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Coastal Community Responses to the Impact of Climate Change in Tanzania—A Case of North "A" District, Zanzibar

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Abstract

Climate change has severely impacted the coastal community livelihoods in Zanzibar. This study examines the coastal communities' responses to the climate change impact in Nungwi, Matemwe, Pwani Mchangani, and Kidoti villages. A total of 400 respondents were selected randomly. The study used questionnaires, interviews, and focus group discussions as data collection tools. The results indicate that community awareness in climate change and its impact is significantly raised, particularly in Matemwe (49.2%) and Pwani Mchangani (43.4%). Furthermore, more than 50% in all villages strongly agreed with the relocation of fishing ground due to the changing environmental conditions. Shifting to other Economic activities has become among essential response, with a substantial percentage (between 53.8% and 80.9%) transitioning from fishing to agriculture and business, motivated by diminishing fish populations and wider socio-economic changes. Moreover, the establishment of social helping groups receives substantial endorsement (64.2% - 76.1%), indicating strong community solidarity and cooperative support among escalating climate-related adversities. The study shows migration is a strong adaptive strategy, with strong agreement in all villages (55% - 70%), indicating the vulnerabilities and adaptive mobility of these populations. Whereby, petty trade activities were identified as a key economic safety net, particularly in Nungwi and Pwani Mchangani, where more than 60% of individuals strongly agreed on its significance, highlighting the role of informal markets in household resilience. Agroforestry was articulated as a significant support in all villages (46.7% - 50.9%), reflecting an increasing acknowledgement of their environmental and economic advantages. Finally, the community mobilization demonstrates the strong engagement levels (67% - 70.1%), indicating successful collective action bolstered by outreach initiatives and multi-stakeholder participation. These adaptive measures collectively illustrate the dynamic, multifaceted, and com-

munity-oriented aspects of climate change adaptation in Zanzibar's coastal areas, providing useful insights for larger climate resilience planning in comparable vulnerable contexts.

Keywords

Coastal Community, Responses, Climate Change Impacts

1. Introduction

Climate change refers to long-term changes in climate variability like temperature, precipitation patterns, wind patterns, and other aspects of the Earth's climate system (Laino & Iglesias, 2023). The livelihoods and activities of coastal populations, which are primarily extremely susceptible to environmental changes, are significantly impacted by these changes (Santojanni et al., 2023). Global climate change is predicted to affect coastal communities worldwide, many already exposed to continuous climate variability. Among these effects is faster sea level rise, which has attracted great attention and may imply elevated tidal inundation, an increased flood frequency, accelerated erosion, increased saltwater intrusion, and a suite of ecological changes (Das & Swain, 2024). Climate change has become a difficult subject. Its detrimental alterations significantly impact animals, humans, and other ocean environments (Ripple et al., 2024). A wide variety of species can be found in coastal ecosystems, which are highly varied and impacted (Berman et al., 2020). These impacts include threats to habitats, particularly those that are very sensitive and more fragile. Numerous effects of global climate change may intensify existing human pressures on coastal systems, including infrastructure development, pollution, and sediment depletion from watersheds or coastal areas. This explained that coastal environments as human-induced alterations in the global atmosphere, characterized by elevated concentrations of carbon dioxide and other trace gases, significant global warming, rising sea levels, and alterations in the frequency and severity of storms (David et al., 2024).

All around the world, Coastal areas are becoming more and more vulnerable to the impact of climate change (Yanda et al., 2023). The sea levels are rising, speeding up coastal erosion, putting stress on homes, farmland, and important infrastructure around the world are at great risk. Saltwater getting into freshwater destroys the aquifers, resulting the water shortage which damages farming and makes it harder to get safe drinking water (Yang et al., 2022). Also, changes in rainfall patterns and random weather are damaging farming systems all over the world, which is a big threat to food security (Daneshi et al., 2021). Coastal areas all put a lot of strain on climate-sensitive industries, including tourism, agriculture, and fishing, which support millions of people (Imani et al., 2023). On the other hand, ocean acidification and warming are changing where and how many fish there are, which is making fishing less productive in both industrial and artisanal set-

tings. Unpredictable weather has also caused yields of staple and cash crops to drop in tropical and subtropical areas, which has had a chain effect on the local economy and nutrition (Omotoso et al., 2023). Coral reefs are dying, and coastal erosion is making many tourist locations less appealing. This is hurting international tourism and local businesses (Chandel et al., 2025).

Coastal areas significantly contributed to the livelihoods of coastal people and national economies through fishing, tourism, and agriculture (Hsu & Peng, 2023). Even without climate change, these coastal areas face numerous difficulties caused by human and environmental change. However, climate change threatens these ecosystems' integrity and ability to continue providing ecological goods and services to local communities (Miah et al., 2023). Climate change is projected to exacerbate many of these stresses by increasing susceptibility in already highly susceptible systems by developing new impacts and/or intensifying existing impacts with synergic and cascading effects (Yanda et al., 2023). It is projected to disrupt coastal resources and ecosystems through sea-level rise, rising sea surface temperatures, flooding, sedimentation, and even long-term droughts. According to the United Nations (2020), Climate change is rapidly affecting coastal areas, which comprise 40% of the world's population. These groups are especially susceptible to the effects of climate change, including increasing sea levels, severe weather, coastal erosion, and ecosystem shifts (Uddin et al., 2021). As global temperatures rise, the coastal zone, its unique interaction between land and ocean, becomes increasingly vulnerable to climate change. These communities usually rely on natural resources like agriculture, tourism, and fisheries that are directly threatened by environmental degradation (Nham, 2023). In this setting, climate change threatens not just the environment but also the livelihoods and cultural identities of people who live along the coast.

Small Island Developing States (SIDS), such as Kiribati, Tuvalu, the Maldives, and the Marshall Islands, are among the nation's most adversely affected by climate change (Thomas et al., 2020). In recent years, the potential for entire nations to vanish due to rising sea levels has garnered heightened attention under the term "sinking islands". (Doorga et al., 2024). As sea levels rise, coupled with coastal erosion and intensified extreme events, low elevation. Small Island Developing States (SIDS) will likely experience significant impacts on their populations, resulting in both displaced individuals, who are compelled to relocate, and migrants, who choose to move due to specific circumstances, as one way of responding to climate change impact (Pouponneau, 2022).

Likewise, Zanzibar Island, as one among small islands, is increasingly facing the adverse effects of climate change, including rising sea levels, coastal erosion, unpredictable weather patterns, and loss of biodiversity (Hamad & Sawe, 2022). These changes pose significant threats to the livelihoods, food security, and socioeconomic stability of the local population, who largely depend on fishing, agriculture, and tourism for their survival (Makame & Shackleton, 2020). Zanzibar has been at the forefront of implementing adaptation strategies to effectively address

climate change impact (Myers et al., 2020). This has been achieved through their active involvement in the pursuit of solutions to direct and indirect losses that have arisen from more severe natural hazards and the rise in sea level (Bush, 2018).

The region has extensive experience in the construction of coastal protective structures, using retreat strategies such as changing fishing grounds, migrating from one location to another, engaging in petty trade activities, raising awareness of the impact of climate change, establishing protected forests, community mobilization, and the establishment of social helping groups (Zhang & Bakar, 2017). Moreover, Zanzibar has devised methods for prioritizing, monitoring, and evaluating adaptation measures with the assistance of multilateral lending agencies and donor organizations. Although the situation is exacerbated by limited infrastructure, poor technical support, and a lack of integrated policies that address a unique coastal vulnerability. Climate adaptation methods may not be effective or sustainable unless they have a good understanding of the local context and reactions. This paper aims to explore the various ways in which the coastal communities are responding to the impacts of climate change and to identify the challenges and opportunities for enhancing their adaptive capacities.

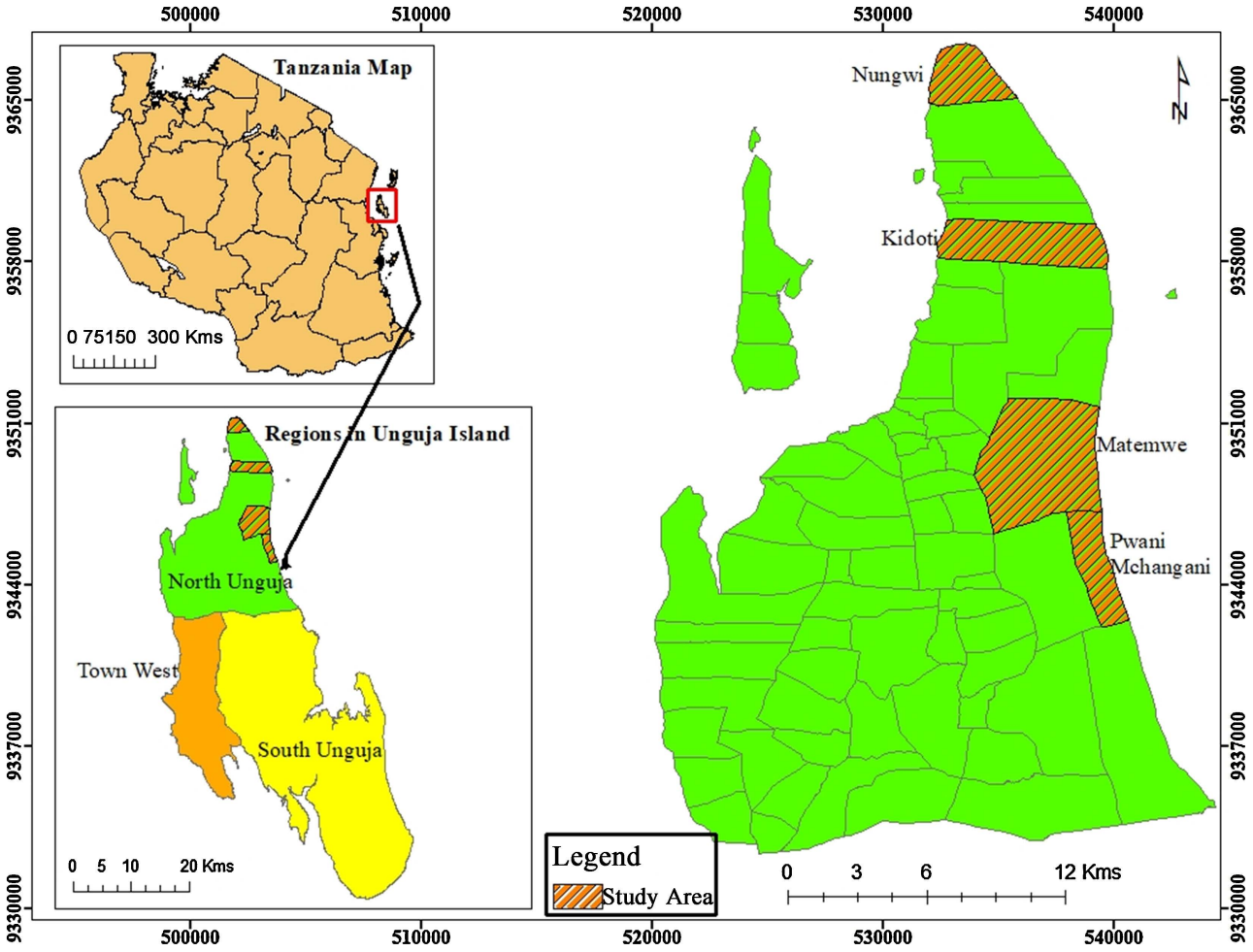
2. Material and Methods

2.1. Study Area

The North "A" District, located in the northern region of Unguja Island between 54˚59.99"S and 39˚15'60.00"E, shows a delicate vulnerability to climate change impacts. This region is equivalent in size to the total geographical area of Andorra, with its administration being located on the island of Zanzibar. The research was conducted in four out of thirty-six villages: Nungwi, Matemwe, Pwani Mchangani, and Kidoti. Nungwi Village (See **Map 1**). The district encompasses an area of 470 km^2 (180 m^2) (URT, 2022). These were randomly selected based on their geographic significance and their heightened vulnerability to climate change impacts, including flooding, coastal erosion, and rising sea levels. Moreover, storms and tidal surges are increasingly frequent and strong, rendering this district more vulnerable to extreme weather events. Furthermore, the economy of the North "A" district predominantly depends on maritime industries such as fishing and coastal tourism, both of which are very vulnerable to climate change impacts. This district also is a critical site for vulnerability assessment due to the direct effects of overfishing, fluctuating ocean temperatures, and coral reef degradation on local livelihoods. The district significantly influences Zanzibar's blue economy, which relies on the prudent use of marine resources. Examining the coastal community responses to climate change impact in this context can facilitate the development of resilience and flexibility within the study area.

2.1.1. Topography

Topologically, Unguja is approximately aligned in a North-South direction. The



Map 1. Study area.

coastline segment of this district is located at an elevation of 0 to 30 meters above sea level and extends 30 to 90 meters inland, with the terrain being predominantly flat and low-lying between the NWZ and NEZ. The eastern coast's morphology transitions from the nearshore to the offshore (Rosati, 2023). The landward side is primarily flat and narrow, while the seaward side demonstrates a significant topographical gradient.

2.1.2. Climate

The North "A" District has a humid tropical climate characterized by two distinct rainy seasons: the "long rains" season (Masika) from March to May, and the "short rains" season (Vuli) from mid-October to December. The district receives rainfall ranging from 900 mm to 1200 mm in the extended wet season and from 400 mm to 500 mm in the short rainy season. The district is conducive to livestock rearing and the production of many commodities due to its annual rainfall pattern and dual rainy seasons. The yearly precipitation averages about 1600 millimeters. The district comprises two biological zones: the littoral strip, characterized by savannah and bushy vegetation, and the upcountry, which is dominated by deep forest.

The coastline area receives significantly more precipitation than the inland region (URT, 2022). The wellbeing of the coastal community of Zanzibar is significantly influenced by climate in various aspects, including the development of agricultural and pasture crops, the viability of animals, the availability of fishing resources, the accessibility to the sea, and the growth of seaweed. Unlike other districts, North "A" District exhibits a diminished quantity of studies investigating community reactions to the effects of climate change. Therefore, this study enriches the body of knowledge by analyzing the historical context of livelihood activities.

2.2. Research Design and Approach

The research used a descriptive design to determine the characteristics and frequency of respondents along with their occurrences. The process involves observing and characterising the respondent's activities in relation to a research question. This design assessed coastal communities' responses to climate change impacts and their adaptation measures. Additionally, a mixed approach that integrates both qualitative and quantitative approaches was used for data collecting and analysis within the descriptive study design. The study used a qualitative approach to refine and contextualise the research enquiries. The researcher visited Matemwe, Nungwi, Pwani Mchangani, and Kidoti to evaluate the current impacts of climate change and the adaptive strategies employed by coastal communities. A qualitative technique, encompassing interviews, focus group discussions (FGD), and field observations which was employed to collect data on the responses of coastal communities to the implications of climate change. A quantitative technique was also used to gather data via questionnaires and evaluate it using Statistical Product and Service Solutions (SPSS) software version 23.0.

2.3. Sampling and Data Collection Methods

This study was conducted in four villages out of 36 villages, which consists of a total number of 21,820 households (URT, 2022). These villages were randomly selected to get four villages. A sample of 400 heads of households from these four villages was also randomly selected. These households form a sample unit which is made up of a husband, wife, children, and other relatives living together. The sample size for each village was then obtained due to corresponding to the corresponding total population for each village. Therefore, the sample size was calculated by using the Yamane formula (1967) relationship, which is outlined below:

$$n = \frac{N}{1 + N(e)^2}$$

where n = sample size, N = population size for households in the sampled four villages (21,820); and e = the level of precision (0.05). In each village, a list of heads of households was obtained from the village executive officer, where the table of random numbers was used to select 400 samples from four villages. The selection of heads of households for the household survey was done by using simple ran-

dom sampling, while the selection of key informants for in-depth interviews and focused group participants was done through a purposive sampling procedure.

The calculated sample size of 400 was used to compute the proportional sample size for each village. Sampling by proportional allocation will be introduced to obtain the number of households that were included in the study for each village (Table 1).

$$nh = \frac{Nh}{N} n$$

Table 1. Shows respondents' distribution.

Villages	Actual Number	No of Respondents	Percentages (%)
Nungwi	10,392	190	48
Matemwe	5014	92	23
Pwani Mchangani	3441	63	16
Kidoti	2983	55	13
Total	**21,830**	**400**	**100**

Primary data were collected through household surveys and in-depth interviews and replies from 400 respondents in all four villages (Matemwe, Pwani Mchangani, Kidoti, and Nungwi), to learn about coastal communities' responses to the impact of climate change. Similarly, data were collected by field observations, Focus Group Discussions (FGDs), and walking along the coastal and land-dwelling zones. This was done to highlight the areas devastated by climate change and to measure people's awareness of its effects. A checklist of questions was used to facilitate systematic observation.

The questionnaire survey was conducted using 400 households, of which 190 were from Nungwi, 92 from Matemwe, 63 from Pwani Mchangani, and 55 from Kidoti. The researcher used self-administered questionnaires because of the characteristics of the study participants. Given that the majority of household heads in the study area lack formal education, it was crucial to employ a self-administered questionnaire. Because of this, the researcher was able to set up further explanations for the questions that the research participants were unfamiliar with. Additionally, the researcher was able to get immediate feedback from the respondents; as such, there was no waiting time for the questionnaires to be collected, and all questions were answered correctly. This method was used as an essential tool for gathering comprehensive, first-hand information on household experiences, attitudes, and adaptation tactics. It makes it possible for the study to provide a complete picture of how various aspects of everyday life, such as livelihoods, resource use, and economic well-being, are impacted by climate change. Also, this technique was purposefully used for ground truthing the reality of the level of community responses to the climate change impact.

Likewise, in-depth interviews with key informants were used with the help of

an interview guide to collect a large amount of data on the perception of the interviewees about the community responses to climate change impact. During the in-depth interviews, the researchers and participants have the freedom to explore additional facts and change the direction of the process when necessary. In addition, this method allows the researcher to gain more insight into the experiences, feelings, and perspectives of the interviewees since the discussions were face-to-face. Fifteen (15) participants were purposively selected to participate in interview sessions in each study area. Four (4) local leaders were selected, one (1) from each village, two (2) leaders from the Fisheries department of the District, two (2) leaders from the Agricultural department of the District, Four (4) leaders from local fisheries port (Diko), one (1) from each village, two (2) people from Natural resources department of the district and one (1) person from pastoralism (department of the district. The in-depth interviews made it possible to gather rich, detailed qualitative data that could not be gained by quantitative approaches alone (Household survey).

Focus Group Discussions (FGD) were used to ensure the respondents' sincerity in producing and generating new concepts or ideas which is useful to the study. FGDs were also very significant as they provided a chance for the respondents to express themselves by using face-to-face interaction. This method helps to determine participants' outlooks and perceptions, knowledge, and experiences, shared during the time of interaction with different people. This method allows the researcher to ask the participants about their shared description and their differences in terms of their understandings, feelings, and worldviews during the open discussion.

Field observation was used to observe the naturally occurring behaviour of people in their natural settings. In this method, the researcher physically visited the study sites as he was performing daily activities and could understand clearly and deeply the problem in the study area. The data was gathered in the form of handwritten notetaking. The study used field observation to give a clear, immediate, and contextual picture of how coastal communities responded to climate change. Improved the study's validity and depth of findings and painted on how coastal communities are responding to the impact of climate change.

2.4. Data Processing and Analysis

The analysis was done using both qualitative and quantitative techniques, as the study included both qualitative and quantitative data. Initially, the data gathered from interviews (qualitative data), significant phrases, concepts, and statements related to the community responses were identified. Afterward, codes were categorized according to their respective purposes. For instance, group codes such as migration, shifting the fish ground, engaging in petty trade activities, engaging in other economic activities, establishing social helping groups, raising awareness of the impact of climate change, and establishing protected forests. The categories that were most significant and aligned with the study questions were refined and

concentrated into broader themes. These were conducted using a content analysis technique. The content analysis was divided into three primary categories: the antecedents, communication effects, and the assumption-making process. The conversation of the interview was recorded and subsequently categorized into distinct themes. Finally, the information was summarized and presented in the form of narration or quotations. Conversely, the quantitative data obtained from questionnaires was entered into the Statistical Product and Service Solution (SPSS) software version 20. Whereby, descriptive statistical techniques were implemented. Frequency distribution and percentages among the data set were illustrated through descriptive techniques, and it was used to indicate the frequency with which each value in a collection of data occurred.

3. Results and Discussion

3.1. Coastal Community Responses to Climate Change

The study offers a variety of community strategies to help them adjust to the effects of climate change. These include shifting fishing grounds, switching to other economic pursuits, creating social assistance organizations, migrating from one place to another, taking up small-scale trades, raising awareness of climate change and its consequences, expanding protected forests around coastal regions, and community mobilization.

3.1.1. Awareness of Climate Change and Its Impact

The results from Table 2 show that Matemwe (49.2%) and Pwani Mchangani (43.4%) indicate the highest proportion of respondents who strongly agreed about the awareness of climate change and its impact as an adaptive strategy to climate change. Whereby, in Nungwi village, there was a considerable percentage of respondents who agreed with the efficiency of awareness of climate change impacts with interventions of (35.2%). While a large number of respondents who strongly agreed was mostly lower at the level of 24.4%. But, in Kidoti village, the results indicate a large number of respondents were eventually distributed, where 36.3% agreed and 34.5% strongly agreed. These patterns imply the different

Table 2. Awareness campaigns about climate change in village wise.

Level of agreement	*Nungwi*		*Matemwe*		*Pwani Mchangani*		*Kidoti*	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Agree	67	35.2	25	27.2	18	28.6	20	36.3
Strongly agree	92	24.4	40	43.4	31	49.2	19	34.5
Neutral	10	21.1	12	13.1	5	7.9	8	14.5
Disagree	7	8.9	8	16.3	6	9.5	5	9.0
Strongly disagree	3	5.3	6	6.8	3	7.9	3	5.4
Total	**190**	**100**	**92**	**100**	**63**	**100**	**55**	**100**

levels of perceived effectiveness of awareness of climate change impact across the study sites, with which Matemwe and Pwani Mchangani showing the strongest endorsement. Also, the results suggest that awareness as a climate change adaptation strategy is a good and widely used strategy in these four villages, though it occurs at a different level of conviction. These differences may be due to local experiences with climate change impacts, the degree of awareness campaigns, or socio-cultural factors affecting information reception. The higher endorsement in Matemwe and Pwani Mchangani highlights potential best practices or successful interventions that could be replicated in other communities.

The data were also collected from the interview session. The researcher wanted to know if there was an awareness campaign provided in their villages and thus could help them manage coastal areas successfully. The following are the answers provided:

> We have periodically received education regarding the effects of climate change so that we can adapt to our surroundings. We have been presented with numerous programs using seminars and regular gatherings from accountable ministries. Because of this effort, the majority of us realized that, even if we live near the ocean, we must learn to live with or without fishing. Because the majority of the inhabitants in this area are now employed in different jobs like drying small fish, they have changed their behavior and are now living comfortably (Dagaa) (Key informant interview with a male 63 years old from Kidoti).

Therefore, these results highlight varying levels of awareness and agreement regarding climate change campaigns across the villages. The stronger agreement in Matemwe and Pwani Mchangani suggests that these areas may have more effective outreach strategies or greater community engagement.

3.1.2. Changing of Fishing Ground

The study findings, shown in Figure 1, indicate that a significant percentage of

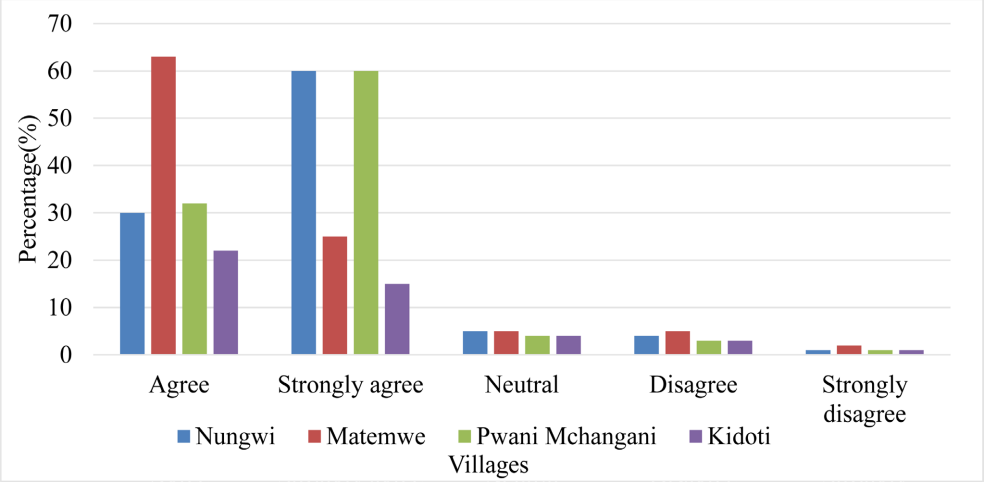


Figure 1. Change of fishing ground village wise.

respondents from Nungwi strongly agreed that the fishing grounds have changed, with over 50% expressing this view. The study also revealed that a significant percentage of responders from Matemwe (40% - 50%), likewise strongly agreed that fishermen have changed their fishing ground from the old to new ground as a strategy for adaptation. This implies that the coastal ecosystem and fishing methods in Nungwi and Matemwe have been substantially affected by climate change, resulting in the relocation of fishing areas. This may also result from environmental changes such as overfishing or coastal erosion, which could alter fish supply in traditional fishing grounds, causing fishermen to adapt by exploring new ground.

During the interview session, the researcher asked respondents about the shifting of fishing grounds in their respective areas. One of the interviewees from Matemwe says the following:

> Nowadays, a lot of fishermen are moving from well-known fishing spots to new ones. Fish migrate from one location to another in order to avoid the extremely high sea surface temperatures that are found close to the coast, which is the main cause of this change. Thankfully, our fishing output has slightly increased as a result of this change. One hundred to one hundred and fifty meters separate the new fishing grounds from the old ones. This shift has boosted economic well-being in addition to increasing fish productivity (Key informant interview with Male, 65 years from Matemwe village).

The coastal zone in these villages is integral to the community's well-being, serving as the lifeblood of their economy and culture. As fish production declines, it directly impacts on the livelihoods of those who depend on the coast for sustenance. In response to this challenge, changing fishing grounds has become an adaptive strategy that supports the sustainable living standards of coastal communities, helping them to maintain their way of life despite environmental shifts.

3.1.3. Diverting to Other Economic Activity

The summarized results from Table 3 showed that most of the heads of households in Nungwi and Matemwe, Pwani Mchangani, and Kidoti (53.8%), (67.3%),

Table 3. Diverting to other economic activity in the village wise.

Level of agreement	*Nungwi*		*Matemwe*		*Pwani Mchangani*		*Kidoti*	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Agree	78	41.1	23	25	8	12.6	12	21.8
Strongly agree	102	53.8	62	67.3	51	80.9	38	69.1
Neutral	5	2.6	3	3.2	2	3.1	1	1.8
Disagree	3	1.6	2	2.2	1	1.5	3	5.4
Strongly disagree	2	1.1	2	2.2	1	1.5	1	1.8
Total	**190**	**100**	**92**	**100**	**63**	**100**	**55**	**100**

(80.9%) and (61.9%) respectively, strongly agreed that most fishers left behind their fishing activities and engaged in other activities such as agriculture and business. This indicates that climate change has had an impact on fishing activities since the production of fish decreased, and coastal communities try to change their lifestyle and even their activities. This can be attributed to declining fish stocks due to overfishing and environmental changes, which have made fishing less profitable or sustainable. Additionally, improved infrastructure, government diversification programs, and better market access have made agriculture and business more attractive alternatives. Economic shifts, technological advancements, and changing social norms also play a role in encouraging people to move away from fishing in search of more stable or lucrative opportunities.

The same results were obtained during the interview session, whereby the interviews from Matemwe village were recorded as follows:

> Most people in this region were originally employed as fishermen and depended on fishing to support their families. However, as fish stocks declined, their income from fishing decreased. As a result, many individuals began exploring other job opportunities. Some turned to small-scale pet trading businesses near the market, which helped them earn a living and provide for their families (Key informant interview with male, 57 years from Matemwe).

In addition, during the interview, one of the interviewees from Kidoti village narrated that,

> The majority of fishing areas in these regions are profoundly impacted by climate change, as they are primarily situated along coastal zones that are highly susceptible to the adverse effects of rising temperatures. This environmental shift disrupts marine ecosystems, prompting the migration of certain fish species to more suitable habitats, which results in a significant reduction in fish productivity. As a consequence, local fisheries experience decreased yields, undermining the livelihoods of communities that depend on them. In response to these challenges, an increasing number of individuals have redirected their efforts toward alternative sources of income, such as small businesses and agricultural activities. This adaptation not only diversifies income streams but also enhances the resilience of these communities in the face of ongoing climate-induced disruptions to the fishing sector (Key informant interview with male 64 years old from Kidoti).

Apart from that, the same results were also obtained from Nungwi village, where one among the respondents was heard say the following:

> A large number of fishermen in this region switch from fishing to other commercial pursuits like business and agriculture. They give up fishing because the money they made twenty or thirty years ago does not compare to what they make now. The number of fish produced in this region, as well as throughout Zanzibar, appears to be declining. Fishermen faced difficulties as a result

of the declining fishery, and they began to consider other means of subsistence. As a result, many abandoned fishing and participated in other economic endeavors, the majority of which involved agriculture (Key informant interview with a male, 55 years from Nungwi).

3.1.4. Establishment of Social Helping Groups

The results from Table 4 reveal that a large number of respondents from Nungwi (64.2%), Matemwe (73.9%), Pwani Mchangani (76.1%), and Kidoti (69.1%) are strongly agreed that the establishment of social helping groups was used as strategies to the impact of climate change in coastal communities' peoples who were mostly dependent on fishing activities. The belief that these communities will play a critical role in adapting to climate change and finding solutions to problems like increased frequency and severity of extreme weather events and environmental degradation likely contributed to these outcomes. When faced with climate-related challenges, it is especially important for communities to be resilient, and these groups help foster that resilience by promoting mutual aid and communal solidarity. The establishment of these groups has the potential to fortify the community's ability to withstand the impacts of climate change by providing a structured method for accessing resources, sharing knowledge, and receiving outside aid. This suggests that local efforts to strengthen community resilience, particularly in times of economic or climate disruption, may benefit greatly from the involvement of social aid agencies.

Table 4. Establishment of social helping groups.

Level of agreement	*Nungwi*		*Matemwe*		*Pwani Mchangani*		*Kidoti*	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Strongly agree	122	64.2	68	73.9	48	76.1	38	69.1
Agree	56	29.4	19	20.7	9	14.3	10	18.2
Neutral	6	3.2	3	3.3	2	3.2	1	1.8
Disagree	3	1.6	2	2.2	1	1.5	5	9.1
Strongly disagree	3	1.6	0	0	3	4.8	1	1.8
Total	**190**	**100**	**92**	**100**	**63**	**100**	**55**	**100**

These groups also, may also play a pivotal role in helping communities adapt to changes caused by climate change, economic shifts, or social challenges. As villages like Pwani Mchangani and Matemwe are highly supportive of these groups, they may be better positioned to respond collectively to external shocks. The variation in agreement levels across villages likely reflects different local dynamics, possibly including leadership, the inclusivity of the groups, their effectiveness in addressing specific village needs, or the socio-economic conditions of each village. For example, Kidoti's higher percentage of disagreement might suggest either weaker

group structures or dissatisfaction with their operation or impact. Therefore, social helping groups are a critical form of social capital in these coastal villages, as indicated by the high levels of agreement. The strong support across all villages suggests that these groups are seen as essential mechanisms for community support, particularly in times of crisis or economic uncertainty

During the interview methods, respondents were asked about the establishment of different social helping groups to adapt to the climate change impact around the coastal zone. One respondent from Matemwe says the following:

> This area faced a great challenge as people from the coastal zone, as we know, our coast is our economy, our lives and everything depend on the coast to run our daily lives. But due to the impact of climate change everything deteriorated, fishing became more difficult, life was very tough because of the decreasing fish production. As a community, we started to think about what to do, we came up with the idea of establishing a social helping group, which we use to obtain loans from banks and other institutions. Thank God we created a group called "Jitegemee" and we succeeded in getting loans and establishing our business (Key informant Interview with a male, 56 years old from Matemwe village).

Another interview conducted at Nungwi village agreed that social helping groups were established to adapt to climate change concerning fishing activities. He explained that,

> After decreasing the production of fishing activities in our area, people in this area suffered with a tough life, since most of them depend upon fishing to run their lives but climate change changes everything. Therefore, the idea of establishing a social helping group was very helpful to our society and most of us joined these groups and now Alhamdulillah we have our lives, and our economy has improved again and is being revived (Key informant Interview with a male 63 years old from Nungwi).

The establishment of social helping groups has been a positive step toward empowering coastal communities. Despite some challenges, village leaders in Nungwi, Matemwe, Pwani Mchangani, and Kidoti see these groups as essential tools for financial stability, community solidarity, and long-term development. With continued support and improved management, social helping groups have the potential to significantly enhance the quality of life in these coastal villages.

3.1.5. Migration

The results from Figure 2 show that a large number of respondents from Matemwe (65%) and Nungwi (55%) reveal that migration of people from one area to is a good strategy to adjust to the impact of climate change. These results imply that these communities are quite conscious of, and open to, movement as an adaptive strategy; this may be due to the fact that these people have lived through environmental stresses like coastal erosion, decline of fishing activities and changing

of economic prospects. Similarly, the results from Pwani Mchangani, large number of respondents strongly agreed, which varies between 65% and 70%, showing that migration is generally seen as an essential coping mechanism in all villages. Considering migration as a method of adaptation is driven by these results, which suggest that the people living in these coastal communities may be more vulnerable to climate-induced risks, such as socio-economic upheavals and environmental deterioration. The strong agreement among all the villages that were asked about how important migration is becoming, both as a short-term response to climate change and as a long-term plan to increase resilience. This method is in line with more comprehensive academic contexts in the literature on climate adaptation, which see human mobility as a sign of the limitations of vulnerable populations' *in-situ* adaptation abilities as well as an adaptive reaction in and of itself.

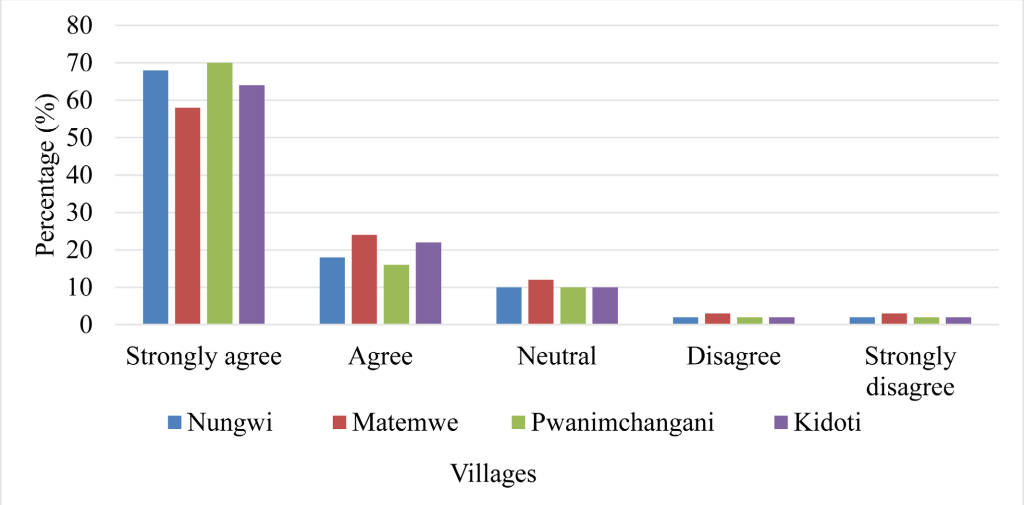


Figure 2. Mobility of people from place to place in Village wise.

During the interview session, the researcher asked the respondents if the research could help manage coastal problems. One of the interviewees from Matemwe village revealed the following:

> We have the problem of fishing activities in our area. This is due to the decreasing fish production and the distraction of coastal communities like erosion and other incidents on the coast. Due to these incidents, people tried their level best to cope with the impact of climate change and decided to migrate to another area, which is more suitable than their origin. People in this area have tried to find other alternatives apart from fishing activities and have moved to the nearest region (Interview from Matemwe …58 years).

3.1.6. Engaging with Petty Trade Activities

As shown in **Figure 3**, Nungwi and Pwani Mchangani display the highest percentage of respondents who strongly agree on the importance of petty trade activities, where both villages report levels exceeding 60%. Similarly, Matemwe and Kidoti villages also reveal significant support for petty trade activities, though to some

extent show the lower levels, with approximately 50% to 55% of respondents expressing strong agreement. This implies that petty trade activities are an important economic activity all around the study areas, with fluctuating degrees of reliance among the different communities. The high degree of agreement detected in Nungwi and Pwani Mchangani suggests that petty trade constitutes a primary livelihood strategy within these communities, which is driven by the inadequate accessibility of formal employment opportunities and the presence of informal market systems. The slightly lower levels of strong agreement in Matemwe and Kidoti villages might show a moderately diversified economic base, where different livelihood sources, like tourism, fishing, and small-scale agriculture, may reduce the relative dependence on petty trade. Nevertheless, the extensive recognition of petty trade activities is important in all villages, underscoring its role as a critical component of household income generation, economic resilience, and adaptive capacity in the face of broader socio-economic and environmental.

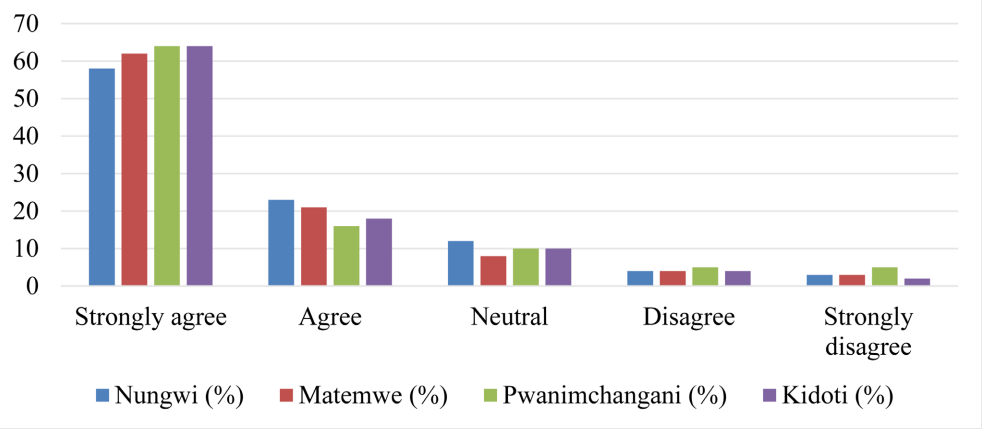


Figure 3. Petty trade activities in village wise.

Additionally, during the interview session, respondents were asked to speak about petty trading activities if they could help them increase their adaptive capacity by having the amount of money to run their lives well. One among the respondents revealed that,

> I had a nice life at the time. I was receiving everything I wanted, and I was an excellent angler. Nevertheless, fishing became extremely difficult because of the declining fish production brought on by fish species migration following climate change. Following that, I decided to go a different route and started a modest business selling seaweed. This is because, in the modern era, the area is threatened by climate change, making fishing an ineffective means of boosting our income (Key informant interview with female 42 years old from Kidoti).

Therefore, petty trade plays in the local economies of these coastal villages, particularly in Nungwi and Pwani Mchangani. These findings align with the broader view of petty trade being essential for income diversification and livelihood sus-

tainability in coastal zones. The differences between the villages reflect varying levels of economic reliance on petty trade, possibly due to differing access to markets, tourism, or other local industries.

3.1.7. Establishment of Agroforest

The concise results obtainable in Table 5 reveal that there are varying levels of community support for agroforestry across the four villages. In Nungwi and Matemwe villages show a significant proportion of respondents stated a strong support for agroforestry, with 47.3% and 46.7% strongly agreeing, respectively. This implies that in these villages, agroforestry is widely predictable as the best strategy to mitigate the impact of climate change. This is possibly due to the successful outreach programs, the favorable experiences with agroforestry practices, and a higher level of awareness regarding their benefits for environmental sustainability. Unlike Kidoti village, most of the respondents who strongly agreed with agroforestry practices as a good method of adaptation are relatively high at 50.9%. This indicates that agroforestry is the most recognized strategy for adaptation to climate change. Meanwhile, Pwani Mchangani shows a more sensible distribution of support for agroforestry, in which about 47.6% strongly agreed, while 35.0% agreed. This implies a larger and more uniform level of acceptance within the community, indicating that agroforestry practices may be widely adopted and integrated into local livelihoods, potentially due to both effective promotion efforts and community-wide recognition of their socio-economic and ecological benefits.

Table 5. Agroforest around the coastal area.

Level of agreement	*Nungwi*		*Matemwe*		*Pwani Mchangani*		*Kidoti*	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Agree	73	38.4	35	38.0	22	35	13	23.6
Strongly agree	90	47.3	43	46.7	30	47.6	28	50.9
Neutral	5	2.6	2	2.2	5	7.9	7	12.7
Disagree	7	3.6	5	5.4	2	3.1	4	7.2
Strongly disagree	4	2.1	6	6.5	4	6.3	3	5.4
Total	**190**	**100**	**92**	**100**	**63**	**100**	**55**	**100**

Apart from that, the data was also collected through the interview method, where respondents were asked about planting forests around the coast zone and whether it helps protect the coast from the impact of climate change. One among the respondents explained the following:

> To be employed as an adaptation strategy, actually planting trees around coastal zones is highly crucial. The purpose of the trees is to reduce land deterioration along the coast and control coastal erosion. The locals have

access to several programs aimed at curbing coastal erosion, such as planting mangrove trees throughout Zanzibar Island. As a result, these tree-planting initiatives are more beneficial and valuable when employed as reaction tactics (Key informant interview with a male, 66 years old from Pwani Mchangani).

3.1.8. Community Mobilization

The study results from Figure 4 reveal that the majority of respondents from all four villages strongly agreed that the mobilization of coastal communities has been actively encouraged in various projects designed so as to facilitate adaptation to the impacts of climate change. About 67% from Nungwi, 68% in Matemwe, 70.1% in Pwani Mchangani, and 69% in Kidoti reported strong agreement with this statement. These results are consistently high percentages across all study areas and indicate a widespread perception of effective community mobilization and participation in adaptation initiatives. The high level of coastal community mobilization indicates that the adaptation strategies have been successfully integrated highly into a lower community level. This is potentially led by effective outreach efforts, capacity-building activities, and the involvement of multiple stakeholders such as government agencies, NGOs, and local leadership. The variation of percentages may reflect the variation in the scope and the strength of adaptation strategies implemented in each village. Generally, the findings of this study reveal the strong community commitment towards collective action in addressing climate change impact. This level of mobilization is essential for enhancing adaptive capacity, ensuring sustainability of interventions, and fostering long-term resilience against the adverse effects of climate change.

On the other hand, the results from the interview schedule revealed that,

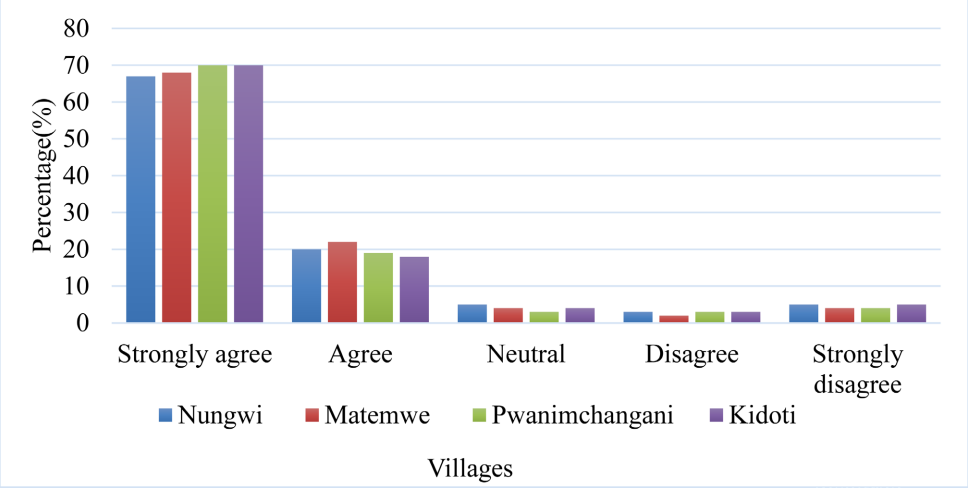


Figure 4. Community mobilization/involvement.

There are times when our community gets involved in various projects to aid in the maintenance of coastal areas. The Ministry of Fisheries is primarily in

charge of these initiatives, which include planting mangroves back along the coast and passing legislation to punish people who oppose the ministry. The community has fully participated in this program to support the ministry's initiatives (Key informant interview with a male, 55 years old from Matemwe village).

Therefore, this implies that the mobilization of local people in different activities could help them to learn more things and be able to initiate different activities of their own. Thus, the results from **Figure 4** clearly show that communities were being mobilized in the project in response to coastal areas due to climate change.

4. Discussion

This study set out to assess how Coastal Communities in North "A" district, Zanzibar, are responding to climate change impact. This was done in four (4) villages, Nungwi, Pwani Mchangani, Matemwe and Kidoti. The presented results revealed different adaptive strategies implemented by coastal community members in the face of sea level rise, coastal erosion, decline of agricultural activities, decline of fishing activities, and changes in rainfall pattern. These responses are like changing fishing ground, diverting to other economic activities, establishing social helping groups, migration, community awareness of climate change and its impact, establishment of agroforestry, and community mobilization.

The results from **Table 2** demonstrate the variations in the perceived distribution of climate change awareness as an adaptive strategy in the study villages. The higher percentages of respondents in Matemwe (49.2%) and Pwani Mchangani (43.4%) who strongly agreed shows the efficiency being aware to the climate change impact among community members in these villages, This could be attributed to several factors, like the higher level of endorsement, including providing education to the targeted groups, active involvement of local leadership, effective dissemination of climate information, or the visible manifestation of climate change impacts that heighten community receptiveness. These results are aligned with the results of Peñalba et al. (2021) showed that most of the coastal populations are aware of risk, developing a risk perception, and becoming conscious of climate change. Additionally, the data recommended that the coastal communities have already begun to take action to improve their capacity for adaptation in response to the impacts of climate change. As a result of this, the study highlights how essential it is for mapping initiatives to make use of information gleaned from the local community.

Fish ground shifting as an adaptive measure to climate change impact was articulated by most of the respondents from Nungwi village and Matemwe. This could be led by climate change, coastal erosion, overfishing, and changes in environmental conditions. The most frequent occurrence of these activities in these villages changes the availability of fish stock in the local location, and hence, most fishermen adapt themselves by finding another new place where fish are most available. These results are similar to results provided by Ojea et al. (2020), who

reported that climate change is causing shifts in marine species due to temperature extremes, disrupting fishing patterns and threatening food security. Consequently, many fishers around the coast have adjusted by changing fishing grounds to align with these climate impacts. Similarly, Galappaththi et al. (2022) identified three categories of adaptive responses to climate change, including changing fishing locations, utilizing traditional knowledge, and diversifying livelihoods.

Furthermore, the results of the study reveal that most of the respondents in North "A" District, including Nungwi (53.8%), Matemwe (67.3%), Pwani Mchangani (80.9%), and Kidoti (61.9%), have strongly agreed that coastal communities in Zanzibar have shifted from fishing activities to other economic activities like agriculture and petty trade activities. These results reflect the growing impact of climate change on coastal community activities, which leads to changes in marine resources and ultimately results in unsustainable fish stocks. When the availability of fish decreases, there is a reduction in the volume of fish caught; this lowers the income of the people, which forces them to search for alternative activities. Similar results were found from the study of Anderson et al. (2020), who imply that climate change impacts, like the rise of global temperatures, result in coastal communities that rely on fishing activities leaving the fishing industry in search of more secure livelihoods. Similarly, Devi et al. (2018) reported that declining catch per unit effort, caused by unsustainable fishing practices and climate-induced vulnerabilities, has led to reduced income for small-scale fishers, compelling them to diversify into agriculture and business activities.

The high levels of support for the establishment of social helping groups across all villages suggest that these groups are seen as critical for adapting to the impacts of climate change. Communities notice that these groups are very essential mechanisms to handle challenges of climate change impact. This is because the social helping groups foster community resilience by encouraging mutual aid, collective action, and shared responsibility, which are especially valuable during periods of climate-related hardship. These findings are consistent with the work of Mozumder et al. (2023), who identified various social and economic adaptation strategies that include building social connections, engaging in risk mitigation, and participating in adaptation planning. The study also noted that economic strategies such as aquaculture, livelihood diversification, and improved financial access contribute to resilience. Furthermore, effective ecological adaptations involve the establishment of sanctuaries, network building among protected areas, and enhancing local ecological knowledge and understanding of climate change impacts.

As it was indicated, a significant percentage of respondents in Matemwe (65%) and Nungwi (55%) show migration as a viable strategy to adapt to the impacts of climate change. Similarly, in Pwani Mchangani, between 65% and 70% of respondents strongly agreed with this view. This demonstrates an extensive acceptance of migration of the people as a way of adaptation across all study areas. These results imply that coastal communities in Zanzibar are highly recognizing a migration strategy not only as a coping mechanism but also as a potential long-term strategy

to manage ongoing environmental and socio-economic challenges. In a similar vein, the study by Balsari et al. (2020) shows how human migration and climate change interact. They revealed that a significant number of people are anticipated to relocate from rural to urban regions due to climate change, and many of them would do so until living in urban areas becomes intolerable. Also, Maharjan et al. (2021) reported that migration is a crucial strategy for diversifying livelihoods and a response to a range of threats, including climate change, in hotspots that are vulnerable to climate change. Usually, one or more household members, often young men, moved abroad or within the country to find employment in the largely unorganized sectors. Remittances distributed risks, contributed to a spatially diversified household income, and provided protection from outside stresses. The people that migrate, where they go, and the abilities they have all have an impact on the results.

Generally, the findings indicate that agroforestry is widely regarded as a potential key adaptive strategy across all four communities. The relatively high levels of strong agreement across these villages reflect both the apparent and experienced benefits of agroforestry in addressing the complicated impacts of climate change. Furthermore, these results highlight the reputation of sustained awareness capacity building, and institutional support to further enhance the adoption and long-term sustainability of agroforestry practices at the community level. This implies that the high levels of strong agreement observed in Nungwi and Matemwe indicate effective recognition of agroforestry's benefits, likely attributed to successful awareness campaigns or effective community practices in these regions. The strong agreement in Kidoti village shows the potential passionate supporters for agroforestry practices. Similar results were obtained from the study of Jacquemont et al. (2022). Coastal communities are progressively conscious of responding to climate change impacts and are responding with greater engagement. This awareness is particularly pertinent given the ongoing salinity challenges faced by Bangladesh, which are projected to exacerbate as a result of climate change. The research further reveals that, in response to rising temperatures in the Khulna region, coastal communities have taken initiatives to enhance the vegetation in their local environments.

The study results revealed that a large number of respondents in all four villages strongly agreed on the potential of community mobilization as one of the adaptive strategies to impact climate change. The high levels of strong agreement in these villages are demonstrated by the substantial efforts undertaken to build adaptive capacity at the community level. These findings are comparable with the findings obtained from Cinner et al. (2018), who, based on the significant funds that have been organized by government agencies, development organizations, and the establishment of a group of civil society that used to enhance capacity building to the coastal communities for the impact climate change adaptation. Like the increasing flexibility in livelihood strategies, strengthening organizational capacity, and enhancing community knowledge and awareness to recognize and effectively

respond to climate change threats. These continuing efforts aim to mitigate the adverse effects of climate change and foster resilience within vulnerable coastal communities.

5. Conclusion

Zanzibar's coastal communities face multifaceted challenges from complex climate change impacts, including sea level rise in all villages, increased storm frequency, and shifting weather patterns. These stressors damage fragile coastal ecosystems and undermine critical livelihood sectors—agriculture, fishing, and tourism—which are vital to the region's economy. Because of these climate change challenges, the communities have established remarkable adaptive capacity by operating indigenous knowledge, traditional practices, and focused government and NGO initiatives. On the other hand, community leaders, fishermen, agriculturalists, and youth organisations have been instrumental in popular adaptation strategies. The existing adaptation strategies like shifting to new fishing ground, migration, establishment of agroforestry, community mobilization, and others are hindered by insufficient funding, technical expertise, institutional coordination, and climate change data. Current adaptation strategies typically lack long-term viability. Despite these measures, some significant challenges remain, such as insufficient financial resources, lack of technical support, and the need for better policy coordination. Therefore, future interventions should prioritize enhancing climate resilience through integrated coastal management, improving access to climate information, and promoting sustainable livelihoods. On the other hand, policies must emphasise integrated coastal zone management frameworks that integrate ecosystem-based and community-centered approaches. To enhance community resilience, authorities at local, regional, and national levels should prioritise capacity-building initiatives, institutional coordination, and financial mechanisms such as climate adaptation funds and microfinance programs. Furthermore, more research is needed to fully understand the long-term effects of climate change on the region and to refine adaptation strategies, ensuring they remain effective in the ongoing environmental changes. While the coastal communities in North "A" District have demonstrated the ability to adapt, more comprehensive and sustained efforts are essential to secure their future and help them thrive in an increasingly uncertain climate.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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