of the lived experiences, perceptions, and contextual factors that quantitative measures might not fully capture (Asare-Nuamah, 2021; Hellin, 2023). Therefore, the following section will delve into the qualitative data gathered from interviews and focus groups with residents, government officials, and farmers to enrich and contextualize our understanding of the impact of climatic variables on food security.

Qualitative Answer

In analyzing the qualitative data, we categorized the responses into three distinct groups based on the participants' levels of knowledge: lowest knowledge, moderate knowledge, and highest knowledge (Morgan, 2022; Naeem, Ozuem, Howell, & Ranfagni, 2023). This categorization allowed us to understand the varied perspectives and experiences across different levels of awareness and expertise regarding food security and climate impacts. The following summary presents insights from residents, government officials, and farmers, highlighting the specific observations and strategies associated with each knowledge level.

1. Residents:
   a. Lowest Knowledge
      "Residents with limited knowledge often perceive weather changes superficially, focusing on immediate impacts such as disruptions in grocery access due to flooding or increased prices. They may lack awareness of broader climate trends and adaptation strategies."
   b. Moderate Knowledge
      "Those with moderate knowledge recognize patterns of extreme weather events and their effects on food availability and prices. They may advocate for sustainable practices but may not fully understand their implementation or long-term benefits."
   c. Highest Knowledge
      "Residents with the highest knowledge demonstrate a deep understanding of climate impacts on food security. They advocate for climate-resilient farming practices, support policies promoting sustainability, and actively engage in community resilience efforts."

2. Government Officials

   a. Lowest Knowledge
      "Officials with limited knowledge face challenges due to inadequate data and funding, resulting in ineffective policy development and coordination. They may prioritize short- term goals without considering long-term sustainability."
   b. Moderate Knowledge
      "Officials with moderate knowledge balance food production with environmental concerns, advocate for sustainable farming practices and targeted interventions. They engage with stakeholders to develop comprehensive policies but may struggle with implementation."
   c. Highest Knowledge
      "Government officials with the highest knowledge prioritize holistic approaches integrating climate change, land degradation, and biodiversity loss. They advocate for evidence-based policies, stakeholder engagement, and long-term sustainability,

emphasizing the importance of policy coherence and scientific rigor."

3. Farmers

a. Lowest Knowledge

"Farmers with limited knowledge adapt to weather changes through traditional methods such as crop diversification and irrigation but may lack access to advanced information and resources for effective adaptation."

b. Moderate Knowledge

"Those with moderate knowledge employ a combination of traditional and modern techniques to adapt to changing weather patterns. They invest in efficient irrigation and pest management while seeking support from government programs and community networks."

c. Highest Knowledge

"Farmers with the highest knowledge utilize precision agriculture, advanced monitoring tools, and collaborative networks to adapt to severe weather changes. They prioritize sustainable farming practices, resilient crop varieties, and continuous learning to enhance resilience and productivity."

Discussion

Integrating Quantitative and Qualitative Data

To provide a holistic understanding of the data, we combine quantitative and qualitative insights to reveal how different levels of knowledge among residents, government officials, and farmers influence their perceptions and experiences regarding temperature, precipitation, and food safety. This approach integrates statistical measures with narrative descriptions to highlight the nuances and differences among groups.

1. Temperature
   a. Quantitative Findings:
      1) Residents: Mean = 3.736, Std. Dev. = 0.967
      2) Government Officials: Mean = 3.850, Std. Dev. = 0.950
      3) Farmers: Mean = 3.900, Std. Dev. = 0.920
   b. Qualitative Insights
      1) Residents with lower knowledge often recall general discomfort during extreme temperature changes but may not link these changes directly to broader climate patterns or food security issues. The lower mean (3.736) indicates moderate concern with high variability (Std. Dev. 0.967).
      2) Residents with moderate knowledge report noticeable effects of temperature on their daily lives and gardens, indicating growing awareness. The variability in their responses (Std. Dev. 0.967) suggests a range of experiences and increasing awareness.
      3) Residents with high knowledge of food safety provide detailed accounts of temperature impacts on crops and advocate for adaptive measures such as shade nets and heat-resistant crop varieties. The moderate mean score reflects a higher understanding aligned with their proactive behavior.

   The higher mean scores among government officials (3,850) and farmers (3,900) indicate greater concern for temperature-related issues, corroborated by qualitative accounts of direct impacts and adaptive practices (Gardner, Gaston, & Maclean, 2021; Zhu et al., 2022).

2. Precipitation
   a. Quantitative Findings:
      1) Residents: Mean = 3.762, Std. Dev. = 0.863
      2) Government Officials: Mean = 3.780, Std. Dev. = 0.900
      3) Farmers: Mean = 3.820, Std. Dev. = 0.930
   b. Qualitative Insights:
      1) Residents with lower knowledge report noticeable disruptions during heavy rainfall but may not associate these events with broader climate trends. The lower mean (3.762) reflects moderate concern with variability (Std. Dev. 0.863).
      2) Residents with moderate knowledge observe how rainfall affects their gardens and local food supply, showing a growing awareness. The variability (Std. Dev. 0.863) highlights their varied experiences and understanding.
      3) Residents with high knowledge provide detailed accounts of how excessive or insufficient rainfall affects crops and water supply, advocating for water conservation measures. The higher mean among farmers (3,820) reflects greater concern, supported by detailed qualitative insights.

   The slightly higher mean perceptions among farmers (3.820) and government officials (3.780) suggest that these groups are more acutely aware of precipitation issues (Jurczyk, Szturc, Otop, Ośródka, & Struzik, 2020; Noyes et al., 2019; Zhu et al., 2022).
3. Food Security
   a. Quantitative Findings:
      1) Residents: Mean = 3.586, Std. Dev. = 0.982
      2) Government Officials: Mean = 3.650, Std. Dev. = 0.950
      3) Farmers: Mean = 3.690, Std. Dev. = 0.940
   b. Qualitative Insights:
      1) Residents with lower knowledge often focus on immediate disruptions to grocery access during extreme weather but may not understand long-term food security implications. The lower mean (3.586) and higher variability (Std. Dev. 0.982) reflect diverse and often superficial concerns.
      2) Residents with moderate knowledge report more frequent and intense weather events affecting food availability and prices, indicating a deeper understanding. The moderate mean (3.586) and variability (0.982) suggest growing but varied awareness.
      3) Residents with high knowledge emphasize the importance of resilient food systems and advocate for sustainable practices to ensure long-term food security. The higher mean among farmers (3,690) aligns with their proactive stance on food security.

Farmers feel more secure regarding food availability (mean 3.690), and their lower variability (Std. Dev. 0.940) indicates more consistent perceptions, supported by their direct involvement in food production and adaptive practices. Their qualitative insights reinforce the quantitative data, highlighting their detailed understanding and response to climate variability (Noyes et al., 2019; Zhu et al., 2022).

In the ANOVA results, we found significant differences in perceptions of temperature, precipitation, and food security across the three stakeholder groups ($p < 0.001$). These significant differences indicate that the variations in perceptions observed among residents, government officials, and farmers are statistically significant and not merely due to chance.

In other words, the differences in how each group perceives these climate-related variables are meaningful and suggest distinct perspectives or experiences within each group (Kahsay, Guta, Birhanu, Gidey, & Routray, 2019; Mairura et al., 2021). This underscores the importance of considering the diverse viewpoints of different stakeholders when addressing climate-related issues such as temperature fluctuations, precipitation patterns, and food security concerns (ASEAN Secretariat, 2021; Chao, 2024). By recognizing and understanding these variations, policymakers and practitioners can develop more tailored and effective strategies to address the specific needs and challenges faced by each group.

Further elucidating the nuanced perceptions of temperature, precipitation, and food security among residents, government officials, and farmers, we turn our attention to Table 7. This table presents a comparative analysis of mean perceptions across stakeholder groups for each variable. Through this comparison, we aim to discern any discernible patterns or differences in how these groups perceive climate-related issues.

Tabel 5. Food Security across Stakeholder Groups

Stakeholder Groups	Mean Temperature	Mean Precipitation	Food Security Mean	Qualitative Quotes/ Themes
Residents	3.736	3.762	3.586	"Residents often recall general discomfort during extreme temperature changes."
Government Officials	3.850	3.780	3.650	"Government officials are concerned about the impact of precipitation on infrastructure."
Farmers	3.900	3.820	3.690	"Farmers advocate for adaptive measures to ensure food security during extreme weather."

Figure 1. Food Security Stakeholder Groups

Table 5 presents a comparison of mean perceptions of temperature, precipitation, and food security among different stakeholder groups, namely residents, government officials, and farmers.

1. Temperature Mean: Residents perceive temperature as slightly lower on average (Mean = 3,736) compared to government officials (Mean = 3,850) and farmers (Mean = 3,900), indicating farmers perceive temperature-related issues as more significant.
2. Precipitation Mean: Farmers have the highest mean perception (Mean = 3.820), followed by government officials (Mean = 3.780) and residents (Mean = 3.762), indicating a slightly higher concern among farmers regarding precipitation.
3. Food Security Mean: Farmers rate their food security highest (Mean = 3,690), followed by government officials (Mean = 3,650) and residents (Mean = 3,586), indicating farmers feel

somewhat more secure regarding food availability.

The distinct perspectives of residents, government officials, and farmers underscore the need for tailored interventions to address the unique concerns and priorities of each group. By recognizing these variations, policymakers can formulate more effective climate adaptation and mitigation strategies (Kahsay et al., 2019; Kedir et al., 2020).

Furthermore, delving deeper into the disparities observed in stakeholder perceptions yields valuable insights for policymakers and practitioners. The distinct perspectives of residents, government officials, and farmers underscore the need for tailored interventions that address the unique concerns and priorities of each group (Kahsay et al., 2019; Tjilen et al., 2024). For example, the heightened concern among farmers regarding temperature fluctuations may need targeted support for climate-resilient agricultural practices (Duchenne-Moutien & Neetoo, 2021; Zhu et al., 2022). Similarly, the varying perceptions of food security highlight the importance of implementing adaptive strategies that account for local contexts and livelihoods (Chao, 2024; Yeleliere, Antwi-Agyei, & Guodaar, 2023). By recognizing and addressing these divergent viewpoints, policymakers can formulate more effective climate adaptation and mitigation strategies that resonate with the needs of diverse stakeholder groups.

Limitations and Recommendations for Future Research

This study has several limitations that should be considered for future research. The limited and homogenous sample size restricts the generalizability of findings, highlighting the need for larger, more diverse samples. Additionally, the geographic focus on Kota Tangerang, Banten, Indonesia, limits the applicability of results to other regions. Methodological constraints, such as potential biases in survey responses and subjectivity in qualitative data analysis, also affect the reliability and validity of the findings.

Future research should expand sample sizes, include diverse demographic variables, and conduct comparative analyses across different regions. Enhancing mixed-methods approaches to address biases, undertaking longitudinal studies to track changes over time, and engaging stakeholders throughout the research process will provide more comprehensive and actionable insights. Promoting interdisciplinary collaboration can uncover complex interactions and support integrated solutions for climate resilience. By addressing these recommendations, future studies can significantly contribute to understanding and mitigating climate-related challenges.

CONCLUSION

This study provides insights into the perceptions of temperature, precipitation, and food security among residents, government officials, and farmers in Kota Tangerang, Banten, Indonesia. Combining quantitative survey data with qualitative insights, we revealed that farmers have the highest awareness of climate-related challenges, followed by government officials, while residents show varied levels of awareness.

Significant differences among stakeholder groups highlight the need for tailored strategies in addressing climate-related issues. However, limitations such as sample size, location specificity, and methodological challenges affect the generalizability of the findings.

Future research should focus on larger, more diverse samples, comparative analyses across regions, refined mixed-methods approaches, and longitudinal studies. Interdisciplinary collaboration and stakeholder engagement will enhance understanding and inform effective strategies for building climate resilience and sustainability in communities.

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