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Assessment of Climate Change Awareness Program in Managing Marine Resources of Selected Communities Around Menai Bay Conservation Area, Zanzibar

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Abstract: Climate change threatens marine ecosystems and coastal livelihoods in Zanzibar's Menai Bay Conservation Area (MBCA). Awareness programs exist, but evidence on their effectiveness in changing behaviour is limited. This research focuses on assess climate change awareness programs in managing marine resources among MBCA communities. Cross-sectional mixed-methods research design with 199 household surveys, 16 key informant interviews, and 52 FGD participants. Data analyzed using descriptive statistics, Wilcoxon Signed-Rank Tests, and thematic analysis. The results: **79.9% attended awareness programs (mainly NGO-led). Significant positive behavioural changes were observed ($p < 0.001$; $r = 0.88$) for sustainable fishing gear, avoiding destructive fishing, mangrove conservation, waste disposal, compliance, and reducing overfishing. Perceptions were moderate (56.3%) to high (43.2%). Qualitative findings confirmed increased conservation action and stewardship. Key challenges: poverty, marine dependence, lack of alternative income, weak enforcement, inadequate support, environmental pressures, and limited cooperation.** The study conclusion: **Awareness programs significantly improved knowledge, perceptions, and behaviours, but socioeconomic and institutional barriers persist.** Recommendations: **Strengthen practical, continuous programs; improve enforcement; promote alternative livelihoods; enhance institutional collaboration; empower communities for sustainable marine management and climate adaptation in Zanzibar.**

Keywords: *Climate Change, Climate Change Awareness Program, Marine Resources Management, Menai Bay Conservation Area (MBCA).*

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I. INTRODUCTION

Climate change, driven by greenhouse gas emissions, causes rising temperatures, sea-level rise, and extreme weather events(Bhatti *et al.*, 2024). Coastal regions like Zanzibar are highly vulnerable, as climate stressors directly affect marine ecosystems and community livelihoods (Roy, et al., 2023). Marine ecosystems: coral reefs, seagrass meadows, and mangroves are form an integrated seascape supporting fisheries, shoreline protection, and fish breeding(Gullström, et al., 2006). The Menai Bay Conservation Area (MBCA) in southwest Unguja is ecologically dynamic. Surrounding communities depend on these resources for food security, income, and coastal defense (Shalli et al., 2025). However, sustainability is threatened by climate change (coral bleaching, ocean acidification, storms) and human activities (destructive fishing, unplanned tourism, seaweed farming), which degrade habitats, reducing fish stocks, seagrass cover and reduce resilience(Makame *et al.*, 2021; Fabricius et al., 2025; Saengsupavanich et al., 2024). The combined effects threaten livelihoods, food security, and community safety, underscoring the need for effective awareness programs. In response, the Government of Zanzibar and partners implemented climate change awareness programs to educate communities about climate risks and sustainable marine resource management. Evaluating these programs is essential to ensure awareness translates into behavioural change and strengthening community-based marine resource management in Menai Bay.

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II. METHODOLOGY

This mixed-methods research was conducted on Unguja Island, Zanzibar, located in the tropical Western Indian Ocean bordering mainland Tanzania. Zanzibar comprises two main islands (Unguja and Pemba) with several marine conservation areas. The Menai Bay Conservation Area (MBCA): one of Tanzania's largest marine protected areas contains coral reefs, seagrass meadows, and mangrove forests supporting fisheries, coastal protection, and tourism(Jacquet *et al.*, 2010). The study focused on four communities around MBCA on southwest Unguja: Kwabitikala and Tindini (Unguja Ukuu; population 1,788; 6°22'23"S, 39°18'17"E), and Kidenga and Mfumbwi (Jambiani; population 10,174; 6°18'43"S, 39°32'32"E)(ALI, 2018). The selected communities are heavily dependent on marine resources for food and income and livelihoods. Yet face increasing climate change impacts (coral bleaching, fish stock decline, shoreline erosion, and weather pattern changes)(Artiningsih *et al.*, 2019). In response, multiple government and NGO: led awareness programs in these areas, they were deemed suitable for assessing program effectiveness in promoting sustainable marine resource management.

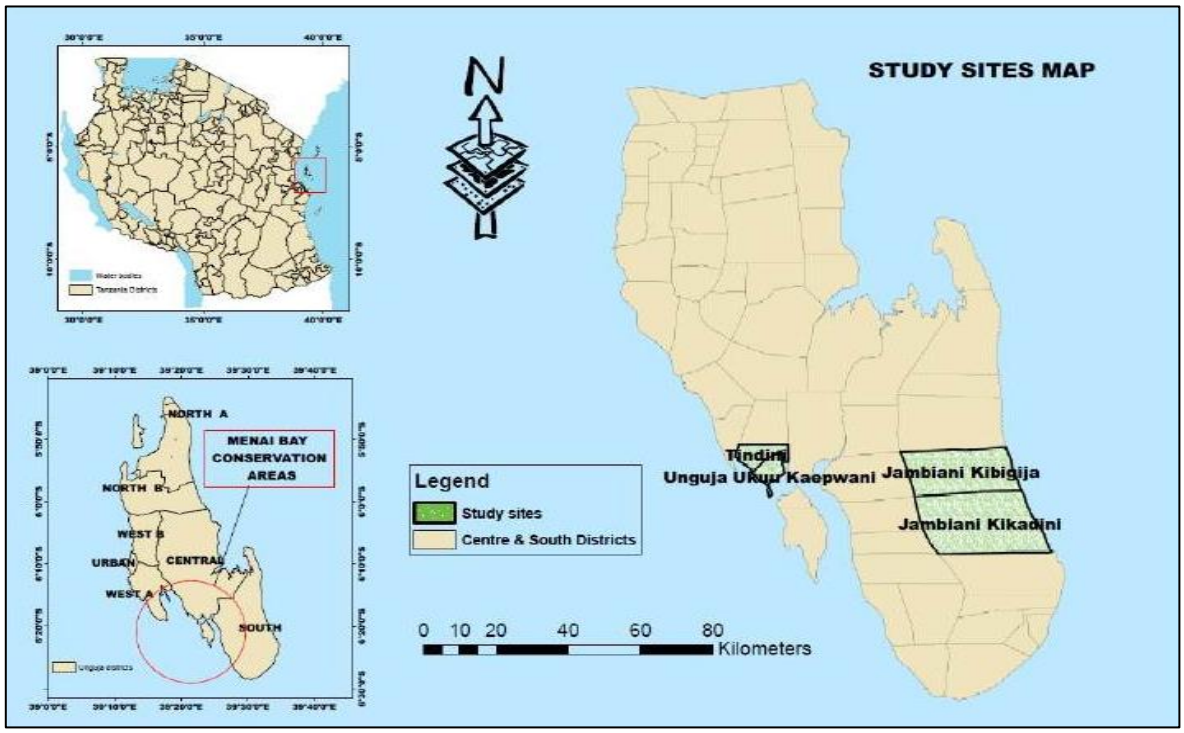

Fig 1 Study Site

III. RESULT AND DISCUSSION

A. Behavioral Changes of Communities after Receiving Climate Change Awareness Programs:

The findings of this study demonstrated significant positive behavioural changes among communities after participating in climate change awareness programs. Quantitative findings from the Wilcoxon Signed-Rank Test showed statistically significant improvements across all behavioural domains, including increased use of sustainable fishing gear, avoidance of destructive practices, mangrove conservation, proper waste disposal, regulation compliance, and reduced overfishing. The very high effect size (r = 0.88) suggests that the awareness programs had a strong influence on community practices related to marine resource management.

Table 1 Wilcoxon Signed-Rank Test Results for Community Behavioural Changes before and after Climate Change Awareness Programs

Domain	Negative Ranks (n, Mean Rank, Sum)	Positive Ranks (n, Mean Rank, Sum)	Ties (n)	Z	p-value	Effect Size (r)
Use of Sustainable Gear	0 (0.00, 0.00)	199 (100.00, 19900.00)	0	-12.423	0.000	0.88
Avoid Destructive Methods	0 (0.00, 0.00)	197 (99.00, 19503.00)	2	-12.344	0.000	0.88
Mangrove Participation	0 (0.00, 0.00)	199 (100.00, 19900.00)	0	-12.442	0.000	0.88
Avoid Sea Grass Damage	0 (0.00, 0.00)	199 (100.00, 19900.00)	0	-12.432	0.000	0.88
Proper Waste Disposal	0 (0.00, 0.00)	199 (100.00, 19900.00)	0	-12.429	0.000	0.88
Follow Regulations	0 (0.00, 0.00)	199 (100.00, 19900.00)	0	-12.418	0.000	0.88
Reduce Overfishing	0 (0.00, 0.00)	197 (99.00, 19503.00)	2	-12.396	0.000	0.88

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➢ *Wilcoxon Signed-Rank Test Results for Environmental Practices*

These findings imply that climate change awareness programs can successfully promote environmentally responsible behaviour when communities are continuously engaged and exposed to conservation messages. Similar findings were reported in the Republic of Korea, where improved ocean literacy was associated with increased climate mitigation and marine conservation behaviours among coastal populations(Choi, et al., 2024b). Likewise, research conducted in the Philippines found that communities with higher climate change awareness were more likely to support ecosystem conservation and sustainable marine practices UCL Open Environment (Alcantara et al., 2023d).The qualitative findings further supported the quantitative results. Key informants and FGDs confirmed that greater participation in mangrove planting, clean-ups, reef rehabilitation and reporting violations, plus diversification into alternative livelihoods (e.g., beekeeping, handcrafts and ecotourism). Also demonstrates that awareness programs encouraged diversification away from overdependence on marine resources. Such behavioural adaptation is important because coastal communities are highly vulnerable to climate-related environmental degradation and declining fish stocks.

The observed behavioural changes may also be linked to the relatively high participation rate in awareness programs, where nearly 80% of respondents reported attending climate-related programs, mainly organized by NGOs and community groups. Repeated exposure to awareness messages through meetings, workshops, and local communication channels likely reinforced sustainable practices over time. Studies have shown that repeated community engagement and participatory environmental education improve long-term conservation behaviour and strengthen environmental stewardship among coastal communities(Cardenas et al., 2025).

However, despite these positive changes, some challenges remain. The study found that certain destructive practices persist due to poverty and economic dependence on marine resources. This supports the argument that awareness alone may improve intentions and attitudes but may not fully transform behaviour without supportive socioeconomic interventions (Volpato, et al., 2025) Therefore, while awareness programs are important, sustainable behavioural change requires integration of livelihood support, policy enforcement, and community empowerment.

B. Community Perceptions Regarding Climate Change Awareness Programs:

The study found that community perceptions toward climate change awareness programs were generally positive. More than half of the respondents had moderate perception levels, while a large proportion demonstrated high perception levels regarding the usefulness and relevance of the programs. Most respondents agreed that the programs were useful, understandable, motivating, and capable of increasing their knowledge about climate change and marine resource conservation. These finding are summarized in Figure 1 below.

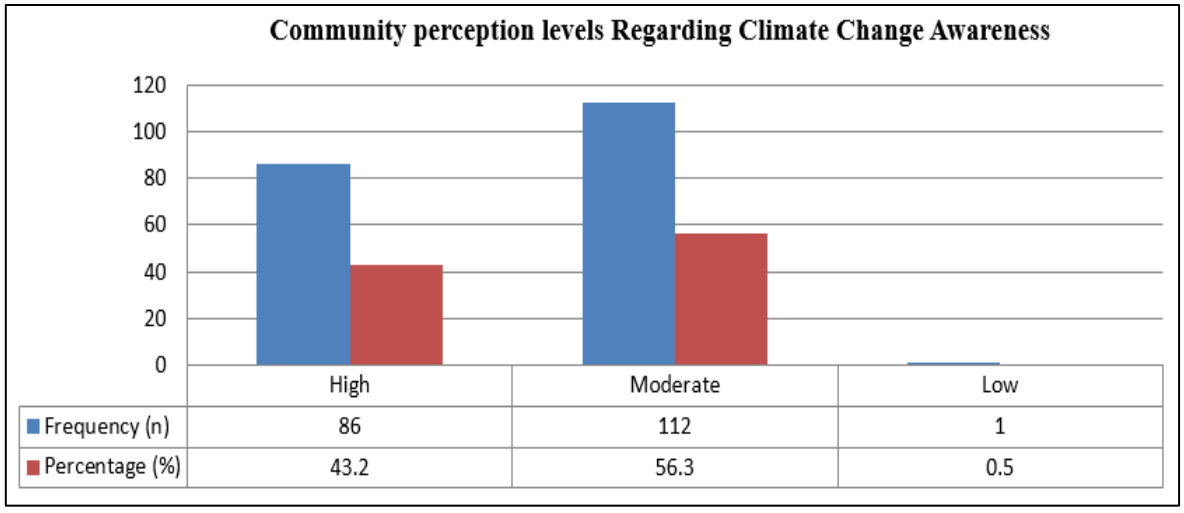

Fig 1 Community Perception Levels Regarding Climate Change Awareness

The findings suggest that the awareness programs were accepted by the community and were perceived as addressing real environmental issues affecting their livelihoods. . Positive perceptions are critical because they influence willingness to participate in conservation initiatives and compliance with environmental regulations. Similar findings have been reported in coastal communities in the Philippines, where positive perceptions of climate risks were associated with greater participation in marine conservation activities UCL Open Environment(Alcantara *et al.*, 2023). Most qualitative respondents, indicted with all informants agreeing that the program was clear and useful, understandable, motivating, and effective information of climate change and marine conservation(Bhatti *et al.*, 2024). The positive perception observed in this study may reflect the importance of clear communications which were linked to participatory delivery methods (e.g., meetings, workshops, peer campaigns and local engagement), which

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fostered trust and ownership among community members. Previous studies indicate that participatory and community-based awareness approaches are more effective than top-down communication strategies because they encourage local involvement and shared responsibility (Stover, et al., 2024). Nevertheless, a notable minority remained neutral about information credibility, citing insufficient practical demonstrations and follow-up. Some FGDs participants recommended shifting from theoretical content to hands-on activities. This finding aligns with studies showing that communities are more likely to value climate adaptation programs when they include practical demonstrations, livelihood support, and visible community benefits (Dorji, et al., 2023). Furthermore, the findings suggest that socioeconomic and educational differences may influence perceptions, with less educated individuals needing simpler, repeated messaging. Similar observations have been reported in African climate perception studies, where education and access to information significantly influenced how communities perceived environmental risks and adaptation measures (Parsons, et al., 2025).

C. Challenges Faced by Communities in Implementing Knowledge Gained from Climate Change Awareness Programs

The table shows the distribution of respondents' ratings for each challenge, ranging from "Not a Challenge" to "Very Major Challenge." Percentages represent the proportion of respondents who selected each severity level. Table 2.

Table 2 Challenges Faced by Communities in Implementing Knowledge Gained from Climate Change Awareness Programs

Challenge	% Moderate to Very Major
Lack of alternative income	66.50%
Lack of tools/equipment	87.50%
Weak law enforcement	93.00%
Limited institutional support	84.50%
Environmental conditions	96.00%
Lack of community cooperation	81.50%

Source: Field Data, 2025.

The qualitative data collected from focus group discussions (FGDs), key informant interviews (KIIs), and quantitative data from the survey highlight six major challenges (Table 2) limiting the application of climate change knowledge: economic dependence, lack of tools and equipment, weak law enforcement, limited institutional support, environmental changes, and poor community cooperation. The findings revealed that low seaweed prices, inadequate drying areas, limited employment outside fishing and poverty traps communities in unsustainable practices despite their awareness. Similar findings (Alcantara *et al.*, 2023;Painter et al., 2022). A widespread lack of conservation tools and equipment FGDs participants reported unsustainable fishing gear and lack of practical resources represents a practical barrier rather than a motivational one, as community members possess awareness and willingness but cannot access necessary physical resources, aligning with (Tobey and Torell, 2006). Weak institutional enforcement was another major challenge identified by both key informants and community participants. Respondents noted poor enforcement of marine regulations, weak patrol systems, and inadequate collaboration between conservation institutions. Illegal, unreported, and unregulated fishing activities were also highlighted as ongoing threats to marine ecosystems. Similar governance-related challenges have been reported in Zanzibar and other coastal regions, where limited institutional capacity undermines effective marine conservation efforts.(Battista *et al.*, 2018;Mascia, Claus and Naidoo, 2010). Environmental factors such as declining fish stocks, coastal erosion, storms, and marine pollution were also perceived as barriers to sustainable marine management. Some participants reported pollution from hotels and tourism-related activities, including careless disposal of swimming pool water into the sea. These findings indicate that climate change impacts are compounded by local anthropogenic pressures, increasing ecological stress within MBCA. Existing literature similarly shows that climate change and unsustainable coastal development jointly threaten marine ecosystems and reduce ecosystem resilience(Wolf and Moser, 2011;Hassoun, et al., 2025)

IV. CONCLUSION

The study concludes that climate change awareness programs have played an important role in improving community engagement in sustainable marine resource management around the Menai Bay Conservation Area. The programs significantly contributed to positive behavioural changes, including increased use of sustainable fishing practices, participation in mangrove conservation, proper waste management, and reef rehabilitation. The study also found that community perceptions of the awareness programs were generally positive. Most respondents considered the programs useful, understandable, relevant, and motivating in promoting environmental conservation and climate change adaptation. These positive perceptions contributed to increased community participation in conservation activities. However, despite these achievements, several challenges continue to hinder the effective implementation of knowledge gained from awareness programs. Socio-economic barriers: high dependence on marine resources, poverty, lack of alternative livelihoods. Another's institutional barriers: institution support, low community cooperation, inadequate enforcement of regulations and environmental barrier which remain major obstacles affecting sustainable marine

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resource management. Therefore, the study concludes that climate change awareness programs alone are insufficient to achieve long-term sustainable conservation outcomes unless they are integrated with economic empowerment initiatives, strong institutional support, practical training approaches, and effective environmental governance systems.

➢ *Author Contributions*

- Habiba O. Juma: Responsible for conceptualizing the study, designing the methodology, conducting investigations and writing the first draft.
- Nariman S. Jiddawi: Oversaw the research, helped with methodology, conducted formal analysis and contributed to reviewing and editing the writing.

➢ *Declaration of Interest*

Habiba O. Juma declares that there is no conflict of interest regarding this publication. The authors jointly agreed on and approved the publication of the article.

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