

THE FINAL REPORT

FOR

The Pilot Test of the Climate Change Vulnerability Assessment (CCVA) Toolkit in Coastal
Communities in Tanzania

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Nairobi, Kenya**

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Submitted by the Consultant: Rushingisha George Majagi, PhD

EXECUTIVE SUMMARY

Climate change poses significant risks to people whose livelihoods rely on coastal systems, particularly in developing countries such as Tanzania. As a result, identifying social vulnerabilities and community adaptation strategies to climate change is crucial for building climate-resilient community initiatives. This study used the CCVA toolkit to assess social vulnerability in the Mkinga and Wete districts of Tanzania, focusing on both household and community scales. Ten fishing communities representative of Tanzania's coastal areas were surveyed at the household level. A total of 700 heads of households were interviewed. At the household and community levels, quantitative indicators and domains were calculated, allowing the calculation of a vulnerability index. Findings reveal that: One, climate change vulnerability differs among households in the Mkinga and Wete districts' fishing communities, and this variance is linked to household income and engagement in numerous income-generating activities. Two, low household income, high reliance on marine resources, limited livelihood multiplicity, limited access to climate change information, limited awareness of fisheries regulations, and limited access to food characterize more vulnerable households to climate change, those whose sensitivity exceeds their adaptive capacity. Three, the degree to which fishing communities are vulnerable to climate change varies, with the Selemu fishing community being the least vulnerable and Mtambwe being the most vulnerable. Four, climate change poses a medium threat to all fishing communities in the Mkinga and Wete districts. Five, the main drivers of fishing communities' sensitivity to climate change are linked to livelihood and demographic characteristics. Six, a variety of social factors influence fishing communities' adaptive capacity, including organization, flexibility, assets, learning, and agency. Seven, household and community vulnerability are inextricably linked and should not be evaluated separately. Reducing poverty and diversifying livelihoods increases the adaptive capacity of households to climate change. Community adaptation capacity to climate change will be improved by better community understanding of fisheries rules, better health, better infrastructure, as well as increased community cohesion and participation in decision-making. This study focused on social vulnerability to climate change in Tanzanian fishing communities, and it assists us in learning more about the extent of the effects in coastal areas, the factors that explain household vulnerability, community sensitivity, and adaptive capacity, as well as provide coping and adaptation strategies to improve climate resilience.

ACRONYMS

AHP	Analytical Hierarchy Process
BMU	Beach Management Unit
CCVA	Climate Change Vulnerability Assessment
FADs	Fish Aggregating Devices
FGD	Focused Group Discussion
GPS	Global Positioning System
MACMON	Marine and Coastal Monitoring
NGO	Non-Governmental Organisation
SD	Standard Deviation
SMEs	Small and Medium Enterprises
UNEP	United Nations Environment Programme
VI	Vulnerability Index
WIO	Western Indian Ocean

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GLOSSARY OF COMMONLY USED TERMS

Adaptation capacity: The ability of systems, institutions, humans, and other organisms to adjust to potential harm, seize opportunities, or respond to consequences.

Aggregation: Combination of normalized indicators to the final index.

Climate change: Climate change is a change in the pattern of weather, and related changes in oceans, land surfaces and ice sheets, occurring over time scales of decades or longer

Climate change vulnerability: Is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change including climate variability and extremes.

Household: A house and its occupants regarded as a unit.

Indicators: Is a measurable variable used as a representation of an associated measurable or non-measurable variable.

Livelihood security: The adequate and sustainable access to income and other resources to enable households to meet basic needs.

Sensitivity: Is the responsiveness of a system to climatic influences, and the degree to which changes in climate might affect it in its current form.

Vulnerability: Is an integrated measure of the expected magnitude of adverse effects to a system caused by a given level of certain external stressors to generate risk.

Vulnerability index: Is a metric characterising the vulnerability of a system, which is typically derived by combining, with or without weighting, several indicators assumed to represent vulnerability.

Weighting: The relative degree of indicator importance.

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CHAPTER ONE: INTRODUCTION

1.1 Background and rationale

Coastal ecosystems in Tanzania, such as mangroves, seagrass meadows, and coral reefs, are known for their high biodiversity and offer livelihoods for local fishing communities, making them immensely valuable in both socioeconomic and ecological terms (Moshy et al. 2015; Samoilys & Kanyange, 2008). They provide benefits to people in a variety of ways, including food production, money generation, coastal protection, and social and cultural meaning, all of which are important aspects of human well-being (Summers et al. 2012). However, the provision of these services by coastal ecosystems is jeopardized by climate change, and the effects are projected to worsen in the coming decades (Omambia & Yu, 2010; Sekandende et al., 2020; He & Silliman, 2019). This will have a huge impact on people whose livelihoods are strongly reliant on coastal ecosystems (Nyangoko et al., 2020; Lyimo et al., 2013; Misana & Tilumanywa, 2019). The effects, however, will vary depending on scale, such as household, community, national, and regional levels (Huynh & Stringer, 2018; Silas et al., 2020). Hence, it's critical to assess people's vulnerabilities to future climate change on a variety of scales.

Vulnerability assessments enable researchers to investigate complex human-natural resource relationships and how climate change threatens these relationships (Nguyen et al., 2016). Obviously, social vulnerability focuses on all socioeconomic and demographic factors that are impacted by environmental stress in a given community (Huynh & Stringer, 2018; Silas et al., 2020). As a result, social vulnerability assessments assist in identifying the households or communities most vulnerable to climate change and its consequences, as well as developing mitigation measures and adaptations to help those households or communities attain better resilience (Adger, 2006; Yuen et al., 2013; Huynh & Stringer, 2018; Silas et al., 2020).

Given the importance and urgency of vulnerability assessments, the Nairobi Convention of the United Nations Environment Programme (UNEP) recently developed a Climate Change Vulnerability Assessments (CCVA) toolkit, which is required to be pilot tested in Tanzanian coastal communities before being standardized for use in the Western Indian Ocean (WIO). In light of this, the United Nations Environment Programme (UNEP) Nairobi Convention commissioned a consultant to conduct a socioeconomic assessment of climate change vulnerability in fishing communities in Mkinga district, mainland Tanzania, and Wete district, Zanzibar.

This paper report to present vulnerability of fishing communities at the household and community scales, drivers of community sensitivity and adaptive capacity, as well as coping and adaptation strategies to strengthen their resilience to climate change. The report ends with recommendations to help decision-makers improve the resilience of coastal communities to climate change.

1.2 Objectives

1.2.1 Main objective

The main objective of this consultancy is to pilot test the Climate Change Vulnerability Assessment (CCVA) toolkit in fishing communities in Mkinga and Wete districts of Tanzania

1.2.2 Specific objectives

The main goal in **section 1.2.1** above will be achieved through the following specific objectives:

- a. To develop a household climate change vulnerability index and identify the factors associated with individual household vulnerability;
- b. To develop a community vulnerability index and explore the major factors that influence sensitivity and adaptive capacity, as major determinants of community vulnerability;
- c. To identify fishing communities that are vulnerable to climate change

CHAPTER TWO: METHODOLOGY

2.1 Study sites

This study targeted ten fishing-dependent coastal communities in Mkinga District (n = 5) in Tanga, mainland Tanzania, and Wete District (n = 5) on the island of Pemba in Zanzibar (**Figure 1**). Communities were chosen because they rely on important coastal ecosystems such as mangroves, coral reefs, and seagrass beds, as well as other marine resources, all of which are endangered by climate change, and their spatial distribution includes the whole coastal area within the targeted district. Tanga has a population of 2.2 million people, with Mkinga District accounting for 118,065 of them. There are 21 wards in the district, each with a population of 2,500 to 11,000 people. There are 20 fishing communities in the district, divided into five wards, with households ranging from 150 to 1091. Zanzibar, on the other hand, is an autonomous part of the United Republic of Tanzania, consisting of two large islands, Unguja and Pemba, and a population of 1.5 million people, 350,000 of whom live on Pemba Island. Zanzibar is divided further into five administrative areas and eleven districts, with seven in Unguja and four in Pemba. Each district is subdivided into several shehias, the smallest administrative areas, with populations ranging from 2,000 to 5,000 people. Wete district on Pemba Island has a population of 107,916 people and approximately 17 fishing communities, with households ranging from 75 to 150.

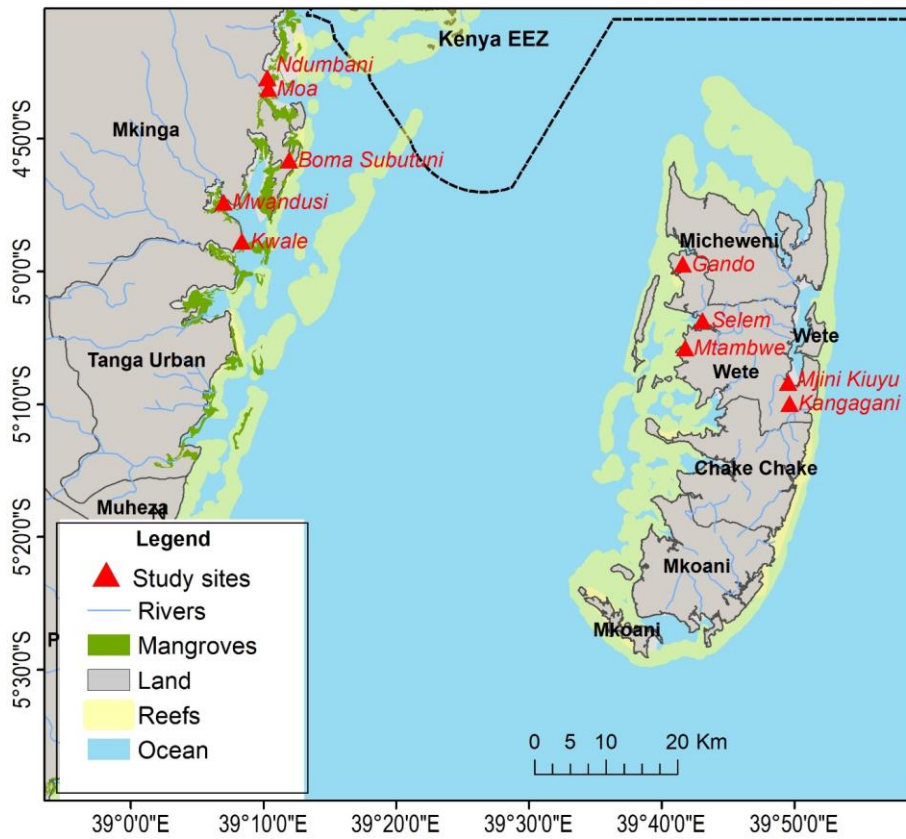


Figure 1. A map of study sites in the Mkinga District of Tanga region, mainland Tanzania, and the Wete District of Pemba, Zanzibar.

2.2 Study implementation approaches

The study was implemented in two main stages, namely desk review and field surveys as illustrated below.

2.2.1 Desktop review

A desk review of the CCVA toolkit was carried out in order to acquire information on the conceptual and analytical framework for conducting CCVA in the WIO region, which includes Tanzania. The toolkit specifies the procedures for assessing climate change vulnerability in a given socio-ecological system. Exposure, sensitivity, and adaptive capability are the three vulnerability dimensions. The social aspects of vulnerability, that is, sensitivity and adaptability capability dimensions and accompanying indicators, were the focus of this study. Cultural, livelihood, health, and demographic are the domains for the sensitivity dimension, each with associated indicators (**Appendix 3**). Learning, flexibility, assets, and agency are the domains for the adaptive capacity dimension, each with associated indicators (**Appendix 3**). A review of the Marine and Coastal Monitoring (MACMON) Monitoring Guide, which provides a detailed methodology on socio-ecological monitoring for conducting CCVA in coastal areas, was also carried out. These resources were used to develop the household survey questionnaire (**Appendix 1**), which was used to collect socioeconomic data for the estimation of the value of variables for indicators and domains, and the Focused Group Discussion interview questionnaire (**Appendix 2**), which was used to collect data for the estimation of indicator and domain weight using the Analytical Hierarchy Principal (AHP) method.

2.2.2 Field surveys

Field visits were conducted in the study sites (**Figure 1**) in order to collect socioeconomic data for variables of selected indicators and domains of sensitivity and adaptive capacity dimensions of vulnerability to climate change, as described below.

2.2.2.1 Household questionnaire interview

A semi-structured household interview was conducted in ten fishing communities using a random sampling protocol. The questionnaire has four domains (cultural, livelihood/economic dependency, health and demographic) for the sensitivity dimension of vulnerability as well as five domains (agency, assets, flexibility, learning and organisation) for the adaptive capacity dimension of vulnerability. Household was used as a sampling unit. The household heads (respondents) were chosen at random. Face-to-face interviews were conducted to collect data. At each fishing

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community, the study's target population includes people who work in fishing, mariculture, fish processing, medium fish trading, boat building and maintenance, small businesses, wage earning fish-harvesters (working in the salt industry and load carrying at landing sites), gleaning, and agriculture (**Table 1**). This guaranteed that the survey was both random and representative in terms of geography. Each questionnaire took approximately 60 minutes to complete. If a head of household refused to participate in the interview, the data collectors moved on to the next household. Only household heads were considered because they were primarily responsible for earning and preserving assets. The number of households in fishing communities in Mkinga and Wete districts was obtained from local government offices and was based on the most recent national census at the geographical level. Because all fishing communities surveyed had more than 50 households, we standardized the number of surveys per community to 70 due to limited time and resources for each community. Thus, from ten fishing communities in the studied districts, we selected 700 households. The surveys were carried out by trained interviewers in the local language and dialects (**Plate 1**). The survey was conducted between November and December 2021.

Commented [SD3]: Fishing associated activities/employment rather?

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Table 1. Characteristics of respondents based on the most common household occupations related to coastal and marine resources.

S/N	Main Activity	Number
1	Fishing	444
2	Mariculture	103
3	Fish processing	60
4	Medium Fish Dealer	25
5	Wage earning	20
6	Boat building and repair	19
7	Small business	11
8	Agriculture	10
9	Gleaning	7
10	Teaching	1
Total		700



Plate 1. Researchers collecting socioeconomic data from the interviewee in (a) Moa fishing communities and (b) Selemu fishing communities

2.2.2.2 Focused Group Discussions

For FGDs, purposive sampling was used to ensure that particular knowledgeable people who can provide detailed information on the subject under investigation are selected. We convened a meeting of 10-12 people, involving fishermen, fish processors, fish traders, mangrove wood traders, and small and medium enterprises (SMEs) operators to discuss and agree on the importance and degree of importance of indicators and domains of sensitivity and adaptive capacity dimensions of vulnerability. The focus group discussion questionnaire was used to discuss and agree on the importance and degree of importance of indicators of sensitivity and adaptive capacity dimensions of vulnerability, which were scaled between 1 and 9, whereby 1 = equal importance, 3 = importance, 5 = strong importance, 7 = very strong importance, and 9 = extremely importance. The AHP accommodated both individual values and shared-value measures (for both indicators and domains) and the interactions between them, with the aim of synthesizing all the information and arriving at priorities that indicate preferences in the group decision process.

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Plate 2. Researchers leading a focus group to gather information on the weight and importance of indicators of social vulnerability categories of sensitivity and adaptive capacity

2.3 Indicator set, variables selection and scoring

The indicators for domains of sensitivity and adaptive capacity dimensions of vulnerability were set according to the MACMON approach (Gurney et al. 2019). The variables for indicators were chosen from the household survey questionnaire (**Appendix 1**) that corresponded well to the indicators in **Appendix 2**. To determine the value of the variables of indicators, the scoring method was used to convert the questions into scores. The selected variables elicited three types of responses: Likert scale responses (ranging from 1 to 5, and 1 to 7), binary responses (yes or no), and ordinal responses (count in numbers). The scores for the Likert scale and ordinal responses were standardized using the min–max linear scaling method (**Equation 1**) (Hebb and Mortsch 2007; Lein and Abel 2010) to assign values between zero (0) and one (1) for the variable, and the binary responses (0 and 1) were used as variable values. The value of a variable for an indicator made up of multiple variables was derived by taking the average of the values of the variables. The Principal Component Analysis (PCA) was used to get the value for the material style of life variable (QN45 in **Appendix 3**), which involved a large number of variables being reduced to a smaller number of uncorrelated latent factors.

$$\text{Standardised value} = \frac{\text{Actual value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}} \dots\dots\dots (1)$$

2.4 Determination of weight and value of indicators and domains

The Analytical Hierarchy Process (AHP) method was used to calculate the weight of domains and indicators (Vaidya & Kumar, 2006). The AHP is a multi-criteria decision-making technique that reduces complex decisions to a series of pairwise comparisons and has been frequently utilized to solve decision issues (Vaidya & Kumar, 2006). Based on the Saaty rating system, the scores for indicators and domains were used to derive relative weights for indicators and domains (Saaty, 2001). **Table 2** shows the weights of the indicators and domains acquired. The value of indicators was computed by multiplying the variable's value by the indicator's weight. The weight of the domain was multiplied by the value of an indicator to determine the value of the domain.

Table 2. Weighting system based on households, officials and experts perceived relative importance of indicators and domains

Sensitivity			Adaptive capacity		
Weights			Weights		
Domains	Livehood/Economic dependency	0.60	Domains	Learning	0.13
	Demographic	0.16		Assets	0.18
	Cultural	0.09		Flexibility	0.33
	Health	0.15		Agency	0.12
				Organization	0.24
Subgroups	Indicator	Weights	Subgroups	Indicator	Weights
b) Livelihood/Economic dependency			b) Learning	Level of education	0.10
	Employment status	0.13		Knowledge of rules	0.34
	% of catch from fishing sold	0.34		Access to information	0.56
	% of income from the main activity	0.34	c) Assets		
				Material style of life	0.26

Sensitivity			Adaptive capacity		
c) Demographic	Time conducting the activity	0.20		Community infrastructure	0.32
	Gender	0.06		Access to credits	0.42
	Years living in the village	0.20	d) Flexibility	Community infrastructure	0.16
	% of children in the family members	0.27		Adapt to live without fishing	0.48
	% Family dependency	0.47		Gear	0.21
d) Cultural	Appreciation of biodiversity	0.25	e) Agency	Spatial mobility	0.14
	Identity and pride	0.45		Perceived capacity	0.41
	Appreciation of lifestyle	0.30		Recognition of causality	0.15
d) Health	Age	0.23	f) Organization	Level of participation	0.44
	Nutritional dependency	0.50		Trust in organizations	0.45
	Sense of place	0.27		Community cohesion	0.22
				Linking social capital	0.33

2.5 Calculation of sensitivity, adaptive capacity and vulnerability indices

This study employed hierarchical designs with 30 indicators separated into domains that all had the same underlying vulnerability dimension (Flanagan et al. 2011). The CCVA used in this study is summarized in **Figure 2**. Individual domain values were added to calculate the sensitivity and adaptive capacity indices. The vulnerability index was calculated by subtracting the adaptive capacity index from the sensitivity index (**Equation 2**). Individual susceptibility was evaluated at the household level, whereas collective vulnerability was evaluated at the level of the fishing community. While a negative sign of household vulnerability indicated greater adaptive capacity than sensitivity, a positive sign indicated greater sensitivity than adaptive capacity.

Commented [SD6]: What do you mean?

Commented [SD7]: How? Averaging?

Vulnerability index = *Sensitivity index* – *Adaptive capacity index* (2)

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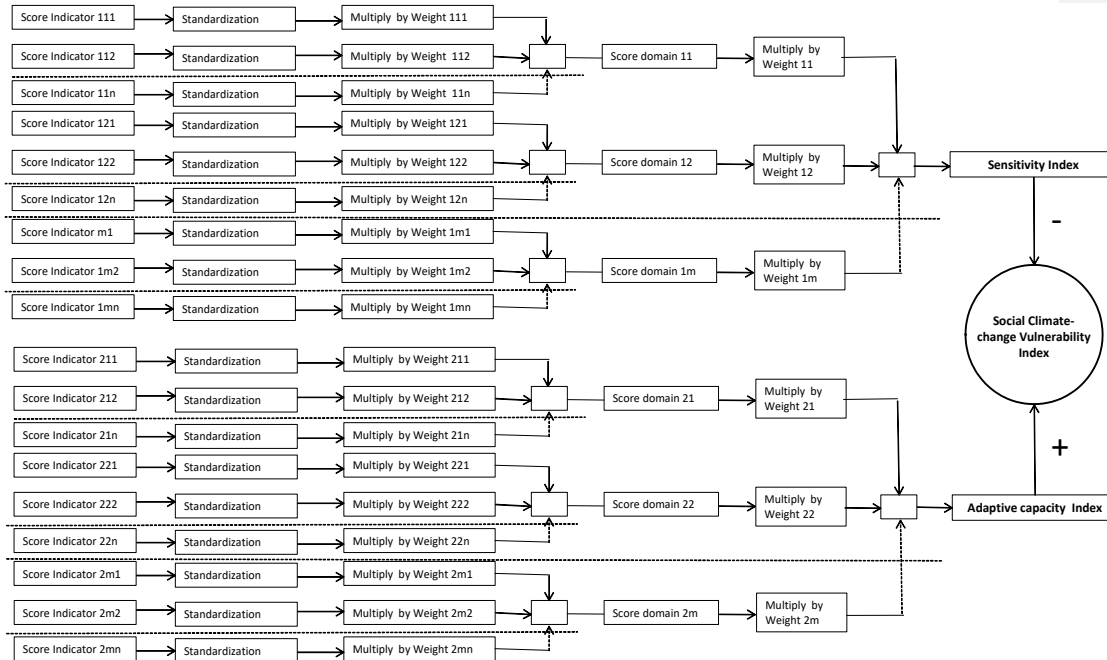


Figure 2. Social Climate Change Vulnerability index structural design

Commented [MM9]: analytical framework

2.6 Determination of degree of community vulnerability

The degree of community vulnerability was classified into five classes using a standard deviation classification (SD) classification (Katic, 2017). **Table 3** presents classification of community vulnerability calculated at the household scale.

Table 3. Classification of social vulnerability calculated at the household scale

Social Vulnerability Score	Level	Value of the class
≤ -1.5 SD	Very low	1
≤ -1.5 to -0.5 SD	Low	2
≤ -0.5 to 0.5 SD	Medium	3
≤ 0.5 to 1.5 SD	High	4
≥ 1.5 SD	Very high	5

Commented [MM10]: this method assumes a normal distribution. You might want to use percentiles instead

CHAPTER THREE: RESULTS

3.1 Socio-economic status of respondents

Table 4 shows the respondents' social and demographic characteristics. The respondents' average age was 43 years old. Seventy-nine percent (78.9%) of respondents had an education level of class seven or less, which is common in fishing communities. There were ten livelihood activities in the fishing community studied, with fishing being the dominant (63.4%), followed by mariculture (14.7%). About 22% percent of household had other source of income. Monthly income varied by household, with the average household earning USD 160.6 + 121.3.

Table 4. Respondents' social and demographic characteristics

Statistics	Mean	SD	Statistics	Percentage (%)
Age (years)	43	14	Female headed	19.74
Household size	7.246	3.548	Class 7 and less	78.986
Monthly income (USD)	160.6	121.328	Secondary school-Level certificate	17.43
			A level certificate	0.00
			Tertiary	0.28
			University or above	0.14
			Occupation	
			Fishing	63.43
			Mariculture	14.71
			Wage earning	2.86
			Agriculture	1.43
			Boat building and repair	2.71
			Fish processing	8.57
			Medium fish dealers	3.57
			Small business	1.57
			Gleaning	1.00
			Teaching	0.14

3.2 Household vulnerability to climate change

There was a large variability in social vulnerability to climate change among households within fishing communities (**Figure 3**). While the majority of households had higher sensitivity to climate change than adaptive capacity (indicated by positive vulnerability sign), some households had higher adaptive capacity than sensitivity (indicated by negative vulnerability sign) (**Figure 3**).

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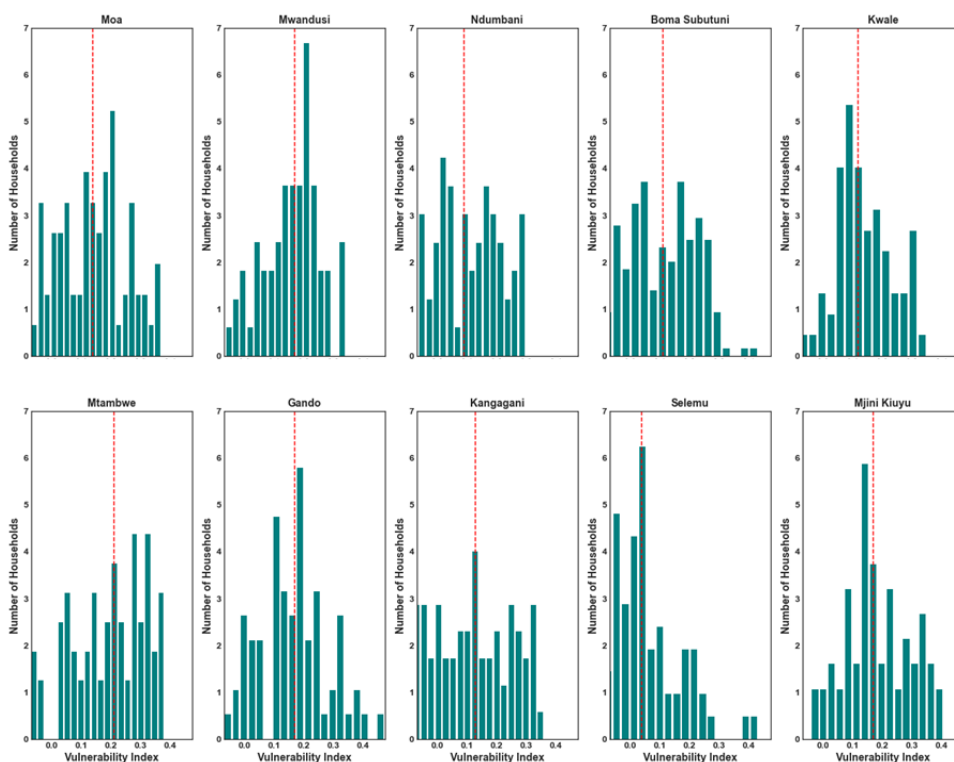


Figure 3. Distribution of vulnerability among each fishing communities. Medians are represented by red dotted lines

Figure 4 shows the percentage of households that are more vulnerable to climate change and those that are less vulnerable to it. Households in Bomasubutuni, Gando, Mjini kiuyu, Moa Mwandusi, and Mtambwe were more sensitive to climate change, as indicated by higher sensitivity than

Commented [SD12]: As the distribution for all households (for the global dataset) and the different vulnerability classification class on the histogram

Commented [SD13]: Define what you mean by "more" and "less vulnerable" (above/below 0?) It needs to be defined

adaptive capacity. Households in Kangagani, Kwale, Ndumbani, and Selemu were less sensitive to climate change, as indicated by higher adaptive capacity than sensitivity.

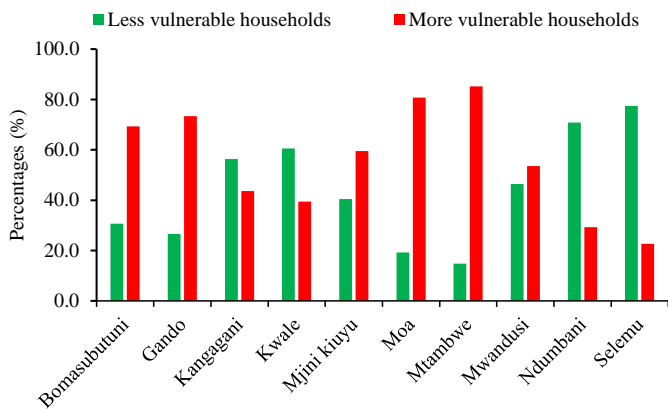


Figure 4. Percentage of less and more vulnerable households to climate change

Commented [SD14]: Same as my previous comment, what does mean “less” or “more” vulnerable?

3.2 Key characteristics associated with households vulnerability

Table 5 shows key features of resilient and vulnerable households to climate change in the fishing communities of Mkinga and Wete. Resilient households had higher monthly incomes than vulnerable households. While all resilient households had more than two years of experience with the main income generating activity, only 20% of vulnerable households had more than two years of experience with the main activity. Resilient households (55%) were more aware of fisheries regulations. The majority of resilient households (85%) had access to climate change and adaptation information. While approximately 40% of resilient households had access to important assets such as CD/radio, smartphones, flushing toilets, washing machines, computers, electric fridges, televisions, satellites, and cattle, only 20% of vulnerable households did. The majority of resilient households (97%) said they could live without fishing.

Commented [SD15]: Here both resilient and vulnerable are used in the same sentence. It is sltly different as vulnerability involved some degree of exposure

Commented [SD16]: Need to be careful here at using “resilient” as the opposite of “vulnerable”

Commented [SD17]: To which figure those percentage do refer to?

Table 5. Key characteristics of less and more vulnerable households

Households indicators	Resilient Households	Vulnerable households
Livelihood income	Average income for less vulnerable households was 187.2 US\$ in which 44.1% of households were fishers.	Average income for more vulnerable households is 156.1 US\$ in which 66.7% of households were fishers
Time conducting the main activity	All less vulnerable households had more than two years of experience in conducting the main income generating activity.	20% of the more vulnerable households had less than two years of experience in conducting the main activity.
Knowledge of rules	About 60% of less vulnerable households understood fisheries regulations i.e. regulations for proper gear to use, species types and sizes of fish allowed to catch.	About 50% of the more vulnerable households did not understand fisheries rules.
Access to information	About 85% of less vulnerable households had access to information on climate change and adaptation measures.	Only 20% of the more vulnerable households had access to information on climate change and adaptation measures.
Nutritional dependency	All less vulnerable households had access to more than two meals per day.	Only 22% of the more vulnerable households had access to more than two meals per day.
Material style of life	About 40% of less vulnerable households had important assets such as CD/Radio, smartphones, flushing toilets, washing machines, computers, electric fridge, TV, satellite and cattle.	Only 16% of the more vulnerable households owned assets such as CD/radio, smartphones, flushing toilets, washing machines, computers, electric fridges, TVs, satellites and cattle.
Adapt to live without fishing	About 97% of less vulnerable households were able to live without fishing.	Only 16% of the more vulnerable households were able to live without fishing.

Commented [MM18]: need to be careful how we use this term overall

3.3 Community vulnerability, sensitivity and adaptive capacity to climate change impacts

Figure 5 depicts the vulnerability (red color), sensitivity (blue color), and adaptive capacity (green color) indices of fishing communities in Mkinga and Wete districts to climate change. The

vulnerability, sensitivity and adaptive capacity to climate change varied across fishing communities. Selemu was the least vulnerable fishing community to climate change (0.07 ± 0.12), while Mtambwe was the most vulnerable (0.21 ± 0.14). Ndumbani and Selemu were the least sensitive fishing communities to climate change (0.56 ± 0.1), while Mtambwe was the most sensitive (0.65 ± 0.087). Gando was the least adapted fishing community to climate change (0.41 ± 0.09), while Kangagani had the most adaptive capacity (0.5 ± 0.07).

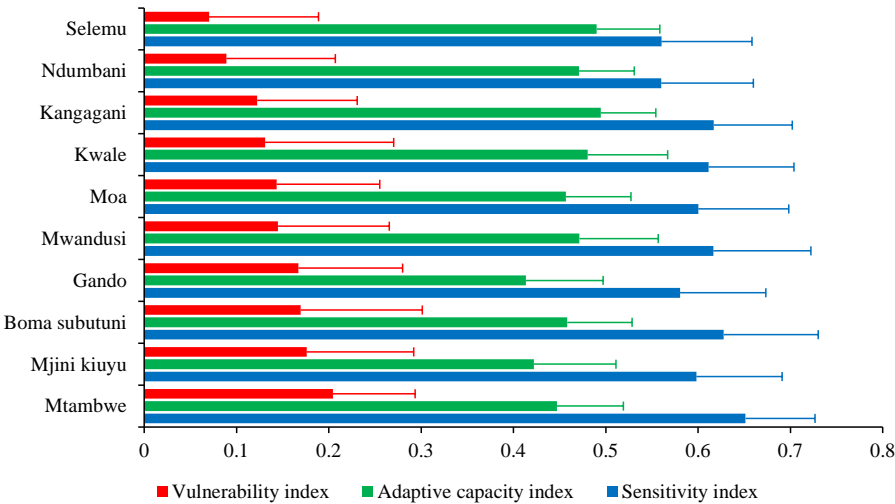


Figure 5. The average vulnerability (red color), sensitivity (blue color) and adaptive capacity (green color) indices of fishing communities in Mkinga and Wete districts in Tanzania. Error bars indicate standard deviation

3.4 Level of vulnerability to climate change among fishing communities

Table 6 shows the level of vulnerability to climate change among fishing communities. All of the fishing communities surveyed were classified as having a medium level of vulnerability to climate change (0.50 to 0.50 SD).

Commented [SD19]: Can you add the district in the figure as well?

Commented [SD20]: Based on mean vulnerability? I do not understand how it is possible, since figure 4 shows that there are “more” and “less” vulnerable. This is related to my comment Figure 3 to add the global distribution of all household

Table 6. The degree of vulnerability in ten fishing communities in Mkinga and Wete districts

Rank	Fishing community	District	Vulnerability		
			index (VI) score	VI SD	Vulnerability
1	Mtambwe	Wete	0.21	0.14	Medium
2	Mjini kiuyu	Wete	0.18	0.12	Medium
3	Boma subutuni	Mkinga	0.17	0.09	Medium
4	Gando	Wete	0.17	0.12	Medium
5	Mwandusi	Mkinga	0.14	0.11	Medium
6	Moa	Mkinga	0.14	0.11	Medium
7	Kwale	Mkinga	0.13	0.11	Medium
8	Kangagani	Wete	0.12	0.13	Medium
9	Ndumbani	Wete	0.09	0.12	Medium
10	Selemu	Wete	0.07	0.12	Medium

3.5 Factors influencing sensitivity to climate change in fishing communities in the Mkinga and Wete districts

Figure 6 depicts the percentage contribution of major drivers of community sensitivity to climate change. The first factor, livelihood, accounted for 64% of community sensitivity to climate change and is affected by a high percentage of revenue from the main income generating activity (50%) and a high percentage of catch from fishing sold (29.7%), employment status (10.9%), and time for conducting the main income generating activity (9.4%). The second factor was demographic, which accounted for 21% of community sensitivity to climate change and was influenced by a high proportion of family dependency (59.1%), years of living in a village (21.3%), and the percentage of children in the family members (18%). The third factor, health, accounted for 8% of community sensitivity to climate change and is influenced by age (25.0%), nutritional dependency (37.5%), and sense of place (37.5%). The fourth factor, culture, contributed 7% to community sensitivity to climate change and is driven by appreciation of lifestyle (42.9%), identity and pride (28.6%), and appreciation of biodiversity (28.5%).

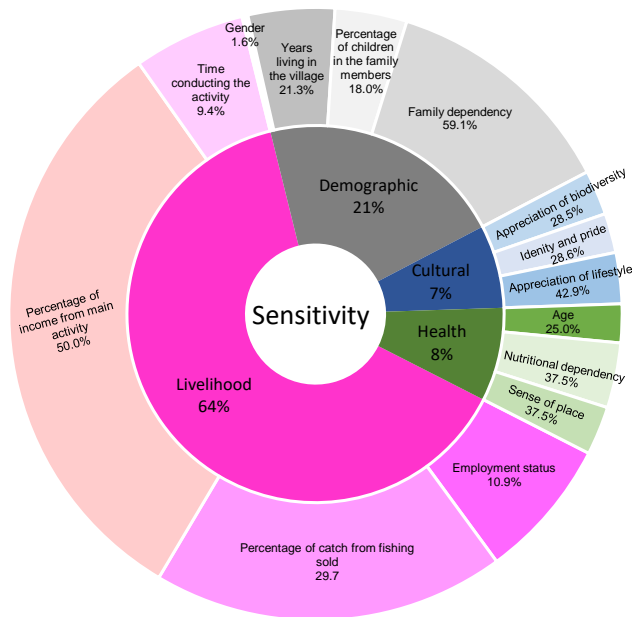


Figure 6. The percentage contribution of the primary determinants of fishing communities' sensitivity to climate change

Commented [SD21]: Can you specify in the method how the percentage contribution was calculated? (as well as for AC). It is the weights?

3.6 Factors influencing adaptive capacity to climate in fishing communities in the Mkinga and Wete districts

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Figure 7 shows the percentage contribution of key determinants to the adaptive capacity of fishing communities to climate change. The foremost factor, organisation, contributed to 36% of the community's adaptive capacity to climate change and is influenced by trust in organisation (47.2%), community cohesion (30.6%) and linking social capital (22.2%). The second factor was flexibility, which contributed 20% of the community's adaptive capacity to climate change and is driven by the need to adapt to living without fishing (70%), spatial mobility (17.4%), livelihood multiplicity (7.6%), and gears used in fishing (5%). The third factor, agency, contributed 8% of the community's adaptive capacity to climate change and is affected by perceived capacity to change (43.8), level of participation (42.5%), and recognition of causality (13.7%). The fourth factor, learning, accounted for 15% of the community's adaptive capacity to climate change and was affected by access to information (70.1%) and knowledge of rules (28.4%). The fifth factor,

assets, accounted for 13% of a community’s adaptive capacity to climate change and is affected by community infrastructure (46.1%), access to credit (38.5%), and materials of life (15.4%).



Figure 7. Percentage contribution of determinants of communities’ adaptive capacity to climate change

CHAPTER FOUR: DISCUSSION

Climate change poses significant risks to people whose livelihoods rely on coastal systems, particularly in developing countries such as Tanzania (He & Silliman, 2019). The impacts, however, differ at the household, community, national, and regional levels, prompting vulnerability assessments at various scales to inform policymakers as they plan for adaptation and coping strategies (Katic, 2017; Thiault et al. 2018). The findings of the study reveal that: (1) there is a wide range of vulnerability to climate change among households in the Mkinga and Wete districts, which is linked to household incomes and engagement in multiple income-generating activities. (2) Low household income, high reliance on marine resources, limited livelihood multiplicity, limited access to climate change information, limited awareness of fisheries regulations, and limited access to food characterize more vulnerable households to climate change, those whose sensitivity exceeds their adaptive capacity. (3) The vulnerability of fishing communities to climate change varies, with Selemu being the least vulnerable and Mtambwe being the most vulnerable. (4) All fishing villages in the Mkinga and Wete districts face a moderate threat from climate change. (5) The main factors influencing fishing communities' sensitivity to climate change are their livelihood and demographic characteristics. (6) Several social elements, including as organization, flexibility, assets, learning, and agency, influence the adaptive capacity of fishing communities in the Mkinga and Wete districts.

4.1 Factors affecting household vulnerability to climate change

This study shows that households in Bomasubutuni, Gando, Mjini kiuyu, Moa Mwandusi, and Mtambwe were more vulnerable to climate change, as indicated by higher sensitivity than adaptive capacity. In contrast, households in Kangagani, Kwale, Ndumbani, and Selemu were less vulnerable to climate change, as indicated by higher adaptive capacity than sensitivity. Differences in household vulnerability to climate change have been associated with gender, educational attainment, occupation, and income, as well as participation in multiple income-generating activities (Huynh & Stringer, 2018). Less vulnerable households in this study were characterized by a high income, more than two years of experience in conducting main income generating activity, a high level of knowledge of fisheries regulations, access to climate change information, alternative livelihood options, and low reliance on the household head, increasing their adaptive capacity to climate change. The effect of these factors on household vulnerability is discussed in terms of two underlying components of household adaptive capacity: poverty reduction and

livelihood security. According to Taupo et al. (2018), households in extreme poverty are more sensitive to climate change. Similarly, Huynh and Stringer (2018) confirmed that poor households are the most vulnerable to climate change in coastal south-central Vietnam. Poverty increases household vulnerability to climate change by increasing reliance on marine resources due to a lack of alternative livelihood options, limiting access to multiple fishing gear options, reducing coping strategies in the face of climate change-induced reductions in fish capture, relying heavily on the household head, limiting credit access, and limiting access to climate change information, all of which reduce adaptive capacity. Poverty is shaped by institutions and is intertwined with policies. In this study, lack of trust in an organization, low involvement in an organization, limited access to credit, and limited access to climate change information, as well as low levels of understanding fisheries regulations, drive more households in Mkinga and Wete fishing communities into poverty, making them more vulnerable to climate change. Household livelihood security is defined as adequate and sustainable access to income and resources to meet basic needs (including adequate access to food, safe drinking water, health care, educational opportunities, housing, time for community participation, and social integration) (Frankenberger & McCaston, 1998). Diversification of livelihoods is one of the interventions to address livelihood security in households vulnerable to climate change (Connolly-Boutin & Smit, 2016). Fishing is one of the most climate-sensitive jobs as it relies on climate-sensitive resources (Silas et al. 2020). The study results indicate households that rely solely on fishing are more vulnerable to climate change, but households that diversify their income into non-fishing sources are less sensitive. This is consistent with the findings of Silas et al. (2020), who found that fishermen who rely solely on fishing will continue to fish even if fish landings are reduced further.

4.2 Factors influencing sensitivity

According to the findings of this study, the leading factors influencing community sensitivity to climate change are livelihood and livelihood options, which are heavily influenced by the percentage of income from the main income-generating activity, the percentage of catch from fishing sold, employment status, and time for conducting the main activity. The impact of livelihood on people is owing to their reliance on coastal resources for survival. If these resources are becoming increasingly scarce as a result of climate change, the potential of these fishing communities to adopt alternate livelihood strategies is a legitimate topic to explore. This is in line with the findings of Alin (2020), who found that in fishing communities, cash income and the

monetary economy are likely to be much more crucial for securing accommodation, food, and services. Furthermore, fishing revenue has been categorized into four categories: self-employed fish harvesters, wage earners, fish processing employees, and malculture employees (Greenan et al, 2019). Despite global climate issues, small-scale fishing communities in Mkinga and Wete districts are engaged also in alternative forms of livelihood, particularly in the Selemu, where community infrastructure appears to be slightly better than in other fishing communities. This could be attributed to the general observation of more lucrative livelihood opportunities in the community, characterized by fish trade and marketing activities. Fishing communities in Mkinga and Wete districts, like the rest of the world's tropical coastal artisanal communities, have a low mean annual income, a high level of unemployment, and a low level of education. Similarly, Perret in 2010 discovered that the majority (54%) of small-scale fishing communities in Singkaraka Lake, Indonesia had completed elementary school, whereas Paudel et al, 2016 discovered that 69% of Nepal's artisanal fishing communities were illiterate. Due to a lack of skills, obtaining a basic education limits access to decent employment opportunities. Higher education, on the other hand, is essential for skilled labor and a productive workforce, resulting in a higher standard of living (ILO, 2011).

In the fishing community of Mkinga and Wete districts, demographic characteristics such as a high proportion of family dependency, years living in a village, and percentage of children in the family members were seen to increase sensitivity to climate change. Fishermen were more closely related with high family reliance on the head of the family, with family members' prospects of surviving when the head of the family is absent appearing to be quite slim, raising family sensitivity to climate change. The findings are consistent with those of Rao (2016), who found that fishing households are characterized by high family dependency.

Age, nutritional dependency, and a sense of place were found to have an impact on health in the fishing communities of Mkinga and Wete districts. While the drivers of individual or community health are likely to be associated with the geographic or socioeconomic context of a fishery, such as age and food security, health is a universal determinant in the maintenance of a viable fishing business. Incorporating subjective dimensions of well-being could contribute to a broader understanding of health that goes beyond material health determinants such as access to healthy foods. Material health factors are significant, as this study shows, especially when it comes to

sensitivity to climate change in fishing communities, but they may not fully account for some of the more intangible health drivers (King et al., in 2015). These include the impact of "contemporary uncertainties" such as mental health management or traumatic event experiences in the past (Cherry et al., 2017). Although fisheries managers are increasingly concerned with social sustainability, the high proportion of articles identified in health-focused journal publications may limit the visibility of health as a concern for fisheries policy. This is significant because evidence suggests that management interventions may have unintended consequences for both the physical health of fishers at sea and the mental health of fishers and their families on land (Emery et al., 2014). (King et al., 2015). Considering health in conjunction with other social impacts may help to explain how climate change affects the quality of life in fishing communities (Coulthard, 2012). This comprehensive approach may allow for the integration of human health into more socially conscious fisheries policy, allowing for better prediction and mitigation of potentially harmful health impacts associated to climate change and so ensuring the long-term viability of fisheries and the communities who rely on them.

People's emotional attachments to locations are linked to the meanings they assign to them as a result of their experiences, memories, and beliefs about a location (Hernandez et al., 2007). The majority of respondents felt grief when asked why they were leaving their existing villages, indicating that fishing communities have a strong sense of place, lowering sensitivity to climate change.

Culture contributes to community sensitivity to climate change and is driven by an appreciation of lifestyle, identity and pride, and biodiversity. Social relationships within the fishing community that serve as a bridge between the industry, the community, and cultural services can influence perceptions of cultural and associated indicators. Recognizing the role of relationships in the survival of viable fishing communities encourages a broader investigation of cultural to include the appreciation of life, identity, and pride, as well as the appreciation of biodiversity to shape cultural outcomes. Furthermore, it can aid in the refinement of cultural interventions so that they are more targeted to specific cultural and social contexts.

4.3 Factors affecting community adaptive capacity

The results of this study show that organization is a leading driver of climate change adaptation capacity among ten fishing communities in the Mkinga and Wete districts. Within the realm of organizations, organizational trust makes a significant contribution to climate change adaptation capacity. These findings are in line with those of Keys et al. (2014), who found that trust fosters a favorable relationship between people and leaders, as well as a positive reaction to climate change adaptation. Effective leadership and organization usually generate trust; therefore, leaders have a significant impact on community changes through providing innovation and developing community understanding (Olsson et al, 2006). This study also identified community cohesion as the second factor in the organizational domain, implying that the welfare of the community determines the economic status and adaptability to changes. As suggested by our study and the study conducted by Sitati et al (2021), the community with high conflicts is highly vulnerable to climate change. Conflict-affected communities face a slew of challenges, including combating climate change and ensuring their own well-being. According to Rahman et al. (2021), social capital has a direct relationship with fisher's adaptive capacity to climate change. Several researchers have identified social capital as a crucial issue in the community's ability to adapt to climate change, with the notion that a better knowledge of the social component can help policymakers build climate change adaptation policies (Aldrich et al. 2016; Saptutyningasih, 2020; Belay & Fekadu, 2021).

Community flexibility was placed second as a determinant of adaptive capacity in the Mkinga and Wete districts. In this domain, adapting to live without fishing had a high contribution of around 70%, surpassing spatial mobility, livelihood multiplicity, and gears, which accounted for 17.4%, 7.6%, and 5%, respectively. Some individuals stated that they can live without fishing, which is a good indicator of climate change adaptation potential. Other income-generating activities such as boat building, load carrying, mariculture, salting carrying in the salt industry, fish processing, and small businesses characterize these locations; nevertheless, some people exclusively depend fishing, while others engage in both fishing and other income-generating activities. If one alternative stays inactive during the transition phase, having various economic activities is a good method for adjusting to climate change, and it has been promoted as a viable strategy for fishermen' adaptation to climate change (Asiedu & Nunoo, 2013). Our findings demonstrate that fishers who employ a variety of fishing gears are better adapted to climate change. Rahman et al (2021)

observed that having more than one fishing gear allows fishermen to use their gears depending on location and fishing grounds, which supports these findings.

When compared to structure organisation and flexibility, agency, assets, and learning facilitate adaptive ability by less than 20% in this study. The agency's degree of participation and perceived capability change account for more than 40% of the total. According to Nenadovi et al (2016), community participation in various aspects of decision making in fisheries resources creates room for high adaptation to climate change, which suggests that community participation in decision making promotes the ability of the fisheries community to use new sources of benefits during changes. In the Mkinga and Wete districts, assets such as material lifestyle, access to credit, and community infrastructure have been demonstrated to contribute to fishers' adaptive ability capacity. The presence of good infrastructure and access to credit is a good indicator of community resilience, which means that whenever the infrastructures are good, the community will be able to absorb any shock caused by climate change (Longo et al 2017). In terms of learning, access to information and rule knowledge are reported shown to have a high contribution of adaptive capacity in this study. People who have access to information have a better chance of understanding the state of the fisheries and preparing for changes. Access to information is strongly linked to the ability to change and use new innovations; in this view, knowledge of rules is also strongly linked to access to information, implying that a community that understands the proper gear, time, location, and species size to catch has a high ability to cope with declining fish catches and become climate resilient.

4.4 Coping mechanisms and adaptive strategies

The study's findings show that trust in organizations, community cohesion, level of participation, linking social capital, access to information, knowledge of rules, community infrastructure, access to credits, livelihood multiplicity, and the ability to live without fishing and fishing gear all influence communities' adaptive capacity to climate change. Efforts to improve any of the aforementioned factors will thus increase community adaptation to climate change. Trust in organizations includes confidence in village leaders, non-governmental organizations, community fisheries management units like the Beach Management Unit (BMU), and the government. Increased responsibility, transparency, and dedication in an organization will make it easier to integrate new adaptive technologies, hence enhancing communities' adaptive potential. People

who have a strong sense of community interact more, which helps them adjust to climate change's impacts. When conflicts occur frequently, however, adaptive capacity to climate change suffers.

The community's tendency to aid one another appears to play a significant part in adapting to climate change, implying that the community will be secure if it can rely on one another when changes occur. A well-connected neighborhood also facilitates access to information, making it easier for residents to receive early warnings about climate change's effects. Because people who understand fisheries regulations are more adaptable to climate change, raising awareness of fisheries regulations can help them cope with changing climate. The tendency of fishers to have more than one fishing gear was observed as an adaptive strategy in the surveyed community; thus, enabling fishing communities to access more than one gear type is likely to improve adaptive capacity.

Individual decision-making participation, particularly among the most vulnerable, improves the effectiveness of long-term development and climate change program goals and strengthens the link between climate actions and people's everyday needs and priorities. Users of maritime resources who do not have the opportunity to participate actively in the process often believe that adaptation measures are 'unfair,' 'unnecessary,' 'wrong,' 'immoral,' and/or 'illegal,' with some individuals benefiting and others suffering. People are more likely to positively assess the risks associated with change and their ability to cope if they are confident about their future and the future of the resource, both of which are important in maintaining social resilience.

The findings of this study show that having better infrastructure, such as a road, a hospital, a school and markets, improves the community's adaptive capacity. Better infrastructure in fishing communities helps individuals to stay in a community and diversify their livelihoods by allowing them to work in transportation, fish retail, and small businesses. When the community has more than one source of revenue, it will be more secure during the transition phases, and the community may be able to survive without fishing. Also, access to credit and the tendency of fishermen to use credit facilities for savings encourages excellent income management and protects fishermen from dangers, which may inspire government and private organizations to grant fishing equipment subsidies.

The most frequently reported information in our survey was a decrease in catch; we hypothesize that this could be due to climate change, which causes a shift in species distribution and a change in seasonal catch. The most effective way to overcome this is to use innovative technologies such as modern gear as well as boats capable of reaching distant waters thought to contain more fish, modern fish processing and storage facilities, and value addition to reduce post-harvest loss. Modern fishing vessels with ample storage space, a global positioning system (GPS), and radar will help fishermen adapt to the effects of climate change. GPS and radar can help to locate potential fishing grounds, reducing fishing time and fuel costs, while storage facilities will ensure the quality of fish caught, increasing income. Fish aggregative devices (FADs) will also be an excellent method for fostering resilient fishing communities in climate-change-affected fishing grounds.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATION

5.1 Conclusions

The current study used the CCVA toolkit to assess climate change vulnerability at the household and community levels in the Mkinga and Wete districts of Tanzania. The following conclusions are reached: One, climate change vulnerability differs among households in the Mkinga and Wete districts' fishing communities, and this variance is linked to household income and engagement in numerous income-generating activities. Two, low household income, high reliance on marine resources, limited livelihood multiplicity, limited access to climate change information, limited awareness of fisheries regulations, and limited access to food characterize more vulnerable households to climate change, whose sensitivity exceeds their adaptive capacity. Three, the degree to which fishing communities are vulnerable to climate change varies, with the Selemu fishing community being the least vulnerable and Mtambwe being the most vulnerable. Four, climate change poses a medium threat to all fishing communities in the Mkinga and Wete districts. Five, the main drivers of fishing communities' sensitivity to climate change are linked to livelihood and demographic characteristics. Six, a variety of social factors influence fishing communities' adaptive capacity, including organization, flexibility, assets, learning, and agency. Seven, household and community vulnerability are inextricably linked and should not be evaluated separately.

5.2 Recommendations

Several recommendations are made, primarily concerning poverty reduction, diversification of income-generating activities, increased trust in the organization, meaningful individual participation in the organization, effective communication systems, promoting community cohesion, improving access to information, improving mobile services, developing, utilizing, and accessing climate technology, and improving infrastructure in fishing communities. The actions and research needed to effectively implement these recommendations and support the significant socioeconomic benefits derived from tuna are outlined below.

- Poor fishing communities are the most vulnerable to climate change and should be targeted first in terms of raising their financial capital. Financial assistance programs that provide start-up capital for individuals to start small businesses will increase people's options and flexibility in their employment.

- The policy should encourage people to employ a variety of livelihood options and diversify their sources of income. Increased human well-being and economic development will minimize reliance on climate-sensitive coastal resources and vulnerability to climate change. Then, economic development is linked to increased climate change awareness, improved education systems, and increased motivation for individuals to participate in decision-making processes.
- The local government, village governments, and BMUs should work more closely with communities to implement and create new adaptation initiatives, because meaningful participation in the decision-making process is critical to fostering feelings of satisfaction, understanding, trust, and confidence in the future.
- The government and other stakeholders should promote high community cohesion by encouraging and emphasizing the formation of groups and harmonizing the unit and cooperation among members of the fishing community. This goes hand in hand with expanded engagement in all matters, including establishing bylaws, making participatory decisions, and developing plans for sustainable fishing in the face of a changing climate.
- Fishing communities should continue to help one another in all conditions as a strategy to strengthen social capital and adapt to the effects of climate change.
- The local government should increase community understanding of fisheries regulations. This can be accomplished through BMUs, NGOs, and community-based organizations.
- The government should capacitate fishers to promote innovation in fishing gears to cope with the changes in the climate.
- The local government should improve infrastructure in fishing communities to encourage people to stay in the community, gain access to better fish markets, and diversify their income by allowing them to work in transportation, fish retail, and small businesses, as well as provide access to health and educational facilities.
- The government should make sure mobile services are available to fishing communities, which will allow them to manage their income and communicate climate change information.
- The local government should develop an effective communication system that integrates communication into development planning. This necessitates the systematic use of

communication and information transfer concepts, tactics, and processes to achieve beneficial social changes.

- The local government and the village governments and BMUs should work more directly with communities in implementing and designing new adaptation projects.
- Develop, use, and access climate technology such as using modern fishing gear, boats capable of reaching distant waters believed to have more fish, and fish processing and storage facilities to reduce post-harvest loss.
- Conduct a vulnerability assessment for other coastal communities outside of the scope of this study. This will aid in the generation of data at the country level for use in national climate change adaptation planning.
- Local governments should foster an atmosphere that encourages fishing communities to educate themselves, as skilled labor and a productive workforce are necessary for a greater standard of living.
- Integrate human health into more socially conscious fishing policies, allowing for better prediction and mitigation of potentially harmful health impacts associated with climate change and so ensuring the long-term viability of fisheries and the communities that rely on them.
- Establishment of a fish processing plant and value addition is one of the most effective strategies for increasing product diversification and marketing of fisheries products to increase income and employment in the fishing community and ensure a consistent supply of fisheries and fisheries-related products even during low catch seasons.

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APPENDICES

Appendix 1. Household questionnaire

CLIMATE CHANGE VULNERABILITY ASSESSMENTS IN SELECTED COASTAL COMMUNITIES IN TANZANIA

HOUSEHOLD QUESTIONNAIRE

Study site: _____ County/District: _____

Village: _____ Date: _____

Survey no.: _____ Name of interviewer: _____

Latitude/longitude: _____

PART 1: SENSITY DIMENSION

Demographic Characteristics *(Please tick one)*

- 1) Age (in years):
- 2) Sex:
[1] Female [2] Male [3] Other
- 3) Formal education:
[1] Class 8 or less [2] Secondary school - level certificate [3] A-level certificate
[4] Tertiary [5] University and above
- 4) What is your religion?
[1] Muslim [2] Christian [3] Hindu
[4] Traditional [5] Other (specify)
- 5) Marital status: [1] Single [2] Married [3] Married before [4] Other
- 6) Where are you originally from? *(Tick only one option below)*
[1] This village [2] Another village in this county [3] Coastal area other than this location
[4] This country (not coastal area) [5] Another country
- 7) How many years have you lived in this village?
- 8) How many people are currently in your household, including yourself? *(Please write down the number of people below each category)*

Adult male	Adult female	Male children	Female children

- 9) What is your employment status? [1] Unemployed [2] Employed
- 10) If employed, what form of employment are you engaged in?

11) If unemployed, is anyone from your household engaged in formal employment?

[1] No [2] Yes

12) Please give details of employment for any members of your household who are employed (specify type of occupation) _____

12a How many family members are employed? _____

13) If unemployed, how do you earn income or obtain food and other necessities?

14) How much income do you earn per week/month/year? Mts. _____

14a List the main sources of income to the family and score them in order of priority and include the average amount per activity.

Activity	Priority	Average income
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Total

15) If fisher, what marine resources do you depend on? Mts. _____

15a How long you have been developing the activity that is the main source of income? _____

PART 2: SOCIAL ADAPTIVE CAPACITY DIMENSION

FLEXIBILITY

Livelihood multiplicity

Traditional uses of marine resources

What goods did you obtain from the marine resources in the past?

Have these goods changed over time? [1] No [2] Yes

If yes, how?

How else did you benefit from the marine resources in the past? (*probe for ecological services*)

Has the benefits changed over time? [1] No [2] Yes

If yes, how?

How do you use marine resources now?

What goods do you obtain from the marine resources now?

How else do you benefit from the marine resources now? (*probe for ecological services*)

What economic activities do you engage in to obtain food or income to your house? What do other people in your house do that brings in food or money to your house?

Livelihood activity	Tick livelihoods of the respondent	Number of people in the household involved in activity		Rank the economic activities in order of importance
		Women	Men	
Fishing				
Gleaning				
Medium scale fish trade/fish dealer				
Fish mongers (<i>mama karanga</i>)				
Mangrove cutting or trade				
Agent (middleman)				
Aquaculture/Mariculture				
Hunting				
Farming (cash crops)				
Farming (peasant/subsistence, livestock)				
Salaried employment (e.g. teacher, nurse)				
Tourism and handicrafts				
Small business(not marine related)				
Other:				
Other:				

Is fishing your primary livelihood? [1] No [2] Yes

If yes, how much do you agree with this statement? (*Please circle one option*):

“I could easily stop fishing, and make my living on land”

Strongly disagree	Somewhat disagree	Neither	Somewhat agree	Strongly agree

Cultural/heritage impacts

What areas of the marine environment/resources are of special interest to communities for cultural or religious purposes?

Has this changed over time? [1] No [2] Yes

If yes, how? _____

Fishing and Marine Resources Management/Gear diversity

Do you own a boat? (Tick as appropriate)

[1] No boat

[2] Boat without a motor (e.g., canoe)

[3] Boat with a motorized engine (engine has _____hp)

[4] Other(specify) _____

Which fishing gears does your household use? (Tick appropriately)

Gear	Tick gear used	Gear	Tick gear used
Hand line (inshore/reef)		Purse seine net	
Hand line (offshore/blue water)		Hand spear	
Multiple hooks (more than 20)		Spear-gun	
Trolling line		Fish trap	
Mesh gillnet, above 5cm(2inches)		Explosives/Poison	
Mesh gillnet, below 5cm(2inches)		Gleaning	
Mosquito nets		Other(specify):	
Small/beach seine net (nets dragged along substrate)		Other(specify):	

Which fishing gear is the most important to your household? _____

Where is your fishing ground? _____

Catch, fishing effort and catch value:

Parameter	Details
Quantity of fish & other seafood landed (Kgs/ Bundles/pieces)	

Number of fishing crew	
Number of hours (fishing and travelling)	
Total value of catch (local currency)	

Typically, what percentage of your catch from fishing or gleaning do you sell, retain for own consumption or give away?

Retain for own consumption ____% sell ____% give away ____% don't know ____%

If you were to get 50% less catch all year what would you do? *(Tick multiple boxes if necessary)*

Keep fishing at same amount	Fish more often	Change fishing grounds	Change fishing gears	Fish less & switch to other livelihood	Stop fishing entirely
Other(specify):					

In general, how often do you and your household eat locally caught fish or other sea food that was caught by you or someone in your community? *(Please circle one option)*

More than once per day	Once per day	More than once per week	Once per week	More than once per month

Over the past 5 years, has the number of fish caught around your area changed? If so, how has it changed? *(Tick one option)*

[1] Significant decrease [2] Decrease [3] No change

[4] Increase [5] Significant increase

What can be done to increase availability of fish in the sea around here?_____

ORGANIZATION

In general, how much do you trust the following people? *(Tick one option for each group).*

	Not at all	Distrust more people than trust	About half-half	Trust more people than distrust	Trust all
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People in your village					
Village leaders					
Marine resource management group					
NGOs					
Government					

I am interested in learning about some of the rules and traditions about fishing here. (A) Are there places where people are not supposed to fish, nor use certain gears, etc.?

(B) Who created the rules? (C) Do people still fish there? If so, how many people? *(Interviewer: please fill out first row before moving to next row, i.e. ask A-C for places where people are not supposed to fish followed by A-C for fishing gears that people are not supposed to use).*

Rule	Description of rules, e.g. what gears are not used etc.	Who created the rules? <i>(tick <u>multiple</u> boxes if necessary)</i>	Do people still fish there? If so, how many? <i>(tick <u>one</u> box)</i>
Places where people are not supposed to fish		Fishers/local users NGO Government Other: __ Don't know	No one A few About half Most Everyone Don't know
Certain fishing gears that people are not supposed to use		Fishers/local users NGO Government Other: __ Don't know	No one A few About half Most Everyone Don't know
Certain times that people are not supposed to fish		Fishers/local users NGO Government Other: __ Don't know	No one A few About half Most Everyone Don't know

Certain species or types of fish that people are not supposed to catch		Fishers/local users NGO Government Other: ____ Don't know	No one A few About half Most Everyone Don't know
Other, please describe:		Fishers/local users NGO Government Other: ____ Don't know	No one A few About half Most Everyone Don't know

Social Capital

Social networks

Are there times when you go to someone else for help? [1] No [2] Yes

If the answer to question a) is yes, who do you run to for help in times of need? ____

Why do you run to this person(s) and not any other person(s)? _____

Who are the key decision makers in the community? _____

How are decisions made in the community? _____

Learning

Local perception of marine resources management and management success

In your opinion, are the marine resources managed well? _____

What aspects of management do you consider successful in your area? _____

Is there effective enforcement of rules and regulations governing marine resources? [1] No [2] Yes

If yes, explain: _____

Are the local communities involved in marine resources management?

[1] No [2] Yes

If yes, how? _____

What is your opinion regarding marine resources conservation? _____

Level of understanding of human impacts on marine resources

Are there any activities that damage marine resources in the area? _____

Are you concerned about sustainability of the marine resources? _____

Distance from village to the sea; importance of markets; slope _____

Distance from village to nearest market _____

How is cultural knowledge passed down by the community from one generation to another?

Is there any cultural memory, traditions, and assets that relate to coastal and marine resources that have been handed over _____ to _____ you? _____

Food Security and Wellbeing

Were there any moments in the last month when your home did not have enough to eat?

[1] No [2] Yes [3] I don't know

Was this unusual?

[1] No [2] Yes [3] I don't know

In the past year, have there been times when you feared that your food would not last until you were able to get more?

[1] No [2] Yes [3] I don't know

In general, how many times do you eat in the day?

[1] Once [2] 2 times [3] 3 times [4] Over 3 times

Since yesterday, can you tell me about the meals you have prepared for your family?

ASSETS AND ACCESS TO CREDIT

Material Style of Life

Material style of life and owned assets. *Please tick all the household items or facilities present in the household.*

Also record the number of each asset owned by the household.

Cooking pots [1] No [2] Yes How many:	Radios/cassette/CD [1] No [2] Yes How many:	DVD/VCD players [1] No [2] Yes How many:
Mattresses [1] No [2] Yes How many:	Mobile phone (not smart phone) [1] No [2] Yes How many:	Smart phone sortables [1] No [2] Yes How many:
Flushing toilet [1] No [2] Yes How many:	Indoor piped water (tap) [1] No [2] Yes How many:	
Washing machine [1] No [2] Yes	Computers [1] No [2] Yes	Electric refrigerators or freezers [1] No [2] Yes

How many:	How many:	How many:	
Cattle/Goats/Pigs /Sheep(livestock) [1] No [2] Yes How many:	Televisions [1] No [2] Yes How many:	Satellite dishes [1] No [2] Yes How many:	
Private toilet [1] No [2] Yes How many:	Other1 [1] No [2] Yes How many:	Other2 [1] No [2] Yes How many:	
Roof Material Bamboo/Thatch Wood Metal Tile Other: __	Wall Material Bamboo/Thatch Wood Metal Cement Other: __	Floor Material Dirt/Soil Wood Concrete Tile Other: __	Electricity Solar Generator Grid None Other: __

Community infrastructure

How are the communities governed?

How do the communities relate with higher levels of government?

How do you classify the quality of community infrastructures, hospitals, schools, coastal protection infrastructures, etc ?

Very bad	bad	Neither good nor bad	Good	Very good

It would be great to know more about how you feel about your life here. All things considered, has your satisfaction with your life as a whole changed over the last three years? [1] No [2] Yes.

If so, how has it changed? (Please tick one option)

Much worse	Worse	No change	Better	Much better

If there was a change, what are the three main causes of this change?

1. _____
 2. _____ 3. _____

Supposing that for some reason you were moving away from your current village, how would you feel about leaving?

Very sad	Sad	Neither happy nor sad	Happy	Very happy

Do you have access to savings to respond to extreme climatic events? [1] No [2] Yes

Do you have access to credit facilities? [1] No [2] Yes; Explain _____

For people dependent on marine resources, do you have access to markets? [1] No [2] Yes

Do both men and women have equal access to resources? [1] No [2] Yes

Are there any barriers restricting access to the coastal and marine resources? Explain

Is government investing in longer term adaptation options? [1] No [2] Yes,

If yes, how? _____

AGENCY

Recognition of causality

Does fisheries and mangrove management affect this community? [1] No [2] Yes

Does fisheries and mangrove management affect you? [1] No [2] Yes

If yes, what are the positive impacts of fisheries and mangrove management for you?

What are the negative impacts of fisheries management on you? _____

In general, do you think management has affected fish stocks? If yes, how has the fish stock been affected? *(Please tick one option)*

Much worse	Worse	No change	Better	Much better

In general, do you think management has affected the quality (e.g., size) of fish and other sea food landed?

(Please tick one option)

A lot less	Somewhat less	No change	Somewhat more	A lot more

In general, do you think management has made it easier or harder to catch fish and other sea food (in terms of time, effort, or travel distance)? *(Please tick one option)*

Much harder	Hard	Neither	Easier	Much easier

In general, do you think management has affected the reliability of what you can catch?

If yes, how has it changed the reliability? *(Please tick one option)*

A lot less reliable	Less reliable	No change	More reliable	A lot more reliable

Level of participation

Currently, are you involved in the following aspects of marine resources management?

decisions about marine resource use (attending meetings about marine resources)

Not at all	Seldom	Never	Often	Very often

management of marine resources

Not involved	Involved a little	Never	Involved	Highly involved (in leadership)

How much do you agree or disagree with this statement: *(Please tick one option)*

"People like me have influence on the management of marine resources."

Strongly disagree	Disagree	Neither	Agree	Strongly agree

In general, do you think the way that decisions are made about marine resource use and management are fair? *(Please circle one option)*

Very unfair	Unfair	Neither	Fair	Very fair	Don't know

Why? _____

Is there any conflict over marine resources here? If yes, how often does this conflict occur? *(Please circle one option)*

No conflict	Less than once per year	More than once per year	Monthly	Weekly	Daily	Don't know

CLIMATE CHANGE

Have you heard of climate change or global warming?

[1] No [2] Yes

Can you tell me what it is? *Please check all the answers the respondent provides. Do not prompt the respondent*

- ☐ Drought – not enough rain
 ☐ More storms & extreme weather
☐ Floods – too enough rain
 ☐ Increased disease
☐ Sea level rise
 ☐ Impact on fish catch
☐ Warmer conditions
☐ Other

Are you worried about this affecting your family?

[1] Not worried [2] A little worried [3] Not sure [4] Worried [5] Very worried

What traditional knowledge or practices relevant to addressing climate are available in the communities?

What adaptation options are available to you and the local communities? _____

Do you and other members of the community have access to relevant information, such as forecasts or early warning?

How do you classify it?

[1] Very limited [2] limited [3] Not bad [4] Good [5] Very good

ADDITIONAL QUESTIONS

Linking Social capital

Do you pay taxes?

[1] No [2] Yes

Are you informed about the taxes paid?

[1] No [2] Yes

Do you have support from the government to sustain the development of your activities based on the taxes paid?

[1] No [2] Yes

Describe, what kind of support do you receive?

Appreciation of biodiversity

Do you think that it is important that people participate in biodiversity preservation? Do you think that the daily activities of local people might impact on biodiversity.

I don't understand the question	My actions do not have effect on the biodiversity	My actions do have limited effect on the biodiversity	My actions have effect on biodiversity	My actions have significant effect on biodiversity

Do you have traditions that regulate the fishing and exploitation of costal resources?

[1] No [2] Yes

Describe, these traditions? _____
_____.

How do you feel about your village, environment and marine resources? Are you willing to protect them as your home land and culture?

[1] No [2] Yes

How much you like you lifestyle in the village?

Very bad	Bad	Not bad but not good	Good	Very good

SUPPLEMENTARY QUESTIONS - Adaptation to Covid-19

How has COVID-19 impacted how you and your family obtain food and income compared to how you normally would at this time of year?

Have you and your family made any changes to cope with these impacts? [1] No [2] Yes

If the answer to question 74 is yes, please explain _____
_____.

Has COVID-19 changed the quantity of fish or other sea food that much you have been catching compared to how you would normally catch at this time of year?

[1] No [2] Yes

If yes, how?

Much worse	Worse	No change	Better	Much better

Has COVID-19 impacted the fish market? [1] No [2] Yes

Please explain _____

Are people in the community able to access markets? [1] No [2] Yes

Please explain _____

Have you and your family made any changes to cope with these impacts? Please tell me about them.

Has COVID-19 changed the price of fish now compared to this time of year normally? How?

Has COVID-19 affected the types and variety of food you and your family are eating now, compared to normally at this time of year? [1] No [2] Yes

If yes, how? _____

Are there foods you normally eat at this time of year that you are not able to eat at the moment? [1] No [2] Yes

If yes, why?

Have you and your family made any changes to cope with these impacts? Please tell me about them.

What impacts has COVID-19 had on livelihoods in the community? _____
_____.

Has the number of people who are engaged in fishing changed? [1] No [2] Yes

If yes, how? _____

Has the intensity of fishing changed? [1] No [2] Yes

If yes, how? _____

How has the community responded to COVID-19? _____

Appendix 2. Focused group questionnaire

CCVA IN SELECTED COASTAL COMMUNITIES IN TANZANIA

FOCUS GROUP DISCUSSION GUIDE

Questionnaire for determination of relative weights of domains and indicators using the AHP method

We are carrying out research, in the context of development of CCVA for the coastal areas of Tanzania. Through this survey, it is intended to determine the relative weights to be attributed to the different domains and to each of the indicators that make up the groups. The methodological explanation is given in an accompanying document; you can also interact with the researchers involved for any clarification on the filling procedures. The survey is completely anonymous.

I. Sensitivity

a) Domains

1 There are different aspects that determine the sensitivity of coastal area communities. In your opinion what is more important in determining the sensitivity to climate change for the communities in Tanzania, the livelihood or demographic aspects? To what degree you think your choice is important.

1.Livelihood	9	7	5	3	1	3	5	7	9	2.Demographic
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2 There are different aspects that determine the sensitivity of coastal area communities. In your opinion what is more important in determining the sensitivity to climate change for the communities in Tanzania, the livelihood and economic dependence on the resource or the Cultural aspects? To what degree you think your choice is important.

1.Livelihood	9	7	5	3	1	3	5	7	9	3.Cultural
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3 There are different aspects that determine the sensitivity of coastal area communities. In your opinion what is more important in determining the sensitivity to climate change for the communities in Tanzania, the Livelihood or the Health issues? To what degree you think your choice is important.

1.Livelihood	9	7	5	3	1	3	5	7	9	4.Health
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4 There are different aspects that determine the sensitivity of coastal area communities. In your opinion what is more important in determining the sensitivity to climate change for the communities in Tanzania, the Demographic aspects or the Cultural aspects? To what degree you think your choice is important.

2.Demographic	9	7	5	3	1	3	5	7	9	3.Cultural
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5 There are different aspects that determine the sensitivity of coastal area communities. In your opinion what is more important in determining the sensitivity to climate change for the communities in Tanzania, the Demographic aspects or the health? To what degree you think your choice is important.

2.Demographic	9	7	5	3	1	3	5	7	9	4.Health
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6 There are different aspects that determine the sensitivity of coastal area communities. In your opinion what is more important in determining the sensitivity to climate change for the communities in Tanzania, the Cultural aspects or the Health aspects? To what degree you think your choice is important.

3.Cultural	9	7	5	3	1	3	5	7	9	4.Health
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b) Livelihood/Economic dependence

7 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the livelihood of coastal communities of Tanzania: In your opinion what is more important the Employment Status or the Percentage of catch from fishing sold? To what degree you think your choice is important.

1. Employment Status	9	7	5	3	1	3	5	7	9	2. Percentage of catch from fishing sold
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8 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the livelihood of coastal communities of Tanzania: In your opinion what is more important the Employment Status or the Percentage of income from the main activity? To what degree you think your choice is important.

1. Employment Status	9	7	5	3	1	3	5	7	9	3. Percentage of income from the main activity
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9 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the livelihood of coastal communities of Tanzania: In your opinion what is more important the Employment Status or the Time conducting the activity? To what degree you think your choice is important.

1. Employment Status	9	7	5	3	1	3	5	7	9	4. Time conducting the activity
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10 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the livelihood of coastal communities of Tanzania: In your opinion what is more important the Percentage of catch from fishing sold or the Percentage of income from the main activity? To what degree you think your choice is important.

2. Percentage of catch from fishing sold	9	7	5	3	1	3	5	7	9	3. Percentage of income from the main activity
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11 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the livelihood of coastal communities of Tanzania: In your opinion what is more important the Percentage of catch from fishing sold or the Time conducting the activity? To what degree you think your choice is important.

2. Percentage of catch from fishing sold	9	7	5	3	1	3	5	7	9	4. Time conducting the activity
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12 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the livelihood of coastal communities of Tanzania: In your opinion what is more important the Percentage of income from the main activity or the Time conducting the activity? To what degree you think your choice is important.

3. Percentage of income from the main activity	9	7	5	3	1	3	5	7	9	4. Time conducting the activity
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c) Demographic

13 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the demographics of coastal communities of Tanzania. In your opinion what is more important the Gender or the Years Living In the village? To what degree you think your choice is important.

1. Gender	9	7	5	3	1	3	5	7	9	2. Years Living In the village
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14 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the demographics of coastal communities of Tanzania. In your opinion what is more important the Gender or the Percentage of children in the family members? To what degree you think your choice is important.

1. Gender	9	7	5	3	1	3	5	7	9	3. Percentage of children in the family members
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15 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the demographics of coastal communities of Tanzania. In your opinion what is more important the Gender or the Family dependency? To what degree you think your choice is important?

1. Gender	9	7	5	3	1	3	5	7	9	4. Family dependency
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16 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the demographics of coastal communities of Tanzania. In your opinion what is more important the Years Living In the village or the Percentage of children in the family members? To what degree you think your choice is important.

2. Years Living In the village	9	7	5	3	1	3	5	7	9	3. Percentage of children in the family members
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17 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the demographics of coastal communities of Tanzania. In your opinion what is more important the Years Living In the village or the Family dependency? To what degree you think your choice is important?

2. Years Living In the village	9	7	5	3	1	3	5	7	9	4. Family dependency
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18 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the demographics of coastal communities of Tanzania. In your opinion what is more important the Percentage of children in the family members or the Family dependency? To what degree you think your choice is important?

3. Percentage of children in the family members	9	7	5	3	1	3	5	7	9	4. Family dependency
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d) Cultural

19 Within the different domains there are different indicators that will contribute to the overall sensitive. For example within the cultural domain of coastal communities of Tanzania. In your opinion what is more important the Appreciation of biodiversity or the Identity and pride? To what degree you think your choice is important?

1. Appreciation of biodiversity	9	7	5	3	1	3	5	7	9	2. Identity and pride
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20 Within the different domains there are different indicators that will contribute to the overall sensitive. For example within the cultural domain of coastal communities of Tanzania. In your opinion what is more important the Appreciation of biodiversity or the Appreciation of lifestyle? To what degree you think your choice is important?

1. Appreciation of biodiversity	9	7	5	3	1	3	5	7	9	3. Appreciation of lifestyle
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21 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the cultural domain of coastal communities of Tanzania. In your opinion what is more important the Identity and pride or the Appreciation of lifestyle? To what degree you think your choice is important?

2. Identity and pride	9	7	5	3	1	3	5	7	9	3. Appreciation of lifestyle
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d) Health

22 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the health of coastal communities of Tanzania. In your opinion what is more important the Age or the Nutritional dependency? To what degree you think your choice is important?

1. Age	9	7	5	3	1	3	5	7	9	2. Nutritional dependency
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23 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the health of coastal communities of Tanzania. In your opinion what is more important the Age or the Sense of place? To what degree you think your choice is important?

1. Age										3. Sense of place
	9	7	5	3	1	3	5	7	9	

24 Within the different domains there are different indicators that will contribute to the overall sensitive. For example, within the health of coastal communities of Tanzania. In your opinion what is more important the Nutritional dependency or the Sense of place? To what degree you think your choice is important?

2. Nutritional dependency										3. Sense of place
	9	7	5	3	1	3	5	7	9	

II. Adaptation Capacity

a) Domains

1 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the communities in Tanzania, the Learning or Assets? To what degree you think your choice is important.

1. Learning										2. Assets
	9	7	5	3	1	3	5	7	9	

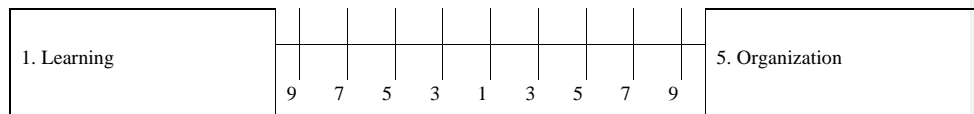
2 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Learning or Flexibility? To what degree you think your choice is important.

1. Learning										3. Flexibility
	9	7	5	3	1	3	5	7	9	

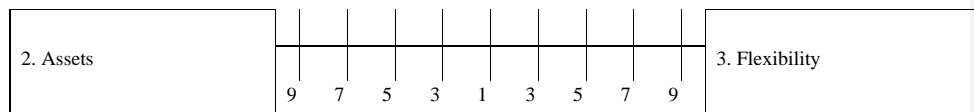
3 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Learning or Agency? To what degree you think your choice is important.

1. Learning										4. Agency
	9	7	5	3	1	3	5	7	9	

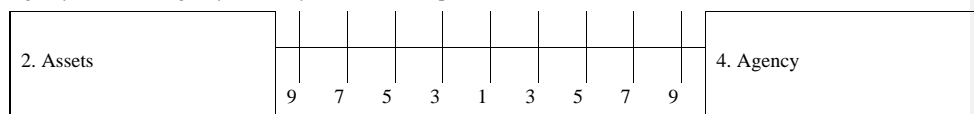
4 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Learning or Organization? To what degree you think your choice is important.



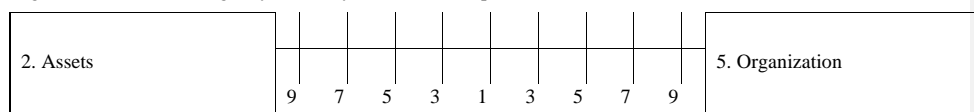
5 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Assets or Flexibility? To what degree you think your choice is important.



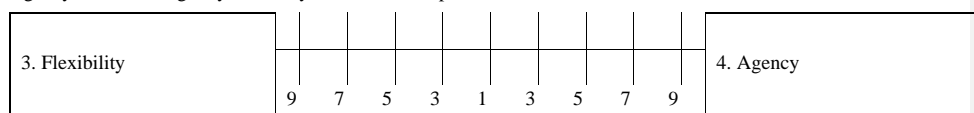
6 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Assets or Agency? To what degree you think your choice is important.



7 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Assets or Organization? To what degree you think your choice is important.



8 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Flexibility or Agency? To what degree you think your choice is important.



9 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Flexibility or Organization? To what degree you think your choice is important.

3. Flexibility										5. Organization
	9	7	5	3	1	3	5	7	9	

10 There are different aspects that impact the Adaptive capacity of coastal communities. In your opinion what is more important in determining the Adaptive capacity to climate change for the community in Tanzania, the Agency or Organization? To what degree you think your choice is important.

4. Agency										5. Organization
	9	7	5	3	1	3	5	7	9	

b) Learning

11 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Learning for the coastal communities of Tanzania. In your opinion what is more important the Level of education or the Knowledge of rules? To what degree you think your choice is important?

1. Level of education										2. Knowledge of rules
	9	7	5	3	1	3	5	7	9	

12 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Learning for the coastal communities of Tanzania. In your opinion what is more important the Level of education or the Access to information? To what degree you think your choice is important?

1. Level of education										3. Access to information
	9	7	5	3	1	3	5	7	9	

13 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Learning for the coastal communities of Tanzania. In your opinion what is more important the Knowledge of rules or the Access to information? To what degree you think your choice is important?

2. Knowledge of rules										3. Access to information
	9	7	5	3	1	3	5	7	9	

c) Assets

14 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Assets for the coastal communities of Tanzania. In your opinion what is more important the Material style of life or the Community Infrastructures? To what degree you think your choice is important?

1. Material style of life										2. Community Infrastructures
	9	7	5	3	1	3	5	7	9	

15 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Assets for the coastal communities of Tanzania. In your opinion what is more important the Material style of life or the Access to credit? To what degree you think your choice is important?

1. Material style of life										3. Access to credits
	9	7	5	3	1	3	5	7	9	

16 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Assets for the coastal communities of Tanzania. In your opinion what is more important the Community Infrastructures or the Access to credit? To what degree you think your choice is important?

2. Community Infrastructures										3. Access to credits
	9	7	5	3	1	3	5	7	9	

d) Flexibility

17 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Flexibility for the coastal communities of Tanzania. In your opinion what is more important the Community Infrastructures or Adapt to live without fishing? To what degree you think your choice is important?

1. Community infrastructures										2. Adapt to live without fishing
	9	7	5	3	1	3	5	7	9	

18 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Flexibility for the coastal communities of Tanzania. In your opinion what is more important the Community Infrastructures or Gear? To what degree you think your choice is important?

1. Community infrastructures										3. Gear
	9	7	5	3	1	3	5	7	9	

19 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Flexibility for the coastal communities of Tanzania. In your opinion what is more important the Community Infrastructures or Spatial mobility? To what degree you think your choice is important?

1.Community infrastructures										4. Spatial mobility
	9	7	5	3	1	3	5	7	9	

20 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within Flexibility, for the coastal communities of Tanzania. In your opinion what is more important the Adapt to live without fishing or Gear? To what degree you think your choice is important?

2. Adapt to live without fishing										3. Gear
	9	7	5	3	1	3	5	7	9	

21 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Flexibility for the coastal communities of Tanzania. In your opinion what is more important the Adapt to live without fishing or Spatial mobility? To what degree you think your choice is important?

2. Adapt to live without fishing										4. Spatial mobility
	9	7	5	3	1	3	5	7	9	

22 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within Flexibility for the coastal communities of Tanzania. In your opinion what is more important the Gear or Spatial mobility? To what degree you think your choice is important?

3. Gear										4. Spatial mobility
	9	7	5	3	1	3	5	7	9	

c) Agency

23 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Agency for the coastal communities of Tanzania. In your opinion what is more important the Perceived capacity to change or Recognition of causality? To what degree you think your choice is important?

1. Perceived capacity to change										2. Recognition of causality
	9	7	5	3	1	3	5	7	9	

24 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Agency for the coastal communities of Tanzania. In your opinion what is more important the Perceived capacity to change or Level of participation? To what degree you think your choice is important?

1. Perceived capacity to change											3. Level of participation
	9	7	5	3	1	3	5	7	9		

25 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Agency for the coastal communities of Tanzania. In your opinion what is more important the Recognition of causality or Level of participation? To what degree you think your choice is important?

2. Recognition of causality											3. Level of participation
	9	7	5	3	1	3	5	7	9		

c) Organization

26 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Organization for the coastal communities of Tanzania. In your opinion what is more important the Trust in organizations or Community cohesion? To what degree you think your choice is important?

1. Trust in organizations											2. Community cohesion
	9	7	5	3	1	3	5	7	9		

27 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Organization for the coastal communities of Tanzania. In your opinion what is more important the Trust in organizations or Linking Social capital? To what degree you think your choice is important?

1. Trust in organizations											3. Linking Social capital
	9	7	5	3	1	3	5	7	9		

28 Within the different domains there are different indicators that will contribute to the overall Adaptive capacity. For example, within the Organization for the coastal communities of Tanzania. In your opinion what is more important the Community cohesion or Linking Social capital? To what degree you think your choice is important?

2. Community cohesion											3. Linking Social capital
	9	7	5	3	1	3	5	7	9		

Appendix 3. MACMON scoring method.

Dimension	Domain	Indicator	Method	Explanation	Scoring method
Sensitivity	Livelihood	Employment Status	Q9; Q17	This is the employment of the family leader, If the employment is sensitive to climate change, this indicator should be considered zero	For Q9 consider Unemployed = 2. Employed in climate sensitive job = 1 Employed = 0. Standardize
		Percentage of catch from fishing sold	Q26	This indicator measures the ability of local communities of getting money from fisheries and how much are they dependent on the marine resources?	For Q26 consider the Percentage of catch sold.
		Percentage of income from the main activity	Q14a	If the income of people comes from the same source it becomes more sensitive	For Q14a consider the Percentage of income from the main activity.
		Time conducting the activity	Q15a;	The family becomes more sensitive if they depend on marine vulnerable resources and they develop only the same activity for a long time	For Q15a consider Less than one year = 1, less sensitive; 1-5 years =2; 6-10 years = 3; 11-20 years = 4; 21-30 years = 5; More than 30 years = 6, highly sensitive. Standardize
	Demographic	Gender (categorical)	Q3	The gender of the family leader. Female leaded families are considered sensitive	For Q3 consider Female =1; Male = 0
		Years of Living In the village	Q7	The time spent in the village might limit the willingness to move to another place, if necessary, thus making them more sensitive to climate change.	For Q7 consider Less than one year = 1, less sensitive 1-5 years = 2; 6-10 years = 3; 11-20 years = 4; 21-30 years = 5; More than 30 years = 6, highly sensitive. Standardize
		Percentage of children in the family members	Q8	If the percentage of children is higher the family becomes more sensible. Children, considering age below 18 years	For Q8 consider the Percentage of children in the household

Dimension	Domain	Indicator	Method	Explanation	Scoring method
		Family dependency	Q12a and Q8	This indicator evaluates the ability to sustain the family if one family member becomes unavailable	For Q12a consider the number of household members employed For Q8 consider the total number of household members Then the Percentage of household members employed $(100\% - X)$
	Cultural	Appreciation of biodiversity	Q77 and Q78	Understanding and appreciation of biodiversity, including associated cultural habits, might reduce the sensitivity of the ecosystem and community by increasing the willingness to participate in the protection of the ecosystems.	For Q77, Consider the Likert Scale, where: I don't understand the question = 5, highly sensitive. My actions have a significant effect on biodiversity = 1, low sensitivity For Q78 Yes = 0, low sensitivity. No = 1, highly sensitive; Then take the standardized average of Q77 and Q78.
		Identity and pride	Q78b and Q19	Feeling pride of the land and resources increase the willingness to participate in the protection of ecosystem and climate change adaptation actions	Yes = 0, low sensitivity. No = 1, highly sensitive;
		Appreciation of lifestyle	Q79; Q47	When the villagers appreciate their lifestyle, they are most likely to participate in actions to protect the environment and adapt actions	For Q79 consider the Likert Scale, where: Very bad = 5, highly sensitive; Very good = 1, low sensitivity For Q47 consider Yes = 1, high sensitivity; No = 0, low sensitivity. Then take the standardized average of Q79 and Q47

Dimension	Domain	Indicator	Method	Explanation	Scoring method
Adaptation capacity	Health	Age	Q1	The age to be considered here is the age of the family leader. If the respondent is the family leader representative, the age of the family leader should be the one to be registered.	For Q1 consider ordinal numbers; Then standardize
		Food security and wellbeing	Q40, Q41, Q42, Q43 and (Q26)	Nutritional dependency is evaluated based on access to food	For Q40, Q41 and Q42 Consider Don't know = 2, Yes =1; highly sensitive and No = 0, not sensitive. For Q43, consider once = 4, highly sensitive and Over 3 times = 0 not sensitive. For Q26 consider the Percentage of catch consumed. Then take the standardized average of Q40, Q41, Q42, Q43 and Q26
		Sense of place	Q49	The wellness to move from the current village to another place gives the person a sense of home, and this makes it difficult to move to another place when required. This effect is comparable with special mobility	For Q49 consider Very sad = 1, low sensitivity; Sad = 2, Neither happy nor sad = 3, Happy = 4 and Very happy = 5, Highly sensitive. Then standardize
	Learning	Level of education	Q3	The education to be considered is the family leader's. A highly educated family leader has a high adaptive capacity.	For Q3 consider a Likert scale where; Class 7 or less = 1, Secondary school - level certificate = 2, A-level certificate = 3, Tertiary = 4 and University and above = 5. Standardize
		Knowledge of rules	Q32	This indicator evaluates if there are rules regarding and if these rules are known (1) Places where people are not	For each item, consider No one = 5, knowledge and implementation of the rule, high adaptive capacity; and Don't

Dimension	Domain	Indicator	Method	Explanation	Scoring method
				supposed to fish, (2) Certain fishing gears that people are not supposed to use, (3) Certain times that people are not supposed to fish, (4) Certain species or types of fish that people are not supposed to catch. If the rules are either not established or known, this will result in low adaptive capacity	know = 0 not knowing the rules, even if there are available low adaptive capacity. Then take the standardize average of each item in Q32
		Access to information	Q68 Q70 and Q73a	Access to information on climate change, adaptation measures, and early warning increases the adaptive capacity of the community	For Q68; Yes = 1, high adaptive capacity; No = 0 Low adaptive capacity; For Q70 and 73a (Not worried and very limited) = 1, low adaptive capacity; (Very worried and very good) = 5, high adaptive capacity. Then take a standardized average of Q68 Q70 and Q73a.
Assets		Material style of life	Q45	Having the assets means high adaptive capacity and not having them means low adaptive capacity	For Q45 consider Yes = 1, high adaptive capacity; No = 0, low adaptive capacity; PCA (principal component analysis).
		Community Infrastructures	Q46c	The community infrastructures such as hospitals, schools, and coastal protection infrastructures determine high adaptive capacity	For Q46c consider Very good = 5, high adaptive capacity; Very bad = 1, low adaptive capacity. Then standardize
		Access to credits	Q51	Access to credits reveals the high adaptive capacity	For Q51 consider No =0, low adaptive capacity; Yes = 1, high adaptive capacity

Dimension	Domain	Indicator	Method	Explanation	Scoring method
	Flexibility	Livelihood multiplicity	Q17	The respondent selects the livelihood options within the list in the Household questionnaire. The high number of options indicates a high adaptive capacity	For Q17 consider the ratio of the Number of livelihood options selected to the total number of livelihood options
		Adapt to live without fishing	Q19	This indicator evaluates the ability to live if fishing in the area becomes unsustainable activity. This indicator is relevant for Tanzania as a coastal country where people are depending greatly on fishing.	For Q19 consider the Likert scale, where Strongly disagree = 1, Highly sensitive and Strongly agree = 5, low sensitivity. Then standardize
		Gear	Q22	This evaluates the possibility of catching marine resources, thus making the respondents able to adapt in case of changes in the fishing methods caused by the reduction of resources availability.	For Q22 consider the Percentage of fishing gear options
		Spatial mobility	Q49	Responding to the question “Supposing that for some reason you were moving away from your current village, how would you feel about leaving?” reveals the willingness to move if required to leave in other areas.	For Q49 consider Very sad = 1, low adaptive capacity; Very happy = 5, high adaptive capacity; Then standardize

Dimension	Domain	Indicator	Method	Explanation	Scoring method
Agency		Perceived capacity to change	Q65	Responding to the question “People like me have influence on the management of marine resources” reveals the capacity to initiate changes if required for sustainable management of marine resources.	For Q65 consider Strongly disagree = 1; low adaptive capacity and Strongly agree = 5, high adaptive capacity. Then standardize
		Recognition of causality	Q60 to Q63	Recognition of management affecting the availability and quality of marine resources represents high adaptive capacity because enables the community on willing to participate in the management.	For Q60, Q61, Q62 and Q63 consider the Likert scale where; (Much better, A lot more, Much easier, and A lot more reliable respectively) = 5, high adaptive capacity; (Much worse, A lot less, much harder and A lot less reliable respectively) = 1, low adaptive capacity. Then take a standardized average of Q60, Q61, Q62, and Q63
		Level of participation	Q64a), Q64b), Q66 and Q67	This indicator measures the involvement of the community in different aspects of marine resources management.	For Q64a, 64b consider the Likert scale where; (Not at all and Not involved respectively) =1, low adaptive capacity; (Very often and Highly involved (in leadership) respectively) = 5, high adaptive capacity For Q66 consider the Likert scale where Very unfair = 1, low adaptive capacity Very fair, = 5 high adaptive capacity For Q67 consider No conflict = 7 and Don’t know = 1. Then take a standardized average of Q64a, Q64b, Q66, and Q67
Organization		Trust in organization	Q31	This indicator measures how much the community trusts	For each item, consider Not at all = 1, showing non-trust in the

Dimension	Domain	Indicator	Method	Explanation	Scoring method
				the organizations, which include, other people in the village, village leaders, marine resources management, NGOs, and government	organizations, low adaptive capacity; and Trust all = 5, showing trust in the organizations, high adaptive capacity. Then take a standardized average of each item in Q32
		Community cohesion	Q67	The occurrence of conflicts among the community members demonstrated less social cohesion and lower adaptive capacity	For Q65 consider No conflict = 7, demonstrates high community cohesion, high adaptive capacity; Don't know = 1 demonstrates low community cohesion, low adaptive capacity. Then standardize
		Linking Social capital	Q33a, Q74, Q75 and Q76	The availability to help each other in every circumstance demonstrated the linking social capital and higher adaptive capacity Information on the taxes paid to ensure that the community argue for the intended support from the government. Well structured, taxes can be used to build adaptive capacity	For Q33a, Q74, Q75 and Q76 consider Yes = 1, high adaptive capacity; No = 0, low adaptive capacity

