

Original Article

# Climate Justice Awareness and Local Climate and Disaster Governance: A Generalized Linear Modelling

Jesson L. Hero 

## Author Information:

Langka Integrated School, Schools Division  
of City of Meycauayan, City of Meycauayan,  
Bulacan, Philippines

Correspondence:  
[jesson.hero@deped.gov.ph](mailto:jesson.hero@deped.gov.ph)

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**Abstract.** Climate justice and climate justice awareness have gained increasing attention through research, advocacy, and education, reinforced by global commitments such as Sustainable Development Goal 13. However, the Municipality of Obando, Bulacan, lacks published policy briefs, empirical studies, documentation, or baseline data examining climate justice awareness and its linkage to local climate and disaster governance. No formal municipal assessments have been conducted to evaluate these understudied yet critical variables. Addressing this gap, the present study, anchored in Environmental Justice Theory, examined how recognition, procedural, distributive, and intergenerational justice influence local climate and disaster governance in Obando, Bulacan. The study adopted a quantitative descriptive-correlational research design utilizing descriptive statistics and Generalized Linear Modeling (GLM), comparing Gaussian and Gamma log-link specifications. This was used to compare distributional assumptions for climate justice and governance perception data. Findings revealed that residents exhibited moderate climate justice awareness and a moderate level of agreement with existing climate and disaster governance mechanisms. Results from the Gaussian model indicated that recognition, procedural, and distributive justice were significant predictors, while intergenerational justice was not. In contrast, the Gamma log-link model showed that all four climate justice dimensions significantly influenced local climate and disaster governance. Moreover, the Gamma model demonstrated strong goodness-of-fit, confirming the theoretical and empirical alignment of Environmental Justice Theory with the local context and its suitability in capturing the non-normal and socially differentiated nature of justice perceptions. The study recommends institutionalizing justice-centered climate and disaster governance, with emphasis on equitable resource distribution, inclusive participation, and intergenerational planning.

**Keywords:** *Climate justice awareness; Climate; Disaster governance; Environmental Justice Theory; Generalized Linear Model.*

In the Philippine context, climate justice and climate justice awareness were growing, driven by increased research, advocacy, and educational initiatives that focus on the disproportionate impacts of climate change and the effects of uncontrollable natural hazards on vulnerable communities. Based on the Greenpeace.org (2024) report, the urgency of climate justice and robust environmental action should be emphasized. With the

proposed call of action which is a climate justice agenda that would serve as a comprehensive framework grounded in human rights and corporate accountability, there should be a community-based action for climate-related harm, securing reparations for loss and damage, having a climate accountability to support an equitable and sustainable transition that protects Filipino communities now and for generations to come (greenpeace.org, 2024). Thus, climate justice and people's awareness of this should be emphasized to underscore the need to involve communities, especially the most vulnerable, in decision-making processes related to climate action and disaster risk reduction.

In the province of Bulacan, it is recognized as one of the most hazard-vulnerable communities in the Philippines due to its flat, low-lying coastal terrain along Manila Bay, which makes it highly prone to flooding and subsidence. The municipality of Obando was identified as highly susceptible to flooding, and other climate-related issues had reached alarming levels, largely driven by groundwater extraction, which has lowered the groundwater table and created flood basins that inundate homes even during high tides or minimal rainfall. Floodwaters regularly enter the area, with seaside roads often submerged and residents forced to elevate their homes or live solely on upper floors (Lagos et al., 2024). This municipality's setting also places it at substantial risk of tsunami inundation and soil liquefaction, particularly in the event of major earthquakes along the Manila Trench or nearby offshore faults (PDPFP, 2024). These findings, as a municipality with entrenched vulnerabilities that affect residents' quality of life and socioeconomic status, underscore the urgent need for climate justice awareness. These hazards and natural calamities disproportionately afflicted fisherfolk and marginalized communities in the province of Bulacan.

Specifically, local vulnerabilities in Obando, Bulacan, such as recurrent flooding, subsidence, and disproportionate exposure of fisherfolk and low-income households to climate and disaster risks, are not only environmental problems but also manifestations of structural inequality in resource access, political voice, and institutional responsiveness. These conditions necessitate a justice-based governance lens because technical hazard management alone cannot explain why certain groups consistently bear greater climate burdens or experience limited benefits from governance interventions. Environmental Justice Theory uniquely responds to these conditions by conceptualizing climate and disaster governance as a multidimensional justice issue that integrates distributive equity, procedural fairness, social recognition, and intergenerational responsibility. Framing Obando's climate challenges through this theoretical lens enables the study to move beyond descriptive vulnerability and analytically examine how governance processes reproduce or mitigate inequities, thereby justifying the theory's relevance and explanatory power in the local Philippine context.

Apparently, there is currently no published policy brief, research and empirical evidence, documentation, or baseline data on climate justice awareness in any sector in the Municipality of Obando, Bulacan, linking it to local climate and disaster governance. The municipality conducts no assessments or evaluations of the understudied variables. These insights and observations highlighted a clear gap in the rationale for conducting the pilot assessment. These observations are similar to the findings of Sanz & Blazquez (2025), which identified inconsistencies in the implementation, monitoring, and evaluation of the local climate and disaster risk program. Lastly, the contextualization of environmental justice theory on climate justice awareness has yet to be established and tested in communities, specifically in the Municipality of Obando, Bulacan, which is vulnerable to flooding and other related natural hazards.

The concepts and studies of climate justice and residents' awareness levels have not yet been explored or deepened in the Philippine context. Climate change and disaster preparedness are taught in basic education, but climate justice is not, resulting in residents' lack of awareness of this issue. As Ogunbode et al. (2024) discussed, people are not aware of the climate justice reasons for this discourse. There is a gap in the existing knowledge and understanding of climate justice in the province of Bulacan. There are no community standards on climate justice, leaving people with no idea what it is all about. A similar observation was corroborated by the 2023 national survey, which found that approximately two-thirds of Americans had never heard of climate justice and its application in community extension and involvement in resolving climate-related problems (Carman et al., 2023). It is also observed that there is a gap between the theoretical and practical understanding of climate justice awareness in community education. Environmental justice theory has not yet been explored or applied to assess climate justice awareness in the province of Bulacan. There is a need to explore and test the assessment, narratives, and stories of the study's respondents to generate further insights. There was a dearth of studies in the Philippines on climate justice awareness that used environmental justice theory as its framework.

To map out the discourse that will strengthen the study's intent in assessing climate justice awareness and local climate and disaster governance. It is tailored to the needs of vulnerable and highly susceptible municipalities such as Obando, Bulacan, and opens pathways for effective climate change education. This research is theoretically anchored on the Environmental Justice Theory of Schlosberg & Collins (2014). This framework shifts the focus from the traditional notion of environmental equity toward a broader conception of climate justice that integrates distributive justice, procedural fairness, recognition, capabilities, and intergenerational community participation. Drawing from Schlosberg & Collins (2014), the study situates environmental justice as a multidimensional framework that not only emphasizes the equitable distribution of environmental burdens and benefits but also highlights the essential roles of recognition, procedural fairness, and strengthening community capabilities as foundations for meaningful and effective climate change education. Furthermore, the discussion and continuing evolution of environmental justice contributed to the emergence of climate justice, which serves as the central lens of this study. This progression deepens the ethical and social scope of environmental justice. It reorients both policy and grassroots movements toward ensuring that climate solutions are equitable, inclusive, and grounded in community empowerment (Smith & Wodajo, 2022). This shift reflects a transition from scholarly emphasis on historical responsibility, equity, and human rights toward movement-driven priorities that focus on strengthening community resilience and capabilities, ensuring recognition and participatory inclusion, and expanding responses beyond mitigation to include adaptation and resilient policy strategies.

Given the gaps and issues in climate justice awareness, the study aimed to assess and explore perceived climate justice awareness and local climate and disaster governance among the residents of Obando, Bulacan, using Generalized Linear Modelling. Specifically, it sought to determine respondents' perceptions of climate justice awareness across the recognitional, procedural, distributive, and intergenerational dimensions of justice. It also aimed to assess respondents' perceptions of local climate and disaster governance in the municipality, including perceived vertical coordination, perceived horizontal collaboration, and information flow and communication. Moreover, the study seeks to identify which significant climate justice awareness factors affect local climate and disaster governance in Obando, Bulacan. Furthermore, it aimed to determine the linear model that best fits and illustrates the relationship between climate justice awareness and local climate and disaster governance in the Municipality of Obando, Bulacan.

## **Methodology**

### **Research Design**

This study employed a quantitative approach using a descriptive correlational research design. This study, specifically, used descriptive statistics and bivariate correlational analysis to examine climate justice awareness and local climate and disaster governance. The descriptive component summarized respondents' perceptions using frequencies, percentages, weighted means, and standard deviations to establish the overall levels and patterns of climate justice awareness and governance across dimensions. In contrast, the correlational (inferential) component examined the magnitude and direction of relationships between climate justice awareness dimensions and local climate and disaster governance using correlational and regression-based techniques within the generalized linear modeling framework (Creswell, 2014). While the descriptive analysis provides an empirical profile of the variables, the correlational analysis explains how and to what extent these variables are statistically associated, making the two components conceptually distinct yet analytically complementary (Creswell, 2018).

The study used a quantitative research approach to analyze and understand the predictor and criterion variables. A self-developed questionnaire on climate justice awareness and local climate and disaster governance, anchored in Environmental Justice Theory, was used as the primary data-gathering tool. A generative linear model was the best fit for describing and analyzing the correlation between the independent variable (climate justice awareness) and the dependent variable (local climate and disaster governance).

### **Participants and Sampling Technique**

The respondents were residents of the Municipality of Obando, Bulacan, which is identified as a highly vulnerable area in the Provincial Development and Physical Framework Plan (PDFP, 2024). Participation was voluntary and conducted in accordance with research ethics and the Data Privacy Act of 2012. Simple random sampling was used to ensure that every individual had an equal chance of selection, minimizing researcher bias and allowing the findings to represent the general population's perspectives on climate justice. The sample size of 383 respondents was calculated using Cochran's (1977) formula at a 95% confidence level and 5% margin of error, and was proportionally distributed across the eleven barangays based on population size to ensure adequate

representation. Respondents were required to be residents of Obando for at least five years, aged 18 or older, with a permanent address, and registered voters. Individuals who did not meet these criteria were excluded to ensure that participants had sufficient community exposure and legal eligibility to provide informed responses.

### **Research Instrument**

The researcher developed a self-administered survey, informed by a literature review and theoretical analysis, to assess residents of Obando, Bulacan's awareness of climate justice and local climate and disaster governance. The instrument had three parts: (1) climate justice awareness measured across four dimensions—recognitional, procedural, distributive, and intergenerational justice—using a 5-point Likert scale; and (2) local climate and disaster governance measured through indicators of vertical coordination, horizontal collaboration, and information flow and communication.

The questionnaire underwent expert validation by five specialists. Two phases of validation were conducted: content validation to ensure alignment with climate justice dimensions, and face validation to refine the clarity and appropriateness of the items. Reliability was established through a pilot test conducted in a climate-vulnerable barangay outside Obando. The instrument obtained a mean score of 4.233 (SD = 0.448) and a Cronbach's alpha of 0.911, indicating excellent internal consistency and confirming its suitability for subsequent statistical analyses.

### **Data Gathering Procedure**

The data were collected through face-to-face data gathering conducted in the Municipality of Obando, Bulacan. The researcher administered a self-developed survey questionnaire to respondents through Barangay officials and the Committee on Climate Change. This ensures clarity of instructions and completeness of responses. The entire data collection process took one month and was conducted via Google Forms. This study used only a survey method; thus, there were no interventions, and it did not involve pre-tests or post-tests, control or treatment groups, or experimental procedures. The primary measurement tool used in the study was a researcher-developed survey questionnaire that collected data on respondents' perceptions of climate justice awareness and local climate and disaster governance.

### **Data Analysis Procedure**

Quantitative data were analyzed using JAMOVI software. Descriptive statistics (weighted means and standard deviations) were computed to describe levels of climate justice awareness and perceptions of local climate and disaster governance. The Shapiro-Wilk test was performed to assess the normality of the data. To examine relationships between climate justice awareness dimensions and local climate and disaster governance, bivariate correlational analyses were initially conducted to identify significant relationships among variables. Building on these results, Generalized Linear Modeling (GLM) was employed as the primary inferential technique to determine the magnitude and direction of the influence of recognitional, procedural, distributive, and intergenerational justice on local climate and disaster governance. This analytical sequence ensures alignment between the study's correlational objectives and the statistical procedures used to test them.

Gaussian and Gamma modeling were used to compare alternative distributional assumptions for the dependent variable and identify the most appropriate statistical model for analyzing governance perception data. The Gaussian model was estimated as a baseline under the assumption of approximate normality. In contrast, the Gamma log-link model was applied because the outcome variable consists of continuous, strictly positive, and non-normally distributed perception scores. Comparing these two specifications allowed the study to determine which model better represents the data structure, with the Gamma model's superior goodness-of-fit justifying its use as the final model.

### **Ethical Considerations**

The following ethical considerations will be strictly observed in the conduct of this research. The researcher adhered to established ethical protocols for data collection, in full compliance with the mandates of the Data Privacy Act of 2012, ensuring that all personal information was handled responsibly and lawfully. The dignity, rights, and overall well-being of the respondents were safeguarded, and no participant was subjected to physical, psychological, or emotional harm, nor placed in any uncomfortable or compromising situation. Informed consent was obtained from the necessary individuals, who were provided with clear and sufficient information about the nature, purpose, and procedures of the study. Participation in the study was entirely voluntary, with no coercion, pressure, or deception used. All data collected were treated with strict confidentiality throughout the research

process, and proper citation and acknowledgment of sources were observed throughout the manuscript. Furthermore, respondents provided permission to document and include the information they provided for research purposes, and it was assured that their identities would remain anonymous and would not appear in the final research output.

## Results and Discussion

### Climate Justice Awareness of the Municipality of Obando, Bulacan

Table 1 presents the descriptive statistics on climate justice awareness among residents of the Municipality of Obando, Bulacan. The table shows that the four dimensions of climate justice awareness are moderately aware, with a general average of 3.07 and a standard deviation of 0.88. Generally, the findings indicate that the residents of Obando, Bulacan, are moderately aware or leaning towards disagreement on understanding climate justice issues. However, the findings suggest they have developed a foundation for addressing climate- and justice-related issues in the local context of climate change and disasters.

**Table 1.** Descriptive Statistics of Climate Justice Awareness as Perceived by the Residents of the Municipality of Obando, Bulacan

Indicators	M	SD	CV	Shapiro-Wilk	Interpretation
1. Recognitional Justice	3.18	0.83	26.1	<.001	Moderately Aware
2. Procedural Justice	3.21	0.89	27.7	<.001	Moderately Aware
3. Distributive Justice	2.96	0.93	31.4	<.001	Moderately Aware
4. Intergenerational Justice	2.91	0.88	30.2	<.001	Moderately Aware
<b>General Average</b>	<b>3.07</b>	<b>0.88</b>			<b>Moderately Aware</b>

M = Mean; SD = Standard Deviation; CV = Coefficient of Variation

It was observed that the procedural justice dimension reported the highest mean of 3.21, but was interpreted as moderately agreeable. This implies that residents have moderate involvement in climate planning and disaster response. Moreover, they have limited opportunities to voice their perspectives and positionality about climate-related concerns. These findings are closely followed by recognitional justice with a reported mean of 3.18 and a standard deviation of 0.83, interpreted as moderately aware. This implies that there is a moderate consideration that poverty and livelihood type influence how residents experience climate change. There is also a perceived lack of equal access to clean water, electricity, transportation, and health services for all residents. The results suggest that respondents are relatively more aware of issues related to participation, transparency, inclusivity in decision-making, and the recognition of vulnerable groups in climate and disaster governance. This aligns with Environmental Justice Theory, which emphasizes that fair procedures and social recognition are often the most visible and immediately experienced dimensions of justice at the local level (Newell et al., 2020).

Distributive justice, with a reported mean of 2.96 and standard deviation of 0.93, and intergenerational justice, with a reported mean of 2.91 and standard deviation of 0.88, are also interpreted as moderately aware but with much lower mean scores and higher coefficients of variation. The results imply that residents have weaker, more uneven awareness of how climate-related benefits, risks, and responsibilities are distributed, as well as how current actions and steps affect future generations. The findings are similar to those of Kashwan et al. (2020), who suggest that distributive and intergenerational justice are the most challenging dimensions to institutionalize, particularly in communities facing immediate socio-economic and disaster-related pressures. Furthermore, the greater variability in these indicators suggests varied lived experiences among respondents, reinforcing the theory's claim that environmental burdens and protections are not evenly shared.

The Shapiro-Wilk test for normality shows a p-value of < .001 across all climate justice dimensions. This indicates a significant deviation from normality, suggesting that perceptions of climate justice awareness are not uniformly distributed within the community. This non-normal distribution of data reflects the socially differentiated nature of environmental justice experiences, where awareness is shaped by factors such as exposure to climate risks, access to information, and engagement with governance processes (Sovacool et al., 2019). The moderate mean scores coupled with non-normal distributions justify the use of generalized linear modeling in subsequent analyses and support justice-oriented interpretations that move beyond assumptions of uniform community experience.

In general, the findings indicate that while residents are moderately aware of climate justice, awareness is stronger in the recognition and procedural dimensions than in the distributive and intergenerational dimensions. Climate justice awareness in Obando is uneven rather than uniform, with residents more attuned to recognitional and

procedural justice than to distributive and intergenerational concerns. From an Environmental Justice Theory perspective, this suggests that participatory and consultative aspects of governance are more visible than equitable resource distribution and long-term responsibility. The weaker and more variable perceptions of distributive and intergenerational justice point to persistent inequalities in how climate-related benefits, protections, and future obligations are understood and experienced, revealing a critical justice gap between process-oriented awareness and material and intergenerational equity. As elaborated by Environmental Justice Theory, the results suggest that local climate and disaster governance efforts may be more effective at fostering participation and recognition than at ensuring equitable resource distribution and long-term justice for future generations. These results highlight the need for policy and governance interventions that strengthen distributive equity and explicitly integrate intergenerational considerations to advance a more holistic and inclusive climate justice agenda at the community level (Newell et al., 2020; Kashwan et al., 2020; Sovacool et al., 2019).

### Local Climate and Disaster Governance of the Municipality of Obando, Bulacan

Table 2 presents the descriptive statistics of local climate and disaster governance as perceived by residents of the Municipality of Obando, Bulacan. The table shows that the three dimensions of local climate and disaster governance are rated as moderately aware, with a mean of 3.14 and a standard deviation of 0.90. Overall, the findings indicate that residents moderately agree on the effectiveness of the Municipality of Obando, Bulacan's existing governance mechanisms for climate change and disaster management. The findings suggest that institutional arrangements for climate and disaster management are present but remain uneven in their reach and implementation across the community.

**Table 2.** Descriptive Statistics of Local Climate and Disaster Governance as Perceived by the Residents of the Municipality of Obando, Bulacan

Indicators	M	SD	CV	Shapiro-Wilk	Interpretation
1. Perceived Vertical Coordination	3.25	0.84	25.8	<.001	Moderately Agree
2. Perceived Horizontal Collaboration	3.10	0.88	28.4	<.001	Moderately Agree
3. Information Flow and Communication	3.06	0.99	32.4	<.001	Moderately Agree
<b>General Average</b>	<b>3.14</b>	<b>0.90</b>			<b>Moderately Agree</b>

M = Mean; SD = Standard Deviation; CV = Coefficient of Variation

In the analysis, perceived vertical coordination had the highest mean score of 3.25, with a standard deviation of 0.84, indicating a moderately agree response. This indicates that residents moderately recognize coordination between local government units and higher levels of authority. Moreover, residents report moderate cooperation between the barangay and municipal governments during climate-related disasters. From the theoretical lens of Environmental Justice Theory, vertical coordination is essential to procedural justice, as it facilitates policy coherence, access to national resources, and accountability mechanisms that are critical for protecting climate-vulnerable populations (Ziervogel et al., 2022). The moderate level of agreement, however, suggests that such coordination may not be consistently translated into tangible benefits at the community level.

The perceived horizontal collaboration reports a mean of 3.10 with a standard deviation of 0.88, indicating a moderately agree rating. It reflects a moderate level of agreement, pointing to partial cooperation among barangays, local agencies, and community organizations. Also, residents observe a moderate level of unity within the community during disasters, since political parties influence how they respond to each barangay. It is also claimed that residents believe that community collaboration strengthens recovery after disasters. Recent environmental justice literature emphasizes that strong horizontal collaboration supports recognitional justice by including diverse local voices and lived experiences in governance processes (Chu et al., 2017; Eriksen et al., 2021). The observed variability implies that collaborative governance remains fragmented, potentially limiting inclusive participation in climate and disaster decision-making.

The information flow and communication reported the lowest mean of 3.06, a standard deviation of 0.99, but was still interpreted as moderately agree. However, the report on the highest coefficient of variation indicates substantial divergence in residents' experiences. From an environmental justice standpoint, uneven access to timely and understandable climate and disaster information undermines procedural justice by constraining meaningful participation and distributive justice by affecting equitable access to preparedness, response, and recovery resources (Ferreira, 2024; Meerow & Woodruff, 2020). This literature highlights that information gaps often reinforce existing social inequalities, particularly in disaster-prone localities.

The Shapiro-Wilk test for normality shows a p-value of < .001 across all local climate and disaster governance

dimensions. This indicates a significant deviation from normality, suggesting that perceptions of local climate and disaster governance are not uniformly distributed within the community. This also suggests that while local climate and disaster governance in Obando, Bulacan, is perceived as moderately functional, there are critical gaps that need to be addressed, particularly in information dissemination and collaborative mechanisms. Moreover, local climate and disaster governance in Obando is perceived as functional but uneven, with greater emphasis on vertical coordination than on horizontal collaboration and information flow. From an Environmental Justice Theory perspective, this suggests that while institutional structures are in place, their benefits are not evenly realized, as uneven communication and collaboration constrain meaningful participation and equitable access to services. Analytically, this points to a governance system that operates in form but fails to deliver consistently inclusive and just outcomes across social groups and barangays. Strengthening vertical coordination, deepening horizontal collaboration, and improving transparent communication are necessary to advance procedural equity, enhance recognition of vulnerable sectors, and support more just and inclusive climate and disaster governance at the community level (Anguelovski et al., 2019).

### Generalized Linear Model Using Gaussian Log-Link in Examining the Relationship Between Climate Justice Awareness and Local Climate and Disaster Governance

The results of the generalized linear model analysis using the Gaussian Log-Link in Table 3 reveal that all four dimensions of climate justice awareness are correlated with local climate and disaster governance to varying extents. The relationship is positive, as indicated by the B coefficients, meaning that, in general, higher climate justice awareness is associated with better local climate and disaster governance. Conversely, lower climate justice awareness is associated with lower local climate and disaster governance.

Table 3. Parameter Estimates (Coefficients)

Name	Estimate	SE	95% Confidence Intervals		z	p
			Lower	Upper		
(Intercept)	1.128	0.008	1.113	1.142	149.500	<.001
Recognitional Justice	0.063	0.012	0.040	0.086	5.360	<.001*
Procedural Justice	0.068	0.012	0.045	0.091	5.752	<.001*
Distributive Justice	0.095	0.010	0.075	0.116	9.190	<.001*
Intergenerational Justice	0.018	0.009	-0.000	0.036	1.959	.050

A closer look at the obtained coefficients, the three dimensions recorded a B coefficient with associated probability less than the significance level set at .05. This means that recognitional, procedural, and distributive justices with B coefficients of .063, .068, .095, and .018, respectively, correlate significantly with the local climate and disaster governance. Still, intergenerational justice, with a B coefficient of 0.018, is correlated with local climate and disaster governance, but not significantly, as the associated probability exceeds the alpha level. Further analysis of the regression run indicates that for every unit increase in recognitional, procedural, distributive, and intergenerational justice, teaching performance increases by 6.3% to 9.5%. respectively.

Overall, the findings in Table 5 using the Gaussian Log-Link provide strong empirical support for Environmental Justice Theory. The findings demonstrate that climate justice awareness is primarily driven by experiential and present-oriented justice dimensions, particularly distributive, procedural, and recognitional justice. The comparatively weaker influence of intergenerational justice suggests the need for local climate and disaster governance strategies that more explicitly connect present actions to long-term consequences for future generations. Strengthening equitable resource distribution, inclusive participation, and social recognition remains central to advancing climate justice awareness at the community level.

Table 4. Model Fit

R <sup>2</sup>	df	X <sup>2</sup>	p
0.655	4	141.691	<.001

The results of the model fit analysis in Table 4 reveal a substantial correlation between climate justice awareness and the Municipality of Obando, Bulacan's local climate and disaster governance, with an r-value of 0.655. This means that approximately 65.5% of the variation in climate justice awareness is explained by the governance-related justice dimensions in the Gaussian Log-Link model. This reflects a strong explanatory power for a community-based governance model. The chi-square statistic ( $\chi^2 = 141.691$ ,  $df = 4$ ,  $p < .001$ ) indicates that the model fits the data significantly. Furthermore, since the associated probability does not exceed alpha, this indicates

that residents' perceived climate justice awareness in the Municipality of Obando, Bulacan, is significantly correlated with the municipality's current local climate and disaster governance. All of the dimensions of climate justice significantly affect the current local climate and disaster governance. As it collaborated with Environmental Justice Theory, this strong model fit suggests that recognitional, procedural, distributive, and intergenerational justice are empirically meaningful pathways through which local governance shapes residents' perceptions of climate justice. Overall, the results affirm that justice-centered governance mechanisms are central to understanding climate justice awareness at the local level.

**Table 5. Additional Indices**

Info	Model Value	Comment
Log Likelihood	-230.530	
AIC	473.060	Less is better
BIC	496.748	Less is better
Deviance	74.737	Less is better
Residual DF	378	
Chi-squared/DF	0.198	Overdispersion indicator

Table 5 presents additional goodness-of-fit indicators for the model. The log-likelihood of -230.530 reflects the model's overall fit; lower values indicate a better fit. The Akaike Information Criterion (AIC = 473.060) and the Bayesian Information Criterion (BIC = 496.748) suggest a weaker model fit, as lower values are preferred when comparing models. The deviance value of 74.737 indicates a relatively large amount of unexplained variation in the model. The chi-square to degrees of freedom ratio (0.198) shows that there is no evidence of overdispersion, meaning the model's variability is adequately controlled.

While the model does not violate dispersion assumptions, the relatively high AIC, BIC, and deviance values suggest it fits the data less well than alternative models with lower information criteria and deviance. Furthermore, the additional indices suggest that Environmental Justice Theory aligns conceptually with the study but offers limited explanatory power in this model. To strengthen the applicability of the theory in the context of climate justice and disaster governance in the Municipality of Obando, Bulacan, it should be incorporated into additional governance, socio-economic, or contextual variables. This may further support the empirical fit and improve its ability to explain variations in local-level climate justice awareness.

### Generalized Linear Model Using Gamma Log-Link in Examining the Relationship Between Climate Justice Awareness and Local Climate and Disaster Governance

**Table 6. Parameter Estimates (Coefficients)**

Name	Estimate	SE	95% Confidence Intervals		z	p
			Lower	Upper		
(Intercept)	1.123	0.007	1.110	1.137	158.124	<.001*
Recognitional Justice	0.067	0.011	0.044	0.089	5.885	<.001*
Procedural Justice	0.073	0.011	0.051	0.094	6.625	<.001*
Distributive Justice	0.112	0.010	0.093	0.131	11.627	<.001*
Intergenerational Justice	0.024	0.009	0.005	0.042	2.537	.011*

The results of the generalized linear model analysis using the Gamma Log-Link in Table 6 reveal that all four dimensions of climate justice awareness are correlated with local climate and disaster governance to varying extents. The nature of relationships is positive, as indicated by the B coefficients, meaning that, in general, higher climate justice awareness is associated with better local climate and disaster governance. Conversely, lower climate justice awareness is associated with lower local climate and disaster governance.

A closer look at the obtained coefficients, the three dimensions recorded a B coefficient with associated probability less than the significance level set at .05. This means that recognitional, procedural, distributive, and intergenerational justices with B coefficients of .067, .073, .112, and .024, respectively, correlate significantly with the local climate and disaster governance. Further analysis of the regression run indicates that for every unit increase in recognitional, procedural, distributive, and intergenerational justice, teaching performance increases by 911.2% to 2.4%. respectively.

Overall, the findings in Table 8 using the Gaussian Log-Link provide strong empirical support for Environmental Justice Theory. The results of Table 8 demonstrate that climate justice awareness is strongly shaped by justice-

oriented governance mechanisms, particularly those related to equitable distribution, fair procedures, and social recognition. The use of a Gamma log-link model further suggests that these relationships are best captured through a framework that accommodates uneven and non-normal perceptions of justice within the community.

**Table 7. Model Fit**

R <sup>2</sup>	df	X <sup>2</sup>	p
0.682	4	14.538	<.001

The results of the model fit analysis in Table 7 reveal a substantial correlation between climate justice awareness and the Municipality of Obando, Bulacan's local climate and disaster governance, with an r-value of 0.682. This means that approximately 68.2% of the variation in climate justice awareness is explained by the governance-related justice dimensions in the Gamma Log-Link model. This reflects a strong explanatory power for a community-based governance model. The chi-square statistic ( $\chi^2 = 14.538$ ,  $df = 4$ ,  $p < .001$ ) indicates that the model fits the data significantly. Furthermore, since the associated probability does not exceed alpha, this indicates that residents' perceived climate justice awareness in the Municipality of Obando, Bulacan, is significantly correlated with the municipality's current local climate and disaster governance. All the dimensions of climate justice awareness significantly affect the current local climate and disaster governance. By integrating Environmental Justice Theory, the Gamma Log-Link model fits the data well, confirming that the predictors jointly contribute meaningfully to explaining climate justice awareness. Furthermore, the model fit results indicate that the Gamma log-link model provides a statistically adequate fit, supporting the relevance of justice-based governance factors in understanding climate justice awareness at the community level.

**Table 8. Additional Indices**

Info	Model Value	Comment
Log Likelihood	-198.176	
AIC	408.352	Less is better
BIC	432.041	Less is better
Deviance	6.772	Less is better
Residual DF	378	
Chi-squared/DF	0.019	Overdispersion indicator

Table 8 presents additional goodness-of-fit indices for the Generalized Linear Model (Gamma log-link) used to examine the relationship between climate justice awareness and local climate and disaster governance. The log-likelihood of -198.176 indicates a relatively strong model fit, with lower values indicating improved explanatory capacity. The Akaike Information Criterion (AIC = 408.352) and Bayesian Information Criterion (BIC = 432.041) are relatively low, suggesting that the model achieves a good balance between explanatory power and parsimony, as lower values indicate better model performance. The deviance value of 6.772 is notably small, indicating that the model leaves minimal unexplained variation in climate justice awareness.

Moreover, the chi-square-to-degrees-of-freedom ratio (0.019) indicates no evidence of overdispersion, confirming that the model adequately accounts for the data's variability. The additional indices demonstrate that the Gamma log-link model provides a very good fit to the data. It supports the appropriateness of analyzing how justice-oriented governance mechanisms influence climate justice awareness. The results provide a strong alignment between Environmental Justice Theory and the Gamma log-link model. It provides empirical support for the theory's applicability in explaining how justice-oriented governance mechanisms shape local-level climate justice awareness.

**Comparison of Gamma and Gaussian Log-Link Specification in Illustrating the Climate Justice Awareness and Local Climate and Disaster Governance in the Municipality of Obando, Bulacan**

Table 9 presents the linear model using the Gaussian and Gamma Log-Link of climate justice awareness and local climate and disaster governance in the Municipality of Obando, Bulacan. The result shows that the Gamma log-link model provides a markedly better fit for explaining climate justice awareness in relation to local climate and disaster governance in the Municipality of Obando, Bulacan. Gleaning from the table above, the Gamma model achieves a higher log-likelihood (-198.176) than the Gaussian log-link model (-230.530). This signifies a stronger explanatory power. This superiority is reinforced by substantially lower information criteria for the Gamma model (AIC = 408.352; BIC = 432.041) than for the Gaussian model (AIC = 473.060; BIC = 496.748). This analysis indicates a closer representation of the data. Moreover, the deviance of the Gamma model (6.772) is lower than the Gaussian model (74.737). This illuminates significantly reduced unexplained variability. While both models showed no

evidence of overdispersion based on the chi-square-to-degrees-of-freedom ratio ( $\Gamma = 0.019$ ; Gaussian = 0.198), the consistent advantage of the Gamma model across all fit indices supports its statistical significance.

**Table 9.** Linear Model that Best Fits to Illustrate the Climate Justice Awareness and Local Climate and Disaster Governance in the Municipality of Obando, Bulacan

<i>Generalized Linear Model Using Gaussian Log-Link</i>		
<b>Info</b>	<b>Model Value</b>	<b>Comment</b>
Log Likelihood	-230.530	
AIC	473.060	Less is better
BIC	496.748	Less is better
Deviance	74.737	Less is better
Residual DF	378	
Chi-squared/DF	0.198	Overdispersion indicator

  

<i>Generalized Linear Model Using Gamma Log-Link</i>		
<b>Info</b>	<b>Model Value</b>	<b>Comment</b>
Log Likelihood	-198.176	
AIC	408.352	Less is better
BIC	432.041	Less is better
Deviance	6.772	Less is better
Residual DF	378	
Chi-squared/DF	0.019	Overdispersion indicator

From the perspective of Environmental Justice Theory, the Gamma model's superior performance is theoretically expected. Climate justice awareness is shaped by unequal access to resources, uneven participation in governance, and differentiated exposure to climate and disaster risks, leading to asymmetric and non-normally distributed perceptions (Schlosberg, 2020; Newell et al., 2020). Recent studies emphasize that distributive and intergenerational justice outcomes are particularly uneven at the local level, making models that accommodate skewed distributions more appropriate for justice-oriented climate research (Kashwan et al., 2021; Otto et al., 2020). Consequently, the underperformance of the Gaussian model can be attributed to its assumption of symmetry, which fails to capture the socially differentiated nature of environmental justice outcomes.

The emergence of intergenerational justice as a significant predictor in the Gamma log-link model can be conceptually explained by the model's ability to capture asymmetric and socially uneven perception patterns that are obscured under Gaussian assumptions. Intergenerational justice reflects future-oriented concerns that are often weakly expressed by many residents but strongly held by specific subgroups (e.g., youth, highly exposed households, or environmentally active individuals), producing a positively skewed distribution. The Gaussian model, which assumes symmetry around a mean, dampens these uneven effects, rendering intergenerational justice only marginal. In contrast, the Gamma model explicitly accommodates right-skewed, heterogeneous responses, allowing the influence of concentrated future-oriented concerns to surface as statistically significant. Thus, the significance of intergenerational justice in the Gamma model reflects the reality that concern for future generations is not uniformly shared but socially differentiated, reinforcing the appropriateness of a justice-based, non-normal modeling framework for perceptions of climate governance.

Furthermore, the goodness-of-fit results demonstrate that the Gamma log-link generalized linear model aligns well with the core assumptions of Environmental Justice Theory, as it effectively captures the uneven and asymmetric nature of climate justice awareness shaped by differentiated governance experiences. This convergence between statistical fit and theory affirms the empirical validity of Environmental Justice Theory in explaining how local climate and disaster governance influence climate justice awareness.

### ***Implication of the Study***

The findings of this study carry important theoretical, policy, and practical implications for climate and disaster governance for the Municipality of Obando, Bulacan. From a theoretical analysis, the strong explanatory power and goodness-of-fit of the Gamma log-link generalized linear model support the applicability of Environmental Justice Theory in explaining climate justice awareness in the Municipality of Obando, Bulacan. The significant effects of recognitional, procedural, distributive, and intergenerational justice demonstrate that climate justice is not a singular concept but a multidimensional construct shaped by climate change, disaster governance processes, and social inequalities. This implies that future climate governance research should move beyond hazard-based

or technocratic approaches and develop a justice-centered, localized framework that directly addresses the unequal experiences, power relations, and long-term ethical responsibilities of the residents of Obando, Bulacan.

As for policy and local governance implications, the results indicate that improving local climate and disaster governance requires more than compliance with national mandates; it requires institutional reforms and localized actions that embed justice principles into planning, decision-making, and implementation. The strong influence of distributive justice highlights the need for equitable allocation of disaster preparedness resources, relief assistance, and recovery support, particularly for vulnerable sectors. Meanwhile, the significance of procedural and recognition justice underscores the importance of inclusive participation, transparency, and the formal recognition of marginalized groups in governance processes. The comparatively weaker yet significant role of intergenerational justice suggests that long-term climate considerations remain underemphasized, indicating the need for policies that explicitly safeguard the welfare of future generations through sustainable planning and youth engagement.

In terms of practical implications, the study suggests that local government units, such as the Municipality of Obando, Bulacan, can enhance climate resilience by strengthening community participation, improving information flow and risk communication, and fostering coordination across governance levels. By operationalizing Environmental Justice Theory through justice-based indicators and monitoring mechanisms, LGUs can better assess whether governance interventions are inclusive, equitable, and sustainable. Overall, the study implies that advancing climate justice awareness is both a governance outcome and a pathway toward more resilient communities, reinforcing the need for justice-oriented, evidence-based approaches in local climate and disaster management.

#### *Limitations of the Study*

The study has several observed limitations. First, it was conducted only in the Municipality of Obando, Bulacan, which limits the generalizability of the findings to other highly vulnerable and susceptible municipalities within Bulacan or in similar contexts. Although the sample size was statistically sufficient, it remained relatively small compared with the total municipal population, which may have limited subgroup-level analysis and the inclusion of specific sectors, such as minors actively involved in climate change advocacy. While the generalized linear model is a robust statistical tool, the study employed a cross-sectional design that captured respondents' perceptions at only one point in time, thereby limiting the ability to observe changes over time or establish causal relationships. The study relied on self-reported perceptions, which pose threats to validity because responses may be influenced by social desirability bias or recent experiences with disasters.

The model focused primarily on justice dimensions and did not incorporate other socio-economic or institutional variables that may also shape perceptions of governance, largely due to the scarcity of established frameworks and supporting literature linking socio-economic profiles to climate and environmental governance indicators. The research utilized a purely quantitative approach; therefore, the exclusive reliance on survey data limited deeper exploration of lived experiences, contextual meanings, and nuanced community realities that could have been captured through mixed-method designs. Lastly, intergenerational justice had a weaker effect, which may reflect the difficulty of measuring future-oriented concepts with survey instruments. Additionally, the researcher observed that most respondents were middle-aged or older adults, with only a few in Gen Z, which may have influenced their responses on intergenerational concerns.

#### **Conclusion**

Based on the results and discussion, several conclusions were drawn from the study. The strong convergence between theoretical application and statistical performance affirms the empirical validity and practical relevance of Environmental Justice Theory in assessing climate justice awareness and local climate and disaster governance in the Municipality of Obando, Bulacan. Hence, the study confirms the goodness of fit and applicability of Environmental Justice Theory in explaining local climate justice awareness and governance dynamics. The residents of Obando exhibit a moderate level of climate justice awareness across the recognition, procedural, distributive, and intergenerational dimensions, suggesting that community participation and recognition are relatively evident at the local level. At the same time, equitable distribution of climate-related resources and long-term considerations for future generations remain less understood and unevenly perceived. The local climate and disaster governance are also moderately perceived as functional, implying that mechanisms for coordination, collaboration, and information dissemination are present but are not consistently experienced across all sectors of

the community.

The Gaussian Log-Link model indicates that climate justice awareness is primarily shaped by experiential and present-oriented justice dimensions, particularly distributive, procedural, and recognitional justice. In contrast, intergenerational justice demonstrates comparatively weaker influence. Meanwhile, the Gamma Log-Link models confirm that all four dimensions of climate justice awareness are significant predictors and influence the municipality's current local climate and disaster governance. The Gamma log-link generalized linear model emerged as the best-fitting model in explaining the relationship between climate justice awareness and local climate and disaster governance. Compared to the Gaussian model, the Gamma model demonstrated superior goodness-of-fit, reinforcing its suitability in capturing the non-normal and socially differentiated nature of climate justice perceptions. Furthermore, this model's strong fit supports the empirical validity and contextual relevance of Environmental Justice Theory in the local setting of Obando, Bulacan.

It also concluded that community perceptions of climate governance are shaped not only by institutional presence but by how governance arrangements recognize vulnerable groups, enable meaningful participation, distribute resources equitably, and account for future generations. In this sense, the study contributes theoretically by providing empirical validation of Environmental Justice Theory through the application of generalized linear modeling in a local Philippine context, demonstrating its explanatory power in capturing non-normal, uneven, and asymmetric perceptions of justice. While grounded in a specific municipality, the results offer transferable insights for other climate-vulnerable localities in the Philippines and similar developing-country contexts, where strengthening climate governance requires embedding justice principles into everyday institutional practice rather than relying solely on technocratic solutions.

The following recommendations were offered for both disaster management policy and future research directions. In terms of disaster management policy and practice, it is recommended that the Local Government Unit (LGU) strengthen and intensify the application of distributive justice in local climate and disaster governance in the Municipality of Obando, Bulacan by prioritizing, in its strategic action planning, the equitable allocation of disaster preparedness resources across barangays, including fair distribution of relief goods, recovery and financial assistance, and climate adaptation programs. It is further recommended that the LGU increase community involvement by conducting forums that promote participatory and inclusive decision-making in climate change and disaster governance planning; in line with this, the municipality may enact a resolution or municipal ordinance institutionalizing the integration of climate justice awareness guided by Environmental Justice Theory into climate justice and disaster planning, implementation, and monitoring and evaluation processes. Moreover, the LGU should enhance information flow and communication systems by developing clear, accessible, and regularly updated communication strategies and climate-related information materials disseminated through multiple platforms to ensure that vulnerable sectors, high-risk barangays, and exposed communities are not excluded. Lastly, the LGU is encouraged to integrate and intensify intergenerational justice principles through youth formation initiatives, climate change and environmental justice advocacy, and localized environmental activities and projects embedded in local climate action plans; this may be supported through a municipal ordinance and a comprehensive long-term action framework that integrates sustainability perspectives, climate justice education, and contextualized governance strategies aligned with Sustainable Development Goal 13 on Climate Action.

For research recommendations, it is suggested that future studies expand this understudied context through comparative, multi-site analyses of other highly vulnerable and susceptible municipalities in Bulacan to validate Environmental Justice Theory across contexts and determine whether the justice-based governance dynamics observed in Obando are similarly reflected in other local settings. Future researchers are also encouraged to use larger, stratified samples to ensure adequate representation across barangays, age groups, livelihood sectors, and marginalized populations, as larger sample sizes and stratification can enhance representativeness and enable more detailed subgroup analyses. Additionally, future research may adopt longitudinal or time-series designs using the same theoretical framework to examine changes in climate justice awareness and governance perceptions over time, particularly before and after major disaster events or policy interventions, thereby strengthening causal inference and policy evaluation. Researchers are likewise encouraged to integrate objective indicators such as budget allocation records, disaster response timelines, policy audits, and governance performance documents, as triangulation with administrative and institutional data can improve validity and strengthen empirical findings. It is also recommended that future studies incorporate additional explanatory

variables such as income level, disaster exposure frequency, length of residency, political trust, and institutional capacity to broaden the explanatory scope and improve the predictive power of generalized linear models in understanding local climate governance dynamics. Furthermore, adopting mixed-methods or qualitative approaches—including focus group discussions, key informant interviews, and narrative analysis—may deepen understanding of residents' lived experiences and interpretations of climate justice and governance beyond numerical patterns. Finally, future research should refine measurement tools for intergenerational justice through scenario-based items, participatory foresight methods, or youth-centered qualitative investigations to enhance sensitivity in capturing long-term justice concerns and future-oriented governance perspectives.

## Contributions of Authors

The sole author contributed to all aspects of the study, including conceptualization, methodology, proposal writing, data gathering, data curation, formal analysis, investigation, writing – original draft, writing – review and editing, and final approval of the manuscript.

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## Conflict of Interests

The author declares that there is no conflict of interest associated with this publication.

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