SEESDGJ
Social, Ecology, Economy, and Sustainable Development Goals Journal
SEESDGJ 2(1): 59-77
ISSN 3025-3942

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

Understanding Climate Change Awareness and Adaptation Measures in Urban Settings

Nguyen Thi Hue[1], Ernoiz Antriyandarti[2]*

[1] *Bachelor of Environmental Science and Management, Faculty of International Programs Office, Thai Nguyen University of Agriculture and Forestry, Tân Thịnh, Thành phố Thái Nguyên, Thai Nguyen, Vietnam;*

[2] *Agribusiness Study Program, Faculty of Agriculture, Universitas Sebelas Maret, Ir. Sutami Street 36, Surakarta, Central Java 57126, Indonesia.*

*Correspondence: ernoiz_a@staff.unc.ac.id

Received Date: 29 April 2024 Revised Date: 18 July 2024 Accepted Date: 30 July 2024

ABSTRACT

Backgorund: Extreme weather events, such as flooding and droughts, are becoming more common, posing significant challenges to human existence, economic growth, and the natural environment. This research aims to provide a comprehensive understanding of climate change awareness and adaptation measures among adolescents and local people in Surakarta, Indonesia. The study seeks to assess how the local population perceives and responds to climate change, as well as to identify factors that make communities vulnerable to severe weather events. By exploring these factors, the study aims to shed light on the underlying causes of vulnerability and inform the development of effective adaptation and mitigation strategies. **Method:** The research methodology involves the use of structured questionnaires and surveys to collect data from 100 respondents in Surakarta. Statistical analysis, including regression analysis, is employed to assess the relationship between various demographic factors and climate change awareness. Demographic factors such as age, education level, and income are evaluated to understand their impact on climate change perception and responsiveness. **Findings:** The findings of the study highlight the importance of enhancing climate change knowledge among adolescents and local residents and underscore the need for targeted adaptation measures to address the unique challenges faced by urban communities in Surakarta. **Conclusion:** Overall, this study contributes to the broader understanding of climate change adaptation and resilience-building efforts in urban settings and provides valuable insights for policymakers, researchers, and community stakeholders working in the field of climate change mitigation and adaptation. **Novelty/Originality of this article:** Using a structured survey, this study assessed climate change awareness and adaptation measures among adolescents and residents. The findings highlight the importance of improving knowledge about climate change and developing appropriate adaptation strategies for urban communities.

KEYWORDS: Adaptation; climate change; Indonesia; resilience-building; vulnerability.

1. Introduction

Climate change, characterized by alterations in climate patterns over extensive periods and across vast regions, has emerged as a pressing global concern, with human activities playing a pivotal role in its exacerbation. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a transition specifically or implicitly attributable to human intervention, altering the structure of the global environment beyond normal variations observed over comparable timeframes (UNFCCC,

Cite This Article:
Hue, N. T. (2024). Understanding Climate Change Awareness and Adaptation Measures in Urban Settings: A Study in Surakarta, Indonesia. *Social, Ecology, Economy, and Sustainable Development Goals Journal, 2*(1), 59-77. https://doi.org/10.61511/seesdgj.v2i1.2024.776

1992). Its impacts span environmental, social, and economic realms, manifesting in diminished access to essential resources like food and water, biodiversity loss, and compromised living conditions, particularly affecting vulnerable demographics such as youth. These impacts include phenomena like ice melting, sea level rise, and intensified extreme weather events, as outlined by the Intergovermental Panel on Climate Change (IPCC) (2014), which unequivocally attributes these changes to human influence.

Climate change's adverse effects extend beyond environmental degradation, profoundly impacting human health and well-being across various domains. Rising temperatures exacerbate respiratory conditions like asthma, while alterations in precipitation patterns and extreme weather events pose health risks, particularly among susceptible populations. In Indonesia, a country predisposed to climate change due to its geographical positioning and high population density reliant on agriculture, climate-induced threats such as sea-level rise, flooding, and droughts loom large. Particularly, Central Java, marked by vulnerability to natural hazards and accelerated urbanization, emerges as a focal point for climate change research, necessitating an understanding of its impacts and adaptation strategies (BPS Provinsi Jawa Tengah, 2014; Heijmans, 2012). Surakarta, a densely populated city in Central Java, epitomizes the multifaceted challenges posed by climate change, including recurrent floods and dwindling agricultural lands (Isharyanto, 2018).

Given the imperative to comprehend and mitigate the impacts of climate change, especially among vulnerable populations, this study endeavors to evaluate the awareness of young people and local communities regarding climate change in Surakarta, Central Java. By identifying climate change awareness, factors influencing people's awareness, and analyzing local policies aimed at enhancing awareness, this research seeks to formulate recommendations for fostering climate change literacy and engagement among youth and indigenous communities.

1.1 Environmental Issues in Indonesia

Research indicates that Indonesia is highly susceptible to climate change and lacks adequate preparedness to address its consequences. Factors contributing to this vulnerability include lower agricultural productivity, technical inefficiency, inadequate education quality, and pervasive corruption (Mora et al., 2013). Climate departures, where average air temperatures approach variations observed over the past 150 years, are projected to occur as early as 2030 in Indonesia, exacerbating challenges for farmers whose planting seasons are shifting unpredictably (Adiyoga, 2018). Droughts and floods, the country's most severe disasters, are anticipated to become more frequent, further exacerbating poverty (Fujii, 2016).

Studies have shown that air pollution, exacerbated by forest fires, significantly increases health risks and reduces labor productivity, resulting in substantial economic losses (Kim et al., 2017). Additionally, Indonesia's extensive coastline puts millions of residents at risk of rising sea levels, with projections indicating that a one-meter rise could inundate vast swathes of land and displace millions. Indonesia's substantial greenhouse gas emissions, stemming from deforestation and reliance on fossil fuels, particularly coal, further exacerbate its vulnerability to climate change. While the country has committed to carbon reduction goals under the Paris Agreement, achieving these targets necessitates robust measures to combat forest degradation and invest in renewable energy sources like solar and geothermal power. However, Indonesia's readiness for climate change remains inadequate across various domains.

1.2 Awareness and knowledge for climate change

Research reveals widespread awareness of climate change-related terms among the English populace, with 99 percent familiar with terms like "climate change," "extreme warming," or "greenhouse impact" (Norton & Leaman, 2004). However, a disparity exists in

awareness between "climate change" and "global warming," with more individuals knowledgeable about the latter term. Young people exhibit heightened interest and awareness of climate change issues, though misconceptions persist, such as confusion between climate change and ozone layer depletion (Gifford & Comeau, 2011). Despite their interest, young people often feel powerless in addressing climate change due to limited autonomy and reliance on adults for decision-making (Ballantyne et al., 2001). This sense of powerlessness can lead to frustration, especially when individuals perceive a gap between their desired actions and available resources (Fritze et al., 2008).

While some youth adopt problem-focused coping strategies, such as individual action, they may still experience negative emotions due to the recognition of the systemic nature of climate change (Ojala, 2013). Additionally, age-related differences in environmental awareness suggest that climate change education may become less engaging for high school students compared to younger age groups (Díaz Estévez et al., 2014). These findings underscore the complex interplay between climate change awareness, agency, and emotional responses, particularly among youth, in addressing this pressing global issue.

1.3 Adaptation and mitigation in responding to climate change

Adaptation, rooted in recent weather change observations and past experiences, involves developing mechanisms and behaviors to cope with evolving environmental conditions (Tompkins & Eakin, 2012). Key components include enhancing infrastructure resilience, increasing adaptive capacity of vulnerable systems, and improving public awareness. Recognizing the direct link between human activity and climate change impacts, adaptation becomes a critical resource in climate policy. Previous research underscores the urgency of adapting to climate change and increasing instability (Klein et al., 2005), necessitating a focus on enhancing adaptive capacity, resilience, and flexibility.

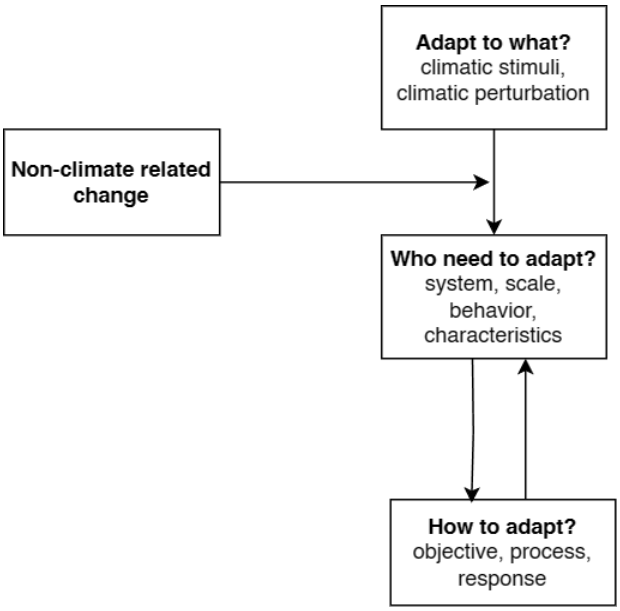

Fig 1. Key factors of adaptation to climate change
(Grafton, 2010)

The United Nations Framework Convention on Climate Change (UNFCCC) outlines adaptation and mitigation as two primary strategies for addressing climate change. While Table 1 delineates key differences between the two approaches, scholars warn against relying solely on either strategy, citing potential inadequacies in response. A nuanced approach is proposed, with a focus on highlighting the dynamic interplay between adaptation and mitigation through categories such as adaptation policies with mitigation roles. The growing significance of adaptation in response strategies is driven by

organizational constraints and limitations in the efficacy of mitigation measures (Pielke, 1998).

Table 1. Conceptual differences between adaptation and mitigation orientation

	Adaptation	Mitigation
Orientation	Social and economic determinants of vulnerability	Physical and biological science of impacts
Temporal scale	- Short-term impact - Immediate benefits	- Long-term phenomenon - Gradual benefits
Spatial scale	Local to global	Global scale is effective
Comparable benefit	Difficult to express and compare with other adaptation options in a single metric	Easy to compare with other mitigation options and expressed as CO_2 equivalent or cost-effectiveness
Actor and Type	Variety of sectoral interests and different levels (individual to national agencies)	Limited sectoral actors and focus on greenhouse gas emission

1.4 Factors influence climate change awareness

Studies identifies four key variables shaping people's understanding of climate change: education, age, personal experience, and access to information. Education plays a pivotal role in heightening awareness and addressing the impact of global warming. It fosters climate literacy, promotes changes in attitudes and behaviors, and encourages adaptation to climate change-related trends. Age emerges as a significant indicator, with older individuals typically exhibiting greater awareness of climate change, although younger generations are increasingly attuned to environmental issues (Patchen, 2006). Personal experience with climate change effects, especially in disaster-prone regions, enhances awareness and concern among affected individuals (Myers et al., 2012; Whitmarsh, 2008).

Access to information also shapes understanding, with media reporting playing a crucial role in influencing public awareness and concern about climate change (Sampei & Aoyagi-Usui, 2009). Gender differences further compound these dynamics, as women are often disproportionately affected by climate change impacts due to societal roles and norms. Women's health and livelihoods are particularly vulnerable to climate-related stresses, such as water scarcity and increased workload, which can exacerbate existing inequalities. Additionally, income level influences vulnerability, with low-income individuals facing greater challenges in preparing for and recovering from climate-related incidents like flooding and heatwaves (Benzie et al., 2011).

For instance, people with low incomes are more likely to lack access to resources and face difficulties in obtaining adequate flood insurance or implementing resilience measures for their homes. They may also be more susceptible to health impacts from extreme weather events due to factors such as age, fitness, or social marginalization (Benzie et al., 2011). Thus, understanding the interplay of these variables is crucial for developing targeted interventions and policies to enhance climate change awareness and resilience among diverse populations.

2. Methods

The research conducted in Surakarta, Central Java, Indonesia, aimed to address the evident lack of awareness among local residents, particularly young adults at the upper secondary and tertiary levels, regarding climate change and its potential impacts on the environment. Surakarta, with a population exceeding 550,000, represents a densely populated urban center within Central Java province. However, despite its demographic density, there exists a concerning dearth of climate change literacy among its inhabitants. Recognizing the urgent need to augment public understanding and stimulate behavioral

changes to mitigate environmental repercussions, the research endeavors to comprehensively assess and enhance knowledge about climate change in Surakarta.

To achieve the research objectives, a multifaceted approach was adopted, encompassing various research materials and methodologies. Utilizing a comprehensive questionnaire administered through Google Forms facilitated efficient data collection, while laptops and computers served as indispensable tools for literature review, data analysis, and statistical modeling. The employment of statistical software such as STATA and SPSS enabled the identification of trends and patterns among respondents' data, crucial for deriving meaningful insights.

The research design was anchored in descriptive statistics, a method widely recognized for its efficacy in collecting and analyzing data in the social sciences. Leveraging surveys and interviews facilitated personal interactions between the researcher and participants, fostering the acquisition of nuanced information essential for addressing research inquiries. Close-ended questions, strategically integrated into the questionnaire, aimed to elucidate respondent characteristics and provide a comprehensive understanding of the research context.

Employing a Descriptive Sampling Method, the research embraced a survey-based strategy to address its objectives effectively. Through meticulous questionnaire design and structured data collection procedures, the study sought to encompass the diverse demographics of Surakarta's populace, ensuring comprehensive coverage of pertinent variables. By categorizing respondents based on educational attainment and other demographic factors, the research aimed to glean insights into the nuanced perceptions and awareness levels regarding climate change across different segments of the population.

The questionnaire utilized in the study comprised multiple sections designed to elicit detailed responses pertaining to respondents' demographics, educational background, and awareness of climate change. Questions ranged from basic inquiries about respondents' understanding of climate change to more complex queries regarding its potential impacts and mitigation strategies. Open-ended, multiple-choice, and rating questions were incorporated to provide a comprehensive assessment of respondents' knowledge and attitudes towards climate change.

Hypothesis testing formed an integral component of the research methodology, employing the Chi-square method to assess statistically significant variations between categorical variables. The null hypothesis, positing no significant discrepancy between survey sample classes, served as the basis for evaluating public perceptions and beliefs regarding climate change. Through rigorous data analysis and hypothesis testing, the research endeavors to unearth valuable insights into public awareness and perceptions of climate change in Surakarta, ultimately informing evidence-based interventions and policy formulations aimed at fostering climate change literacy and promoting sustainable behaviors within the community.

The questionnaire was meticulously designed to capture a wide range of information pertinent to the study objectives. The initial section focused on gathering demographic details of respondents, including age, gender, educational background, and occupation. This demographic information was crucial for segmenting the respondents into distinct groups based on their characteristics, enabling a comprehensive analysis of their perceptions and awareness levels regarding climate change.

Subsequent sections of the questionnaire delved into respondents' understanding of climate change, encompassing questions aimed at gauging their awareness of key concepts such as greenhouse gas emissions, global warming, and climate-related phenomena. Participants were asked to provide open-ended responses detailing their perceptions of climate change, its causes, and potential impacts on the environment and society. Multiple-choice questions were also included to assess respondents' knowledge of specific climate change-related issues, such as the role of deforestation and fossil fuel consumption in exacerbating climate change.

Additionally, the questionnaire sought to evaluate respondents' attitudes and behaviors towards climate change mitigation and adaptation measures. Participants were asked to rate the importance of various actions, such as reducing carbon emissions, conserving energy, and promoting renewable energy sources, in addressing climate change. Likert-scale questions were utilized to measure respondents' agreement with statements related to climate change awareness, responsibility, and perceived efficacy of individual and collective actions in mitigating its impacts.

To ensure the questionnaire's relevance and cultural appropriateness, it was translated into Bahasa Indonesia, the national language of Indonesia. This step was crucial for facilitating a clear understanding of the survey questions among respondents, particularly those with limited proficiency in English. Pilot testing of the questionnaire was conducted to identify and rectify any ambiguities or inconsistencies in the survey instrument, ensuring its reliability and validity in capturing the intended data.

Data collection was carried out through a combination of online surveys and field surveys conducted in Surakarta. The online surveys were distributed via Google Forms to university students and local residents, allowing for broad outreach and efficient data collection. Simultaneously, field surveys were conducted in community settings, such as marketplaces and public spaces, to engage with residents who may have limited access to online platforms or prefer face-to-face interactions.

Cross-classification of data was essential for performing statistical analyses and hypothesis testing. By categorizing respondents based on demographic variables such as age, gender, and educational level, the research aimed to identify meaningful patterns and associations within the data. This process involved organizing the data into rows and columns corresponding to the categories of the variables being analyzed, facilitating the computation of descriptive statistics and the implementation of statistical tests.

The R software, a powerful statistical programming language, was utilized for data analysis and visualization. Leveraging the capabilities of R enabled the researcher to conduct sophisticated statistical analyses, including chi-square tests, regression modeling, and data visualization techniques. The flexibility and extensibility of R allowed for the seamless integration of various statistical packages and libraries, facilitating robust data analysis and interpretation.

Overall, the research methodology employed in the study was designed to facilitate a comprehensive assessment of public awareness and perceptions of climate change in Surakarta. By utilizing a combination of surveys, interviews, and statistical analyses, the study aimed to generate actionable insights that could inform targeted interventions and policy initiatives aimed at enhancing climate change literacy and promoting sustainable behaviors within the community. Through collaborative efforts involving researchers, policymakers, and local stakeholders, the study endeavors to foster a culture of environmental stewardship and resilience in Surakarta, ensuring the city's long-term sustainability in the face of climate change challenges.

3. Results and Discussion

3.1 Survey analysis

Based on the findings obtained from the survey conducted in Surakarta city, a substantial majority of participants (62%) expressed high levels of confidence in their awareness of climate change, indicating prior exposure to information on the topic (Figure 2). Conversely, a notable proportion of respondents (24%) admitted to having never encountered the concept of climate change in their daily lives, suggesting a lack of exposure or access to relevant information. Additionally, a minority of participants (14%) acknowledged being unaware of the issue altogether, indicating a significant gap in knowledge and awareness regarding climate change within the community (Figure 2).

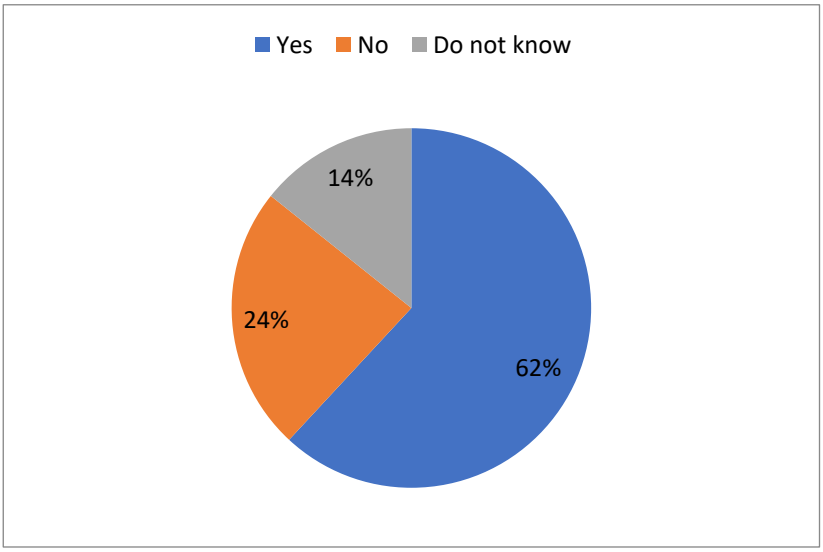

Fig 2. Percentage distribution of responses to question 1: "Have you ever heard about climate change?"

Similarly, a majority of respondents indicated varying degrees of concern regarding climate change as a personal issue, with the majority expressing either high confidence or some reservations about the severity of the problem. Figure 3 illustrates the distribution of responses to question 2: "Do you consider climate change to be a personally important issue?" Among the respondents, 53% expressed high confidence in acknowledging climate change as a very important issue personally. A slightly smaller proportion, 43%, indicated that they consider climate change to be quite important. Only 3% of respondents expressed uncertainty regarding the importance of climate change to them personally. Additionally, 1% of respondents stated that they were unaware of the issue (Figure 3).

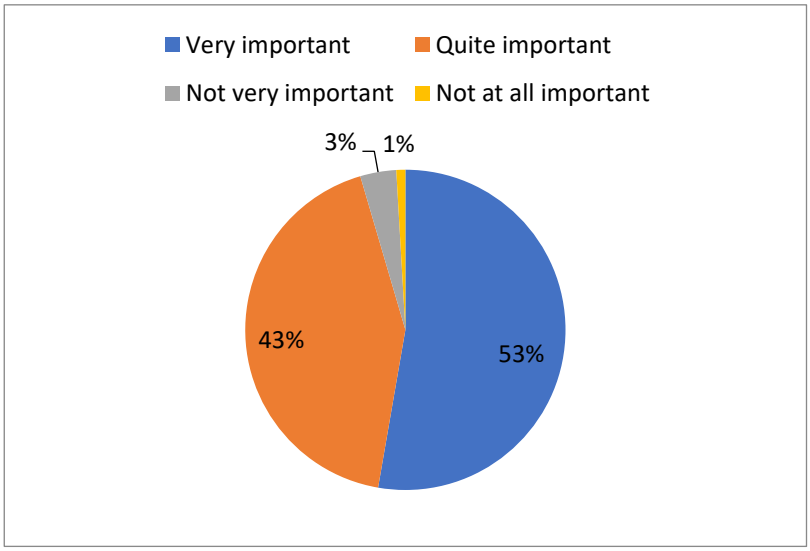

Fig 3. Percentage distribution of responses to question 2: "How important is the issue of climate change to you personally?"

The findings from the survey indicate that the majority of respondents perceive drought and desertification as the most significant threats associated with climate change, as depicted in Figure 4. Specifically, 42% of respondents identified drought and desertification as the worst threat. This was followed by higher temperatures, cited by 24% of respondents, severe storms by 19%, and sea-level rise by 15%.

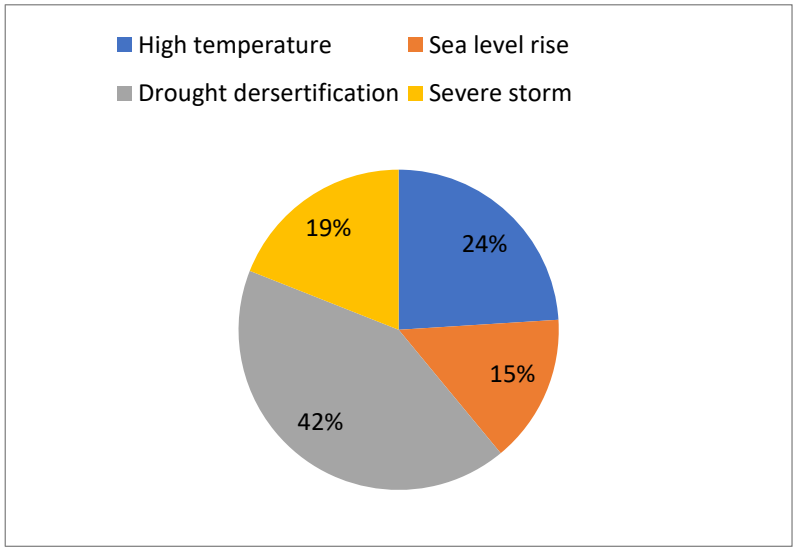

Fig 4. Percentage distribution of responses to question 3: "Which of these natural events affect climate change in the region?"

Furthermore, the survey results revealed that 57% of respondents believe that individuals bear the primary responsibility for climate change, as illustrated in Figure 5. Local authorities were perceived as the next most responsible entity, with 30% of respondents attributing responsibility to them. The national government was cited by 11% of respondents, while environmental organizations were considered responsible by only 2% of respondents (Figure 5).

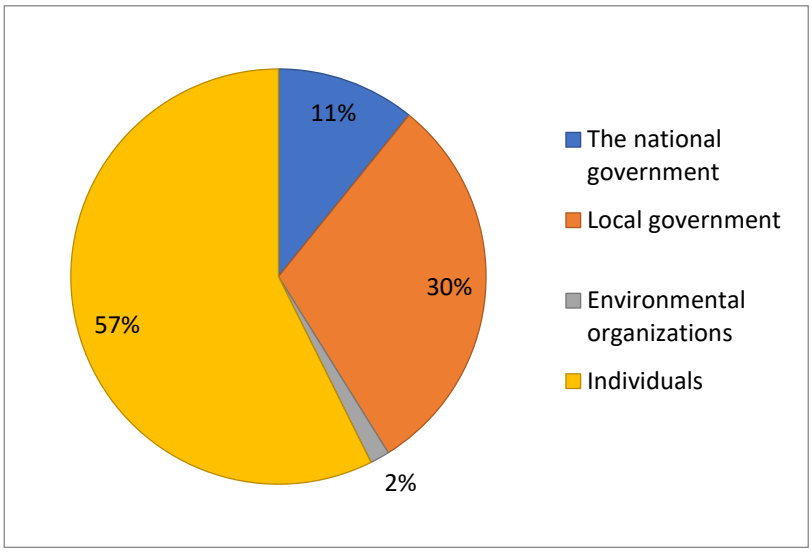

Fig 5. Percentage distribution of responses to question 4: "Who do you think should have the main responsibility for tackling climate change?"

Figure 6 illustrates the level of trust that inhabitants have in the coping ability of local authorities. The graph reveals that a significant proportion of respondents, accounting for 67%, believe that local authorities are not adequately prepared to a great extent. Additionally, a smaller percentage of respondents expressed skepticism but did not provide a negative response. Only 1% of respondents indicated high confidence in the preparedness of local authorities, while 7% provided a positive response with some reservations. Those who stated being unaware of the issue accounted for 3% of respondents.

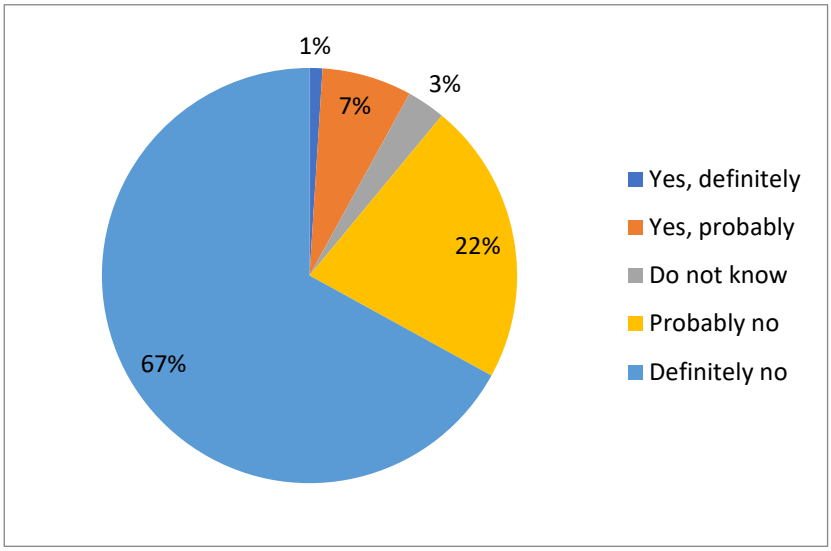

Fig 6. Percentage distribution of responses to question 5: "Do you think that the local authorities are adequately prepared to cope with the possible impacts of climate change?"

Figure 7 depicts the responses regarding whether the interviewees have taken actions related to climate change. The results indicate that more than half of the respondents, comprising 56%, have engaged in activities such as planting trees, collecting rubbish on the beach, or participating in environmental organizations. Conversely, 31% of respondents expressed confidence that they had never participated in activities related to mitigating climate change. Additionally, a relatively high percentage of respondents, accounting for 13%, had no opinion on the matter.

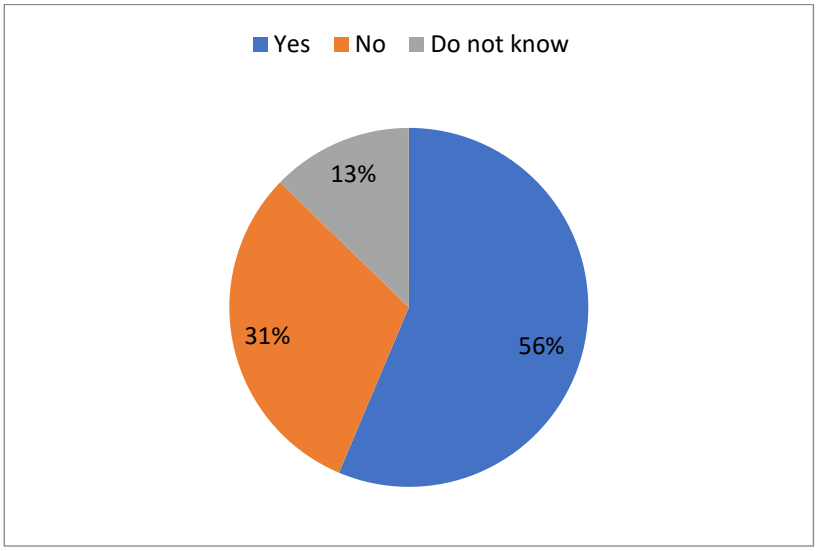

Fig 7. Percentage distribution of responses to question 6: "have you ever taken or do you regularly take, any action out of concern for climate change?"

3.*2 Cross classification and data testing*

The data suggests a strong consensus among respondents across all age groups that climate change is primarily caused by human activities. Notably, the highest percentage of positive responses, comprising 40%, was observed among respondents in the 16-24 age group, indicating a greater level of awareness and concern about human-induced climate change among younger individuals (Table 2).

Table 2. Scoring of climate change beliefs based on age

	Age		
	16-24 (n=40)	25-34 (n=25)	>60 (n=35)
Yes, definitely	20	10	10
Yes, probably	15	7	7
Definitely no	2	5	7
Probably no	3	3	6
Do not know	0	0	5
P-value		0.0601	
df		8	
χ^2		21.461	

3.3 Analysis of factor that affect climate change awareness

Climate change represents a pressing global challenge, necessitating concerted efforts in both mitigation and adaptation strategies. However, the effectiveness of such endeavors can be compromised by inadequate understanding and awareness of climate change within communities, impacting their ability to effectively address and respond to its impacts. Adolescents, along with individuals within communities, are poised to confront the ramifications of climate change in the foreseeable future. Moreover, adolescents wield considerable potential as agents of change in disseminating messages pertaining to climate change awareness.

Identifying and addressing gaps in knowledge and understanding of climate change among adolescents and community members is crucial for fostering meaningful engagement and action. Recognizing knowledge as a pivotal component of building adaptive capacity within communities underscores the importance of conducting assessments to gauge levels of awareness and comprehension. Recent studies investigating the correlation between gender and belief in human-induced climate change have revealed notable insights. Both males and females exhibit high levels of confidence regarding this issue, as depicted in Table 3. It is noteworthy that the higher representation (n) of women in the survey sample can be attributed to their greater willingness to participate in the survey compared to men.

Table 3. Scoring of climate change belief based on gender

	Gender	
	Male (n=36)	Female (n=64)
Yes, definitely	15	30
Yes, probably	10	20
Definitely no	5	5
Probably no	5	5
Do not know	1	4
P-value	0.3126	
df	4	
χ^2	4.76190	

Based on the survey data, it is evident that 70% of respondents at the educational level believe that climate change is primarily caused by human activities. This belief is also shared by 30% of respondents with lower levels of education, including those who have not attended university or have only completed elementary education (Table 4). Moreover, the correlation between respondents' level of education and their belief in climate change due to human activities indicates that the majority of respondents with high school diplomas and university degrees strongly believe in climate change. However, a significant proportion of respondents hold the opposing view, disputing that environmental changes are attributable to human activity.

Table 4. Scoring of climate change beliefs based on educational level

	Education	
	Not with university education	With university education
Yes, definitely	17	42
Yes, probably	10	15
Definitely no	3	5
Probably no	0	3
Do not know	0	5
P-value	0.3006	
df	4	
χ^2	4.8728	

The average correlation between age and the belief that extreme weather conditions are caused by long-term global climate change suggests that respondents across all three age groups predominantly believe in or acknowledge the possibility of experiencing extreme weather conditions due to global climate change (Table 5). In this study, an examination of climate change knowledge among adolescents and university residents in Surakarta city was undertaken using a structured questionnaire. The results yielded a nuanced understanding of participants' awareness and perceptions regarding climate change, highlighting both strengths and areas for improvement in their knowledge and attitudes.

Table 5. Scoring of climate change belief based on age of having experienced weather condition

	Experienced year		
	16-24 (n=40)	25-34 (n=25)	>60 (n=35)
Yes, definitely	20	10	10
Yes, probably	10	5	10
Definitely no	5	10	0
Probably no	0	0	10
Do not know	5	5	5
P-value	0.0713		
df	8		
χ^2	21.461		

One notable finding was that while a significant proportion of participants (80%) demonstrated basic awareness of climate change, including its definition and primary causes, there were notable deficiencies in their understanding. Specifically, the majority of respondents with a clear understanding of climate change tended to be educated individuals and young students. Conversely, a considerable portion of participants exhibited a lack of awareness or perceived climate change as a less pressing issue. This discrepancy in awareness likely contributed to the perception among some respondents that evidence of climate change is inconclusive, with some attributing it to natural cycles rather than anthropogenic factors.

However, scientific evidence overwhelmingly supports the conclusion that human activities, particularly the emission of greenhouse gases, are significant contributors to global warming and climate change. As emphasized by the Intergovernmental Panel on Climate Change (IPCC), urgent action is required to mitigate the severe impacts of climate change, including reducing greenhouse gas emissions and implementing adaptation measures. Moreover, the study revealed disparities in climate change awareness across age groups, with adolescents exhibiting lower awareness of climate change vulnerability compared to older individuals. This underscores the importance of targeted educational interventions to improve climate change literacy among youth. Recommendations include integrating climate change education into school curricula, conducting mass media

campaigns to raise public awareness, and organizing educational sessions led by local authorities.

Furthermore, the study identified the internet as the primary source of climate change knowledge, particularly among individuals aged 16-24. Digital, mainstream, and online media also played significant roles in disseminating information about climate change. Television, with its widespread accessibility and affordability, remained a popular information source among respondents, while the increasing prevalence of smartphones provided another avenue for accessing climate change information.

Despite these findings, inconsistencies were observed in participants' perceptions of climate change and its impact on public health. Improving awareness among teenagers is crucial for societal progress, especially among decision-makers in the education sector. Future research should focus on developing comprehensive programs to enhance community knowledge and awareness of climate change, targeting not only youth and residents but also their families and policymakers. In conclusion, the study underscores the importance of addressing knowledge gaps and improving awareness of climate change among adolescents and university residents in Surakarta city. By implementing targeted educational interventions and utilizing diverse communication channels, society can better understand and respond to the challenges posed by climate change, ultimately contributing to a more sustainable future.

3.3 Analysis of factors affecting climate change awareness in Surakarta

Regression analysis is a statistical technique used to examine the relationship between one or more independent variables and a dependent variable. By analyzing the relationship between these variables, regression analysis aims to assess and predict the mean or average value of the dependent variable in the population. It helps in understanding how changes in the independent variables are associated with changes in the dependent variable. Through regression analysis, we identify the strength and direction of the relationships between variables, enabling them to make predictions and draw conclusions about the phenomenon under study. Equation 1 shows the regression formula, Where Where Y represents awareness of climate change, A is the constant, β is the regression coefficient, X1is gender, X2 is education, and X3 is income.

$$Y = A + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e \quad \text{(Eq. 1)}$$

In this report, STATA software was utilized for data analysis. Following the completion of the study, which involved surveying 100 respondents using a questionnaire, the descriptive statistics data is presented in the Table 6. Table 6 provides a comprehensive overview of the data collected in this study, offering insights into various aspects related to respondents' awareness of climate change. The minimum awareness score recorded was 20, indicating the lowest level of awareness among participants, while the maximum score reached 100, reflecting a high level of awareness in some respondents. This wide range of scores suggests considerable variability in the level of understanding of climate change among the surveyed individuals

Table 6. Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Gender	0.32	0.4688262	0	1
Education	13.93	2.91376	9	16
Income	1035000	752957.1	500000	3500000
Score	49.32	20.02215	20	100

In terms of respondents' age, the data spanned from 16 years to over 60 years, indicating a diverse representation of age groups in the sample. This demographic diversity

is essential for capturing a broad spectrum of perspectives and experiences regarding climate change awareness. Furthermore, the education levels of respondents ranged from 9 years to 16 years, highlighting the varying levels of formal education attained by participants. The inclusion of individuals with different educational backgrounds ensures a more comprehensive analysis of the factors influencing awareness of climate change.

The mean and standard deviation provided in the table offer valuable insights into the central tendency and dispersion of the data. The mean awareness score indicates the average level of awareness among respondents, serving as a useful reference point for comparing individual scores. Meanwhile, the standard deviation reflects the extent of variability or dispersion of awareness scores around the mean, providing insights into the heterogeneity of responses within the sample.

By systematically examining each category of data presented in Table 6, this study aims to identify any significant patterns or trends that may emerge regarding respondents' awareness of climate change. Through rigorous statistical analysis, researchers can uncover valuable insights into the factors influencing awareness levels and inform targeted interventions aimed at improving climate change education and awareness in the community.

3.3.1 Scoring guide

The group of respondents who scored within the range of 20-44 demonstrated a higher level of awareness and understanding of climate change compared to other groups. This cohort exhibited a more conscientious approach towards environmental stewardship, as evidenced by their prudent utilization of natural resources. By employing sustainable practices and making environmentally conscious choices, they actively contribute to preserving the planet and ensuring its cleanliness and health for future generations to enjoy. This commitment to environmental responsibility underscores the importance of fostering awareness and education on climate change, as it empowers individuals to become proactive agents of positive change in safeguarding the Earth's ecological integrity.

Respondents falling within the score range of 45-75 demonstrate a commendable level of environmental consciousness and are making strides towards becoming eco-friendly global citizens. While they may not yet have reached the pinnacle of knowledge on climate change, their scores indicate a solid foundation of understanding and awareness. Individuals in this category are making efforts to adopt sustainable practices and minimize their environmental footprint. However, it is important for them to recognize that even with their current efforts, the collective impact of humanity's actions on the planet remains unsustainable. The Earth's resources are finite, and if everyone were to consume resources at the rate of the average individual in this group, the planet's capacity to sustain life would be quickly depleted. Therefore, individuals in this category are encouraged to redouble their efforts in conserving resources and adopting eco-friendly practices. By taking proactive measures to preserve the Earth's natural capital, they can contribute significantly to the protection and sustainability of the planet for future generations.

Individuals who fall within the score range of 76 to 100 are referred to as "destroyers" due to their alarming lack of environmental awareness and unsustainable consumption habits. These individuals pose a significant threat to the health and well-being of the planet, as their actions contribute to resource depletion and environmental degradation. If everyone were to adopt the lifestyle and consumption patterns of individuals in this category, the consequences would be dire, resulting in widespread environmental destruction and a depletion of natural resources.

It is evident that individuals in this category have little understanding of climate change and its implications. They continue to exploit renewable resources at an unsustainable rate, behaving as though these resources are inexhaustible. However, it is crucial for them to realize that natural resources are finite and must be managed responsibly to ensure their long-term availability.

It is imperative for individuals in this category to undergo a paradigm shift in their behavior towards the environment. They must strive to become eco-friendly corporate citizens, adopting sustainable practices and minimizing their ecological footprint. By doing so, they can contribute to the preservation of the Earth's natural resources and ensure a healthier environment for both present and future generations. It is essential that they recognize the importance of conserving resources and protecting the planet's ecosystems to safeguard the well-being of all living beings on Earth.

Table 7. Analysis of factors affecting climate change awareness in Surakarta

Variable	Coefficient	Standard Error
Gender	5.243586	4.149525
Education	-1.617963	0.6863409
Income	$-7.27e^{-06}$	$2.63e^{-06}$
Constant	77.70177	10.94174
F-stat	4.24	
R-squared	0.1170	
Number of observations	100	

Table 7 provides insights into the relationship between various demographic variables and awareness of climate change in Surakarta. Interestingly, the data indicates that gender does not significantly influence awareness of climate change in this region. Both males and females exhibit similar levels of awareness, suggesting that gender does not play a significant role in shaping perceptions of climate change. This finding contrasts with previous research, which has suggested that climate change disproportionately affects women, particularly those living in rural areas of the Global South. Women in these regions are often more vulnerable to the impacts of climate change and are more likely to experience adverse effects during extreme weather events and disasters. Additionally, gender roles in these areas often result in women bearing the brunt of climate-related hardships, such as caring for households and children (Arora-Jonsson, 2011).

On the other hand, the analysis reveals a significant negative relationship between education level and awareness of climate change. Individuals with higher levels of education tend to have greater knowledge and understanding of climate change, while those with lower levels of education may lack awareness of its impacts. This underscores the importance of education in shaping perceptions of climate change and highlights the need for targeted educational initiatives to raise awareness among all segments of society.

Similarly, income level also appears to influence awareness of climate change, with higher-income individuals exhibiting greater awareness compared to their lower-income counterparts. This finding suggests that socioeconomic factors play a role in shaping awareness of climate change, with individuals from higher-income brackets more likely to be informed about its impacts. However, it is worth noting that there may be disparities in knowledge and action among different income groups. While higher-income individuals may be more knowledgeable about climate change, they may not necessarily engage in environmentally sustainable behaviors. Conversely, lower-income individuals may be less informed about climate change but may engage in sustainable practices out of necessity rather than choice.

Overall, the findings from Table 7 highlight the complex interplay between demographic variables and awareness of climate change in Surakarta. While gender may not significantly influence awareness, education level and income appear to play important roles in shaping perceptions of climate change. Addressing disparities in awareness and understanding across different demographic groups will be essential for developing effective strategies to mitigate and adapt to climate change in the region. Further research is needed to explore the underlying factors driving these disparities and to identify targeted interventions to promote climate change awareness and action among all segments of society.

3.4 Enhancing climate change awareness and adaptation measures in urban settings

Understanding climate change is crucial for communities, particularly for adolescents and individuals of all ages, as it shapes their ability to adapt to social and environmental changes. Providing accurate knowledge about climate change and its implications for wellbeing among young people is essential for effective disaster risk management. This research contributes valuable insights that could inform future urban development strategies, as young people play a significant role in shaping the future of cities. Given the current trajectory of climate change, failure to take meaningful action now could have far-reaching consequences for future generations.

The prevalence of extreme weather events in the region underscores the urgent need for climate change awareness and adaptation measures. The high level of confidence among respondents regarding anthropogenic climate change suggests a strong connection between personal beliefs and lived experiences within the urban community. These findings highlight the critical importance of implementing adaptation measures at both the municipal and governmental levels to mitigate future losses and safeguard the wellbeing of local populations.

The willingness of respondents to take active measures to adapt to the impacts of climate change aligns with previous research findings. However, it is essential to critically evaluate the precision and analysis of these survey results to ensure their reliability and validity. While some research studies may support the findings of this survey, it is crucial to consider the unique socio-economic and environmental contexts of different regions when developing adaptation strategies.

Gender dynamics also play a significant role in shaping awareness, interest, and response to climate change. Women, in particular, tend to be more educated and concerned about climate change, often viewing it as a personal and societal responsibility. In contrast, men may be more motivated by financial concerns than environmental considerations. These gender differences underscore the need for targeted interventions that account for diverse perspectives and priorities within communities. Additionally, income disparities contribute to variations in climate change awareness, with individuals from higher-income households generally exhibiting greater knowledge but potentially less concrete awareness of climate change. This highlights the need to address systemic inequalities and ensure that climate change education and awareness efforts are accessible to all segments of society.

The multiple regression analysis conducted in this study identified several factors that influence awareness of climate change, including education, income, and gender. However, contrary to expectations, these factors did not significantly affect awareness levels among young people and local residents in Surakarta. Despite the valuable insights gained from this research, there are limitations that must be acknowledged. One such limitation concerns the dataset, as evidenced by the relatively low R-squared value. However, the research adhered to the best linear unbiased estimator (BLUE) assumption, enhancing the reliability of the findings.

4. Conclusions

Understanding climate change is vital for our community, including teenagers and all individuals, as it shapes our social adaptation capability. Providing accurate knowledge about climate change and its impact on the well-being of young people is a key success factor in managing the risks of future catastrophes. The reality is that climate change is happening, and if we don't take significant steps, it will continue to worsen. While it may be impossible to completely prevent climate change, the consequences will be far more severe if we don't take individual action.

According to the results, a large percentage of personal belief in climate change related to anthropogenic behaviour is closely connected to the actual reality of the urban community in significant proportions. As a result, the results of the survey revealed a high

level of vulnerability of the local population, as the prefecture appears to be one of the many regions that, to a large extent, may face more losses in several sectors in the future as a result of climate change, especially if no adaptation measures are taken at municipal and government levels, which would otherwise allow and encourage action at the individual level. The survey results indicate the respondents' willingness to take active measures to adapt to the impact of climate change.

Women are more likely than men to trust information on climate change and consider the issue personally 'very important,' mainly due to health impacts and concern for future generations. People are generally more cynical regarding climate change and prefer to assume that individual acts are of slight effectiveness. Women continue to believe that climate change is alarming, that they have a social responsibility to tackle it, and that further efforts can be made by everyone (society, community, company, government) to fix it. While women are more often motivated by environmental concerns to take action, men are more motivated by financial concerns.

Like high-income households, some living in low-income households have less concrete awareness but more illusory awareness about climate change. Such results also identified significant gaps in public perception of climate change within various social classes. One potential reason may be that individuals with large salaries have higher schooling rates and are more prone to societal problems such as climate change. Being sensitive to environmental issues would motivate people to pay attention to these issues, which would lead to better understanding.

This research employed a multiple regression analysis to explore the awareness of climate change among young people and local residents. The results indicate that education, income, and gender are significant factors influencing climate change awareness. Contrary to some assumptions, these factors do not seem to affect the awareness of young people and local residents differently..

Acknowledgement
The authors would like to express sincere gratitude to the reviewers for invaluable feedback and constructive suggestions, which have significantly enhanced the quality of this research.

Author Contribution
All authors equally contributed to the conceptualization, methodology, software, validation, analysis, investigation, data curation, writing, editing, and visualization of this study.

Funding
This research received no external funding.

Ethical Review Board Statement
Not available.

Informed Consent Statement
Not available.

Data Availability Statement
Not available.

Conflicts of Interest
The authors declare no conflict of interest.

Open Access

References

Adiyoga, W. (2018). Farmers perceptions on climate change in lowland and highland vegetable production centers of South Sulawesi, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *122*(1). https://doi.org/10.1088/1755-1315/122/1/012001

Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, *21*(2), 744–751. https://doi.org/10.1016/j.gloenvcha.2011.01.005

Ballantyne, R., Fien, J., & Packer, J. (2001). School environmental education programme impacts upon student and family learning: A case study analysis. *Environmental Education Research*, *7*(1), 23–37. https://doi.org/10.1080/13504620124123

Benzie, M., Harvey, A., Burningham, K., Hodgson, N., & Siddiqi, A. (2011). *Vulnerability to heatwaves and drought: Case studies of adaptation to climate change in south-west England*. Joseph Rowntree Foundation. www.jrf.org.uk

BPS Provinsi Jawa Tengah. (n.d.). Retrieved April 12, 2020, from https://jateng.bps.go.id/publication/2014/10/10/b0a3fef7fa27fffde51a670c/jawa-tengah-dalam-angka-2014.html

Díaz Estévez, M., de Frutos García, R. A., & Peña Moya, J. (2014). Communication of the scientific consensus on climate change to the citizenship: Knowledge and perception of young university students from five countries regarding the media treatment of global warming. *Interactions: Studies in Communication & Culture*, *5*(1), 51–70. https://doi.org/10.1386/iscc.5.1.51_1

Fritze, J. C., Blashki, G. A., Burke, S., & Wiseman, J. (2008). Hope, despair and transformation: Climate change and the promotion of mental health and wellbeing. *International Journal of Mental Health Systems*, *2*(1), 13. https://doi.org/10.1186/1752-4458-2-13

Fujii, T. (2016). *Climate change and vulnerability to poverty: An empirical investigation in rural Indonesia* (ADBI Working Paper No. 622). Asian Development Bank Institute. https://www.adb.org/publications/climate-change-vulnerability-poverty-indonesia

Gifford, R., & Comeau, L. A. (2011). Message framing influences perceived climate change competence, engagement, and behavioral intentions. *Global Environmental Change*, *21*(4), 1301–1307. https://doi.org/10.1016/j.gloenvcha.2011.06.004

Grafton, R. Q. (2010). Adaptation to climate change in marine capture fisheries. *Marine Policy, 34*(3), 606-615. https://doi.org/10.1016/j.marpol.2009.11.011

Heijmans, A. (2012). *Risky Encounters, Institutions and interventions in response to recurrent disasters and conflict* (PhD Thesis). Wageningen University.

Intergovernmental Panel on Climate Change. (2015). *Climate change 2014: Mitigation of climate change. Working Group III contribution to the IPCC Fifth Assessment Report*. Cambridge University Press. https://doi.org/10.1017/CBO9781107415416

Isharyanto. (2018). Responding to climate change: Surakarta city tourism on legal and policy perspectives. *IOP Conference Series: Earth and Environmental Science*, *200*(1). https://doi.org/10.1088/1755-1315/200/1/012047

Kim, Y., Manley, J., & Radoias, V. (2017). Medium- and long-term consequences of pollution on labor supply: evidence from Indonesia. *IZA Journal of Labor Economics*, *6*(1), 5. https://doi.org/10.1186/s40172-017-0055-2

Klein, R. J. T., Schipper, E. L. F., & Dessai, S. (2005). Integrating mitigation and adaptation into climate and development policy: Three research questions. *Environmental Science & Policy, 8*(6), 579-588. https://doi.org/10.1016/j.envsci.2005.06.010

Laukkonen, J., Blanco, P. K., Lenhart, J., Keiner, M., Cavric, B., & Kinuthia-Njenga, C. (2009). Combining climate change adaptation and mitigation measures at the local level. *Habitat International*, *33*(3), 287–292. https://doi.org/10.1016/j.habitatint.2008.10.003

Mora, C., Frazier, A. G., Longman, R. J., Dacks, R. S., Walton, M. M., Tong, E. J., Sanchez, J. J., Kaiser, L. R., Stender, Y. O., Anderson, J. M., Ambrosino, C. M., Fernandez-Silva, I., Giuseffi, L. M., & Giambelluca, T. W. (2013). The projected timing of climate departure from recent variability. *Nature*, *502*(7470), 183–187. https://doi.org/10.1038/nature12540

Myers, T., Maibach, E., Roser-Renouf, C., & et al. (2013). The relationship between personal experience and belief in the reality of global warming. *Nature Climate Change, 3*(4), 343-347. https://doi.org/10.1038/nclimate1754

Noronha, S. (2013). *Climate change and Generation Zero: Analysing the 50/50 campaign: A communication for social change approach*. Unitec ePress. http://www.climateprediction.net/wp-content/schools/mori_poll.pdf

Ojala, M. (2013). Coping with Climate Change among Adolescents: Implications for Subjective Well-Being and Environmental Engagement. *Sustainability*, *5*(5), 2191–2209. https://doi.org/10.3390/su5052191

Patchen, M. (2006). *Public attitudes and behavior about climate change: What shapes them and how to influence them* (PCCRC Outreach Publication 0601). Purdue Climate Change Research Center. www.purdue.edu/climate

Pielke, R. A. Jr. (1998). Rethinking the role of adaptation in climate policy. *Global Environmental Change, 8*(2), 159-170. https://doi.org/10.1016/S0959-3780(98)00011-9

Sampei, Y., & Aoyagi-Usui, M. (2009). Mass-media coverage, its influence on public awareness of climate-change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. *Global Environmental Change*, *19*(2), 203–212. https://doi.org/10.1016/j.gloenvcha.2008.10.005

Tompkins, E. L., & Eakin, H. (2012). Managing private and public adaptation to climate change. *Global Environmental Change*, *22*(1), 3–11. https://doi.org/10.1016/j.gloenvcha.2011.09.010

United Nations Framework Convention. (1992). *62220*.

Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? the role of direct experience in risk perception and behavioural response. *Journal of Risk Research*, *11*(3), 351–374. https://doi.org/10.1080/13669870701552235

Biographies of Authors

Nguyen Thi Hue, Bachelor of Environmental Science and Management, Faculty of International Programs Office, Thai Nguyen University of Agriculture and Forestry.

- Email: ayuvani17@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A

Ernoiz Antriyandarti, Agribusiness Study Program, Faculty of Agriculture, Universitas Sebelas Maret.

- Email: ernoiz_a@staff.unc.ac.id
- ORCID: 0000-0002-0948-4000
- Web of Science ResearcherID: N/A
- Scopus Author ID: 57201775415
- Homepage: https://sinta.kemdikbud.go.id/authors/profile/6666907/?view=googlescholar