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PUBLIC PERCEPTIONS AND AWARENESS OF CLIMATE CHANGE IN RIVER NILE STATE, SUDAN: BRIDGING KNOWLEDGE GAPS FOR EFFECTIVE ADAPTATION STRATEGIES

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ABSTRACT

Climate change presents significant global challenges, necessitating a deep understanding of public perception and awareness to inform effective policies and adaptive strategies. This study examines the perceptions, knowledge, and concerns regarding climate change among residents of River Nile State, Sudan, through a cross-sectional survey of 400 respondents. Most participants were female (79%) and had attained university-level education (41.5%), factors likely influencing environmental awareness. Geographic diversity across localities such as Aldamer, Shendi, and Barbar highlights the importance of localized climate impacts and adaptation needs.

Participants identified terrorism, infectious diseases, and armed conflict as the most serious threats to human survival, with climate change perceived as less immediate (mean = 3.10). This prioritization of socio-political issues over long-term environmental challenges underscores the need for improved risk communication and public awareness campaigns. While 81% of participants acknowledged rising temperatures over the past decade, only 36% were aware of local environmental policies, revealing a significant gap between climate change awareness and knowledge of policy responses.

Participants reported noticeable climate changes, including shifts in rainfall patterns (36%) and temperature (18.8%), consistent with regional climate projections for Africa. Knowledge of specific climate change drivers varied, with greenhouse gases (mean = 4.3) and ocean currents (mean = 4.1) being well understood, while aerosols (mean = 3.2) and deforestation (mean = 3.2) were less familiar, indicating a need for targeted educational initiatives.

Air pollution (67.8%) and river pollution (63.5%) were ranked as the most pressing environmental issues, reflecting concerns about immediate health and ecological impacts. Temperature fluctuations (39.8%) and flooding (58.5%) were also considered important. Agriculture, health, and water resources were identified as the sectors most affected by climate change, aligning with global findings on exacerbated food insecurity, water scarcity, and health risks.

The study emphasizes the importance of addressing knowledge gaps and integrating climate change into broader environmental and development agendas. Public engagement, participatory approaches, and context-specific adaptation strategies are essential for building climate resilience. By framing climate change within the context of local concerns and enhancing public awareness, this study contributes to the development of inclusive and effective climate adaptation strategies, ultimately supporting sustainable development and environmental sustainability.

Keywords: Climate Change, Perception, Awareness, Adaptation, Sudan

1. INTRODUCTION

Climate change represents one of the most profound challenges of the modern era, with far-reaching implications for ecosystems, economies, and societies across the globe. The scientific consensus, as articulated in the Intergovernmental Panel on Climate Change (IPCC) reports, underscores the urgency of addressing climate change's causes and consequences IPCC (2014); IPCC (2018)). The impacts of

climate change are not uniform; they vary across regions, scales, and communities, necessitating diverse adaptation strategies (Adger et al. (2005); Brooks et al. (2005). This variability is particularly evident in vulnerable regions such as Africa, where climate change exacerbates existing socio-economic challenges, including food insecurity, water scarcity, and forced migration (Boko et al. (2007); Niang et al. (2014); Berchin et al. (2017)). Similarly, small island developing states (SIDS) face existential threats from rising sea levels and extreme weather events, highlighting the need for transformative adaptation approaches (Mimura et al. (2007); Pelling and Uitto (2001). Adaptation to climate change is a complex process that involves not only technological and infrastructural solutions but also socio-cultural, economic, and institutional dimensions (Smit and Wandel (2006); Klein et al. (2014)). Successful adaptation requires an understanding of local vulnerabilities, adaptive capacities, and the broader socio-political context in which adaptation occurs (Adger et al. (2005); Conway and Schipper (2011)). For instance, in Zimbabwe, climate change impacts have been met with varying degrees of adaptive capacity, influenced by factors such as governance, resource availability, and community resilience (Brown et al. (2012)). Similarly, in the Caribbean, the interplay between climate change and water management underscores the importance of regional cooperation and integrated approaches to adaptation (Cashman et al. (2010); Campbell et al. (2011)).

Public perceptions and knowledge of climate change play a critical role in shaping adaptive responses. Studies have shown that awareness and understanding of climate risks are key determinants of individual and collective action (DeBono et al. (2012); Glasgow et al. (2018)). However, perceptions are often influenced by socio-cultural factors, leading to diverse interpretations of vulnerability and risk (O'Brienet al. (2007); Thomas and Twyman (2005). For example, farmers in the Limpopo Basin, South Africa, have developed localized adaptation strategies based on their perceptions of climate variability, which may not always align with scientific assessments Gbetibouo (2009). This highlights the need for effective risk communication and participatory approaches to bridge the gap between scientific knowledge and local practices (Eriksen et al. (2011); Wise et al. (2014).

The role of governance and international support in facilitating adaptation cannot be overstated. Official development assistance (ODA) has been identified as a critical mechanism for supporting adaptation in developing countries, particularly in regions with limited financial and technical resources Ayers and Huq (2009). However, the effectiveness of such support depends on its alignment with local priorities and the empowerment of vulnerable communities Denton et al. (2014); Leal Filho et al. (2019). Moreover, the concept of climate-resilient pathways emphasizes the integration of adaptation and mitigation efforts within the broader framework of sustainable development (Denton et al. (2014); Kates et al. (2012). In Africa, the impacts of climate change are particularly severe due to the continent's high dependence on natural resources and its limited adaptive capacity Hulme et al. (2001); Niang et al. (2014). The Fourth Assessment Report of the IPCC highlights that Africa is one of the most vulnerable continents to climate variability and change due to its high exposure and sensitivity to climate hazards Boko et al. (2007). For instance, in Sudan, the sustainable livelihood approach has been used to assess community resilience to climate change, revealing the importance of local knowledge and practices in enhancing adaptive capacity Elasha et al. (2005). Similarly, in Ethiopia, the challenges and opportunities for adaptation are shaped by the country's unique socio-economic and environmental context, underscoring the need for context-specific strategies Conway and Schipper (2011) .In the Caribbean, climate change poses significant threats to water resources, agriculture, and coastal

ecosystems (Campbell et al. (2011); Cashman et al. (2010). The region's vulnerability is exacerbated by its geographical location, which makes it prone to extreme weather events such as hurricanes and tropical storms Fontenard (2016). The Caribbean's experience with climate change adaptation offers valuable lessons for other regions, particularly in terms of the importance of regional cooperation, community engagement, and the integration of traditional knowledge with scientific research (Fontenard (2016); Mimura et al. (2007). Public perceptions of climate change are shaped by a variety of factors, including cultural beliefs, socio-economic status, and access to information (Glasgow et al. (2018); DeBono et al. (2012). In Malta, for example, public perceptions of climate change as a human health threat have been influenced by the country's unique environmental and socio-political context, highlighting the importance of targeted risk communication strategies DeBono et al. (2012). Similarly, in developed nations, observed climate change adaptation has been shaped by public perceptions, institutional frameworks, and the availability of resources Ford et al. (2011). The concept of vulnerability is central to understanding the impacts of climate change and the potential for adaptation (Smit and Wandel (2006); Brooks et al. (2005)). Vulnerability is determined by a combination of factors, including exposure to climate hazards, sensitivity to these hazards, and adaptive capacity (Adger et al. (2005); Thomas and Twyman (2005)). In natural-resource-dependent societies, equity and justice are critical considerations in climate change adaptation, as marginalized groups are often disproportionately affected by climate impacts (Thomas and Twyman (2005)). For example, in Sudan, vulnerability assessments have revealed the importance of addressing socio-economic inequalities and enhancing community resilience through participatory approaches (Zakieldeen (2009). Transformational adaptation is increasingly recognized as a necessary response to climate change, particularly in cases where incremental adaptations are insufficient to address the scale and magnitude of climate impacts (Kates et al. (2012); Wise et al. (2014). Transformational adaptation involves fundamental changes in socio-ecological systems, including changes in governance, economic structures, and social practices (Kates et al. (2012). In Africa, for example, transformational adaptation may involve the adoption of new agricultural practices, the diversification of livelihoods, and the strengthening of institutional frameworks to support climate-resilient development Ziervogel et al. (2008); Niang et al. (2014) .The role of uncertainty in adaptive capacity is another critical consideration in climate change adaptation Vincent (2007). Uncertainty arises from a variety of sources, including incomplete knowledge of climate impacts, variability in climate projections, and the complexity of socio-ecological systems Vincent (2007). Addressing uncertainty requires a flexible and adaptive approach to decision-making, as well as the integration of diverse sources of knowledge, including scientific research, local knowledge, and traditional practices Vincent (2007); Eriksen et al. (2011).

In conclusion, addressing climate change requires a multifaceted approach that considers the interplay between scientific knowledge, local perceptions, and socio-political dynamics. As the global community strives to limit warming to 1.5°C above pre-industrial levels, the need for equitable, inclusive, and context-specific adaptation strategies becomes increasingly urgent IPCC (2018); VijayaVenkataRaman et al. (2012).

2. MATERIALS AND METHOD

2.1. STUDY DESIGN

A descriptive Cross-sectional community-based study was conducted in River Nile State Sudan, aimed to assess the climate change Perception and Awareness level, of the People of the River Nile State Sudan.

2.2. STUDY AREA

The River Nile state lies in northern, Sudan (32'36° N and 16'22° E) and has an area of 124 000 km2 with a population of about 1 250 000 from different ethnic groups. El Damer, Atbara, Shendi, and Abu Hamad are the most important cities.

2.3. STUDY POPULATION, DATA COLLECTION, AND ANALYSIS

The basic data in this study was gathered through a survey of 400 persons in the River Nile State, Sudan. A survey questionnaire was designed to evaluate public awareness and perception of climate change the respondent was asked to fill out the questionnaire and answer all the questions. The first part of the questionnaire was about general demographic and personal information. The second part is climate change-related issues. The respondents were chosen via random stratified sampling and were interviewed face-to-face. The purpose of the survey and when the words used in the study have been clarified to the respondents and kept confidential. Software Statistical Package analyzed the data for the Social Sciences (IBM SPSS Statistics 22).

2.4. ETHICAL CONSIDERATIONS

In conducting this study, all ethical guidelines were strictly followed to ensure the protection and respect of the participants involved. Informed consent was obtained from all participants prior to their involvement in the research. They were thoroughly informed about the purpose of the study, the procedures involved, any potential risks and benefits, and their right to withdraw at any time without any repercussions.

3. RESULTS

Table 1

Table 1 Distribution of Participants by Gender, Educational Level, and Locality

Variable	Category	Frequency	Percent
Gender	Male	84	21.0%
	Female	316	79.0%
Educational Level	Primary School	75	18.8%
	Secondary School	133	33.3%
	University	166	41.5%
	Others	26	6.5%
Locality	Aldamer	101	25.3%
	Atbra	46	11.5%
	Shendi	98	24.5%
	Barbar	56	14.0%
	Almatama	53	13.3%
	Abohamad	28	7.0%

	Albohera	18	4.5%
Total		400	100.0%

Table 2

Table 2 Perceived Threats and Their Severity

Variable	Least threat	Minor affect	Neutral threat	Major Threat	Most serious	Mean	Std. Deviation	Percent	Rank
Terrorism	39	24	67	251	19	4.05	1.38	81%	4
Poverty	57	18	77	183	65	3.75	1.43	75%	4
Economic Situation	48	53	123	66	110	3.34	1.33	67%	3
Lake of Clean (Drinking Water)	39	38	85	183	55	3.76	1.37	75%	4
Biodiversity (Habitats)Loss	63	83	109	36	109	3.11	1.42	62%	3
Increasing Population	89	39	120	66	86	3.22	1.52	64%	3
Spread of Infectious diseases	32	33	54	240	41	4.06	1.34	81%	4
Armed Conflict	35	30	68	217	50	3.96	1.34	79%	4
Nuclear weapon	53	28	39	233	47	3.95	1.47	79%	4
Climate change	56	82	108	74	80	3.10	1.32	62%	3

Figure 1

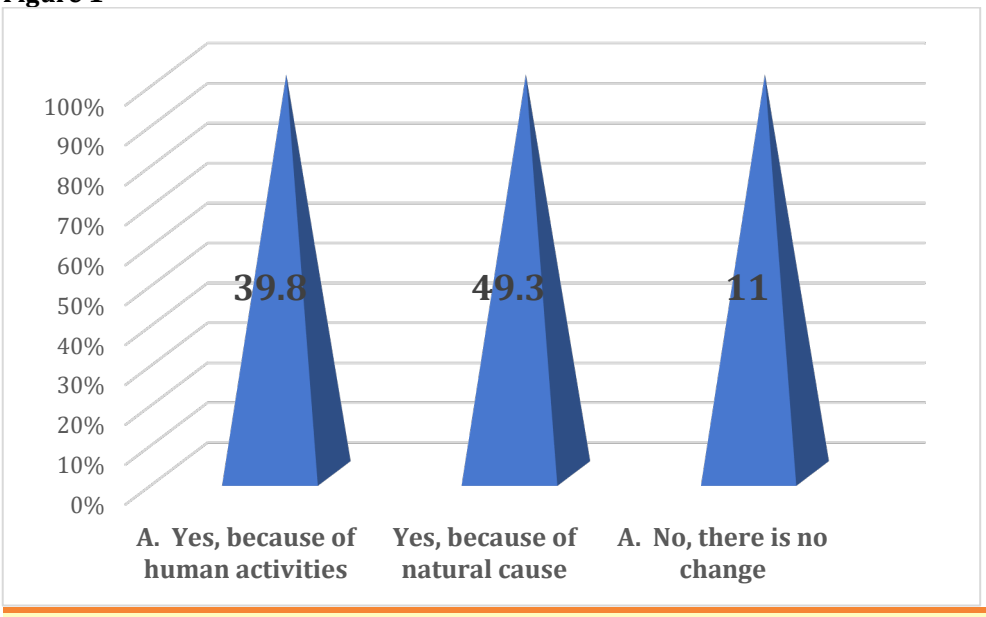

Figure 1 Demonstrate Participants That Think the Earth's Temperature has been Rising over the Past Decade.

Figure 2

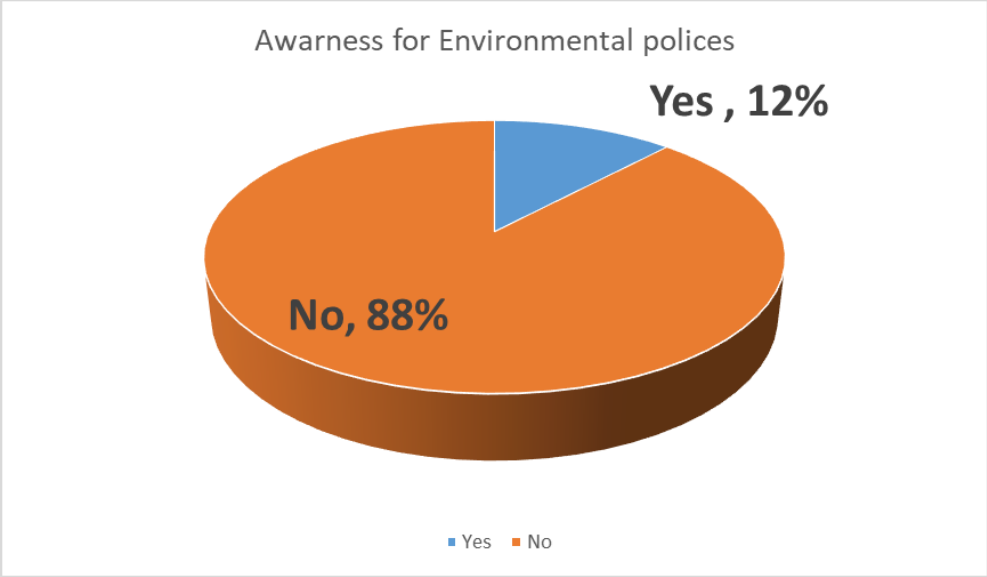

Figure 2 Participant Awareness of the Environmental Policies in River Nile State, Sudan.

Table 3

Table 3 Participants' Observations of Climate Changes over the Past 10 Years

Variable	Frequency	Percent
Rain	144	36.0%
Temperature	75	18.8%
Season Shift	51	12.8%
Flood	88	22.0%
Drought	4	1.0%
NO	38	9.5%
Total	400	100.0%

Figure 3

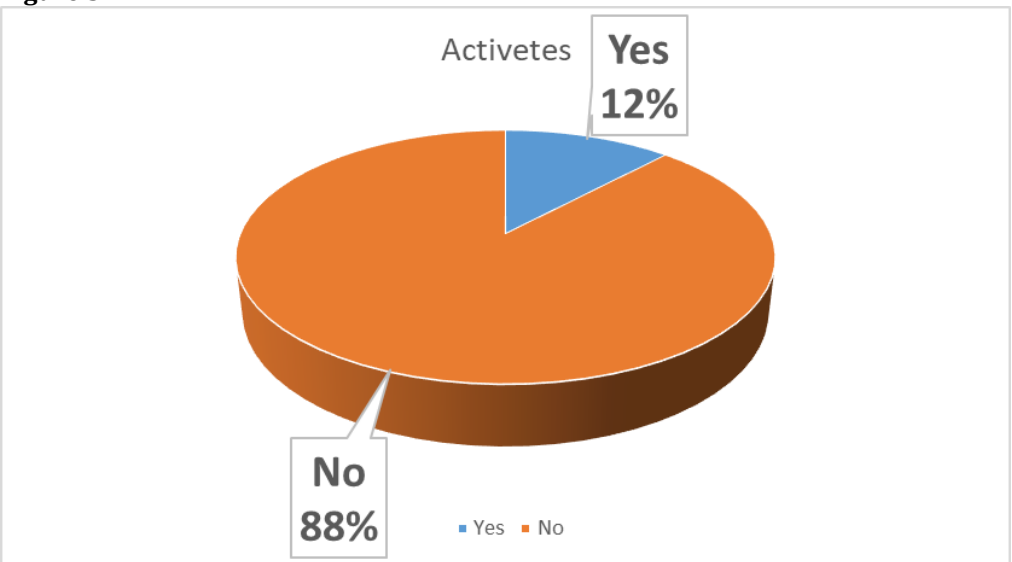

Figure 3 Participants that follow any Climate Change Activities

Table 3

Table 3 Participants' Understanding of Climate Change Factors

Variable	Don know at all	Not broad	Slightly broad	Moderately broad	Quite broad	Very broad	Mean	Std.Deviation	Percent	Rank
Greenhouse gases	36	30	84	55	25	170	4.3	1.7	72	5
Aerosols	33	39	75	95	100	58	3.2	1.7	53	4
Currents in the sea/ocean	58	22	88	51	27	154	4.1	1.8	68	5
Melting of ice or volcanic eruptions	81	44	74	48	129	24	3.7	1.9	62	4
El Niño	58	22	88	51	27	154	4.1	1.8	68	5
Deforestation	37	57	57	41	121	87	3.2	1.9	53	4
Overall, climate change	67	58	135	53	11	76	2.9	1.8	48	2

Figure 4

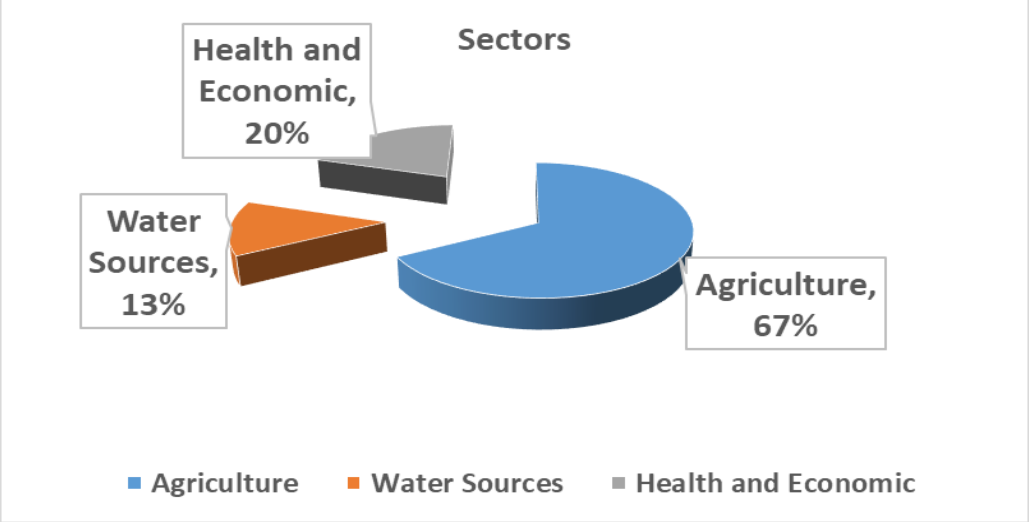

Figure 4 Most Sectors are Affected by Climate Change According to Participant Opinion.

Table 4

Table 4 Perceived Importance of Environmental Issues among Residents

Variable		Very Important	Fairly Important	Important	Slightly Important	Not at all Important	Mean	Std.Deviation	Percent	Rank
Air pollution	F	271	34	42	30	23	1.8	1.2	36	1
	%	67.8	8.5	10.5	7.5	5.8				
Pollution of rivers	F	254	58	61	27	0	1.6	1.5	32	1
	%	63.5	14.5	15.3	6.8	0				
Flooding	F	234	45	63	42	16	1.9	1.3	38	2
	%	58.5	11.3	15.8	10.5	4				
	%	66.5	11.8	15.8	2.5	3.5				
Poor waste management	F	265	40	57	21	17	1.7	1.1	34	1
	%	66.3	10	14.3	5.3	4.3				

Temperature rise or drop	F	159	76	76	65	24	2.3	1.3	46	2
	%	39.8	19	19	16.3	6				
Using up the earth's resources	F	224	53	77	31	15	1.9	1.2	38	1
	%	56	13.3	19.3	7.8	3.8				
Radioactive waste	F	262	43	29	35	31	1.8	1.3	36	2
	%	65.5	10.8	7.3	8.8	7.8				

4. DISCUSSION

The demographic data reveals that the majority of participants were female (79%), with a significant proportion having attained university-level education (41.5%). This gender and educational distribution may influence the participants' awareness and perceptions of climate change, as education is often correlated with higher environmental literacy (Glasgow et al. (2018). The geographic distribution of participants across localities such as Aldamer, Shendi, and Barbar highlights the diversity of the sample, which is crucial for understanding localized climate change impacts and adaptation needs (Boko et al. (2007); Niang et al. (2014).

Participants identified terrorism, the spread of infectious diseases, and armed conflict as the most serious threats to human survival, with mean scores of 4.05, 4.06, and 3.96, respectively. Climate change, however, was ranked lower (mean = 3.10), indicating that it is perceived as a less immediate threat compared to socio-political issues. This aligns with studies suggesting that public perceptions of climate change are often influenced by more visible and immediate concerns, such as health and security (DeBono et al., (2012); Glasgow et al. (2018). The relatively lower ranking of climate change as a threat may reflect a need for improved risk communication and public awareness campaigns to highlight its long-term and interconnected impacts (Eriksen et al. (2011).

Awareness of Climate Change (Figures 1 and Figures 2) Figure 1 shows that a significant majority of participants (81%) believe that the Earth's temperature has been rising over the past decade, indicating a general awareness of global warming. However, Figure 2 reveals that only 36% of participants are aware of environmental policies in River Nile State, Sudan. This disparity suggests a gap between awareness of climate change and knowledge of local policy responses, underscoring the need for better dissemination of information and community engagement in policy implementation Ayers and Huq (2009); Denton et al, (2014).

Participants reported noticeable changes in climate over the past decade, with rainfall (36%) and temperature (18.8%) being the most frequently observed changes. This is consistent with regional climate projections for Africa, which predict increased variability in rainfall patterns and rising temperatures (Hulme et al. (2001); Christensen et al. (2007). The reported shifts in seasons and increased flooding (22%) further highlight the localized impacts of climate change, which are critical for designing context-specific adaptation strategies (Brooks et al. (2005); Conway and Schipper (2011).

Participants demonstrated moderate knowledge of climate change-related issues, with greenhouse gases (mean = 4.3) and ocean currents (mean = 4.1) being the most understood concepts. However, knowledge of aerosols (mean = 3.2) and deforestation (mean = 3.2) was relatively lower. This indicates a need for targeted educational initiatives to enhance understanding of specific climate change drivers and their impacts (Gbetibouo, 2009; Glasgow et al. (2018). The overall knowledge

score for climate change (mean = 2.9) suggests that there is room for improvement in public awareness and education efforts.

Perceived Importance of Environmental Issues (Table 4) Air pollution (67.8%) and river pollution (63.5%) were ranked as the most important environmental issues by participants, reflecting concerns about immediate health and ecological impacts. Temperature rise or drop (39.8%) and flooding (58.5%) were also considered important, though to a lesser extent. These findings align with studies emphasizing the need to address local environmental issues as part of broader climate change adaptation efforts Cashman et al. (2010); Fontenard (2016). Climate Change Adaptation in the Caribbean: Lessons from the Past, Challenges for the Future. Caribbean Studies, 44(1-2), 3-28.. The high importance placed on poor waste management (66.3%).

Participants identified agriculture, health, and water resources as the sectors most affected by climate change. This is consistent with findings from other regions, where climate change exacerbates food insecurity, water scarcity, and health risks (Ziervogel et al. (2008); Niang et al. (2014). The recognition of these impacts highlights the need for integrated adaptation strategies that address multiple sectors simultaneously Denton et al, (2014); Leal Filho et al. (2019).

The results underscore the importance of addressing public perceptions and knowledge gaps in climate change adaptation efforts. While participants are generally aware of climate change, their understanding of specific drivers and local policy responses is limited. This suggests a need for targeted educational campaigns and participatory approaches to enhance public engagement and support for adaptation initiatives (Eriksen et al. (2011); Wise et al. (2014).

The prioritization of immediate environmental issues, such as air and water pollution, over long-term climate change threats highlights the need to frame climate change adaptation within the context of local concerns. This can be achieved by integrating climate change into broader environmental and development agendas, as suggested by the concept of climate-resilient pathways (Denton et al, (2014); Kates et al. (2012).

Conclusion: The findings from this study provide valuable insights into the perceptions, knowledge, and concerns of participants regarding climate change and environmental issues. While there is a general awareness of climate change, significant gaps in knowledge and understanding remain, particularly in relation to local policy responses and specific climate change drivers. Addressing these gaps through targeted education, improved risk communication, and participatory approaches is essential for building public support for climate change adaptation and ensuring the effectiveness of adaptation strategies. The prioritization of local environmental issues further underscores the need for integrated approaches that address both immediate and long-term challenges, ultimately contributing to sustainable development and climate resilience.

These results align with the broader literature on climate change adaptation, which emphasizes the importance of context-specific strategies, public engagement, and the integration of climate change into broader environmental and development agendas (Adger et al. (2005); Smit and Wandel (2006); IPCC (2014). By addressing the identified gaps and building on the strengths of local knowledge and perceptions, it is possible to develop more effective and inclusive climate change adaptation strategies that meet the needs of vulnerable communities.

5. CONCLUSIONS AND RECOMMENDATIONS

The study revealed a significant lack of awareness and compliance with environmental regulations among the residents, with only 12% of respondents being informed and involved in policy-setting or community-wide policy-sharing. A large majority (89%) of respondents believe that the earth's temperature has been rising over the past decade due to human activities, and 90% have noticed significant climate changes in the State, particularly regarding rainfall patterns, flooding, and temperature increases. The rising temperatures and changing climate conditions are increasingly challenging the viability of agriculture, industrial plants, and water availability, threatening the overall balance of the ecosystem.

Initiatives should be undertaken to raise public awareness about environmental policies and the importance of community participation in policy-setting. Educational campaigns and community engagement programs could help bridge the knowledge gap. Efforts should be made to address the public's perception of threats, balancing the focus between immediate concerns like terrorism and the long-term impacts of climate change. This could involve integrating climate change education into broader security discussions. Encouraging greater community involvement in environmental policy-making and dissemination could foster a stronger sense of ownership and responsibility toward climate action and sustainability.

CONFLICT OF INTERESTS

None.

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