November 2023

CLIMATE ACTION NETWORK TANZANIA

BASELINE REPORT

Aligning Climate Resilience, Sustainable Development, and Poverty Reduction






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This baseline report was developed in scope of a project funded by Bread for the World

[ALIGNING CLIMATE RESILIENCE, SUSTAINABLE DEVELOPMENT, AND POVERTY REDUCTION (PHASE III)]

ACKNOWLEDGEMENT

The completion of this baseline report was made possible by several individuals, organizations, institutions, and partners of Climate Action Network Tanzania (CAN Tanzania) who had valuable contributions and support throughout the baseline study activity. It is not easy to mention all but we extend our gratitude to everyone involved in the development of this useful report.

We acknowledge the financial support provided by Bread for the World (BftW) who is an important partner in advancing climate action initiatives aimed at combating poverty and addressing climate change. Their substantial support has played a crucial role in enhancing climate resilience and advocating for renewable energy to foster sustainable development in the United Republic of Tanzania.

Finally, we would like to extend our appreciation to the District Executive Director's offices in Bagamoyo, Chalinze, Lushoto, and Pangani districts for their full support and cooperation. Additionally, we express our gratitude to the communities of Kidomole (Bagamoyo), Mazizi (Chalinze), Dule (Lushoto), Mivumoni and Msaraza (Pangani) villages along with their leadership, for their crucial role in the success of baseline study. Their collaboration and valuable insights greatly facilitated the data collection process, contributing to a comprehensive understanding of local vulnerabilities to the impacts of climate change and promoting community involvement in developing climate resilience strategies.

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EXECUTIVE SUMMARY

Climate change hazards like floods, drought, storms, landslides, and saltwater intrusion impact the livelihoods of smallholders (farmers, pastoralists, and fisher folks) in Tanzania. Weather and Climate Information Services (WCIS) increase the climate resilience of communities if stakeholders are involved in production, packaging, and disseminating the services. This baseline study aimed at establishing the baseline information on Knowledge, Attitude and Practice (KAP) on climate change, available climate services and participation of gender in planning and decision making while implementing livelihood activities.

The study was conducted in Tanzania, specifically targeting four villages: Mazizi, Dule, Msaraza and Mivumoni. These villages are situated in the District Councils of Chalinze, Lushoto and Pangani respectively. Additionally, a rapid assessment was conducted in former villages of Kihangaiko, Mwangoi and Ushongo, originating from the same District Councils, along with the inclusion of Kidomole village from Bagamoyo District Council. Data were collected from 9 Key Informants, 4 group discussants and 32 community representatives. Data were, analysed, interpreted, and discussed to generate informative report. The finding of this study supports the initiatives to align climate resilience, sustainable development, and poverty reduction in Tanzania.

The predominant livelihood activities identified in the study are diverse across the various villages. In Kidomole village, located in Bagamoyo, rain-fed farming and animal husbandry emerged as the primary sources of income. Meanwhile in Mazizi village, situated in Chalinze DC, the resident practice combination of animal husbandry involving mixed animals and rain fed farming. Moving on to Msaraza and Mivumoni village in the Pangani district, the primary livelihood activities include petty business, rain-fed farming, and fishing. In Dule village within the Lushoto DC a mixed of rain-fed farming, animal husbandry and Irrigation farming is observed. Notably, gender dynamics at family level play an inclusive role in both rainfed and irrigation farming sectors. Men, women, and youths join efforts to work on farming especially during rainy season in search for family food and income for recurrent expenses. Despite this collective effort, it is noteworthy that women have shown high participation across all family livelihood activity as compared to men and youth who often specialized in specific activity.

Communities from the study areas are aware of climate related phenomena ranging from uncertain

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irregular rainfall patterns, inconsistent rainfall distribution and disasters that directly affect livelihoods and food security. In addition to the above impacts, Pangani where project village found along the Pangani river estuary had been experiencing additional climate change challenges including sea level raise that cause inundation of farm filed and cause infertility of the soil, intrusion of salt water into freshwater aquifers and increased sea surface temperature and thus increased heat waves.

Despite the knowledge of climate change threats, response practices are less effective to address the growing climate change challenges due to competition for water resources among farmers and pastoralists, farming along water sources, deforestation for illegal forest resources including charcoal business and poor technology in livelihood practices. The malpractices are accelerating low land productivity that raise worry and alarm for food insecurity.

Climate services are regarded as the aid for decision making among small holder farmers, fishers, and pastoralists. The study confirmed the availability of regional coverage weather information from Tanzania Meteorological Authority (TMA) and Indigenous Knowledge (IK) based weather information at village level. However, other decision-making processes and tools concerning production information, pests and disease management were rarely available. The only available information was cropping information in Mazizi village while other villages relied on extension workers visits. Scientific and IK based weather sources are not integrated into area specific and thus less reliable for accurate climate services packaging and dissemination. The information dissemination medias such as radio and televisions are common in project villages. At district levels, there were published weather information, but it seems complex for community the officers to understand. There is a need for developing a national interpretation guideline for weather information forecasts released from the TMA.

The study provides comprehensive recommendations aimed at enhancing climate resilience in Tanzania through multi-stakeholder engagement.

Recommendations for Ministry, Departments and Agencies:

1) Invest in the Tanzania Meteorological Authority (TMA) to enhance data collection and interpretation, improving forecast accuracy.
2) Establish mechanisms for integrating scientific and traditional weather forecasts, involving collaboration with local authorities and communities for downscaling.

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3) Utilize SMS and local radios for climate service dissemination, requiring cooperation with government, telecom companies, and local radio channels for effective outreach.

Recommendations for Local Government:

1) Support the preservation of traditional weather forecasting knowledge and facilitate transparent information flow between communities and district leadership.
2) Enhance the capacity of District and Ward Extension Officers to assist smallholder farmers in interpreting weather information and provide tailored advisory services.

Recommendations for Communities:

1) Take initiatives to preserve natural water sources essential for irrigation, collaborating with local authorities and development partners for sustainability.
2) Develop comprehensive, community-led adaptation plans to address climate change effects, involving participatory risk assessments and collaboration with civil society organizations.

Recommendations for Development Stakeholders such as NGOs:

1) Promote and facilitate the co-production, dissemination, and utilization of climate services within communities, alongside building community capacity for implementing climate advisory services.
2) Advocate and support the transformation of smallholder farming, livestock keeping, and fishing towards a business-led approach to enhance resilience and development.

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ABBREVIATIONS/ACRONYMS

BftW	Bread for the World
CAN Tanzania	Climate Action Network Tanzania
CIS	Climate Information Services
CSA	Climate Smart Agriculture
CSO	Civil Society Organization
DC	District Council
FGD	Focus Group Discussions
SPSS	Statistical Package for Social Sciences
IK	Indigenous Knowledge
IPCC	International panel for Climate Change
KII	Key Informant Interviews
LGA	Local Government Authorities
NFCS	National Framework for Climate Services
SMS	Short Message Services
WCIS	Weather and Climate Information Services
TMA	Tanzania Meteorological Authority
TV	Television Set
UNFCCC	United Nations Framework Convention on Climate Change
WEO	Ward Executive Officer

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CHAPTER 1

1 Introduction

1.1. Background

Climate change stands as one of the prime challenges of our time, transcending borders and impacting communities on a global scale. Sustainable development initiatives need to incorporate climate resilience approaches as a counter measure of contemporary environmental changes that affect poor people in most developing countries including Tanzania. **Aligning Climate Resilience, Sustainable Development, and Poverty Reduction** seeks to contribute to this necessity by navigating the nexus between the impacts of climate change, poverty dynamics, and development needs.

The sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC) indicates that there is more than a 50% chance that global temperature rise will reach or surpass 1.5^0C soon increasing the number of vulnerable groups in developing countries like Tanzania. Every fraction of a degree of global warming intensifies the threats of water stress, heat stress, desertification, biodiversity loss, food insecurity, sea level rises, and floods. Tanzania is already experiencing rising temperatures, longer dry spells, more intense heavy rainfall, and sea level rise, making the country rank as the 26th most vulnerable country to climate risks (Ministry of Finance and Planning, URT, 2023) . The risks associated with the impacts of climate change are already evident in all socio-economic sectors that are essential for Tanzania's livelihood and sustenance, including water resources, energy generation, food security, ecosystems/biodiversity, and human health (URT, 2012). In fact, the impacts of climate change have posed a direct threat to people's survival (Mwanga S. *et al* 2019).

In Tanzania, climate change challenges are already hampering local efforts toward community wellbeing and poverty reduction. On the other hand, poor communities who are relying substantially on natural resources and climate sensitive sectors for a living, notably fisheries, agriculture, and animal husbandry, forestry are increasingly becoming vulnerable to climate change repercussions due to limited options and low adaptation capacity. Among all the groups, women, children and poor old people are the most vulnerable groups.

Climate smart and resilient development pathways have been shown to offer enormous investment opportunities with a triple dividend of avoided losses, positive economic gains, and enhanced social

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and environmental benefits (Global Center on Adaptation, 2023). Climate and weather information services, which give essential climatic data, information, advisory, and expertise to enhance decision-making and action while planning and executing livelihood, are one of the recommended adaption strategies for most smallholders (fish folks, farmers, and pastoralists). The global framework for climate services defines climate service as the provision and use of climate data, information and knowledge to assist decision-making. The utilization of climate and weather information to understand climate risks and vulnerability based on specific context enables identification, prioritize, and implementation of best adaptation actions (United Nations ESCAP, 2020). For instance, well intergrated and downscaled climate services can reduce vulnerabilities caused due to climate change and prolonged drought. Climate services should be co-developed, co-delivered and used in many different ways, based on differing needs and capabilities.

Climate Action Network Tanzania (CAN Tanzania) has been actively advocating for and promoting increased access to and adoption of climate services. Employing an approach centred on co-production, co-packaging, and co-dissemination, the organization engages various stakeholders in integrating Indigenous Knowledge (IK) on weather forecasts and scientific weather forecasting. This integration aims to create downscaled(location-specific) climate services that have multiple benefits to end users.

Under the Aligning Climate Resilience, Sustainable Development, and Poverty Reduction in Tanzania (Phase II) project, spanning from September 2020 to August 2023, the organization implemented diverse interventions supporting climate services. The collaboration between CAN Tanzania, extension officers, the Tanzania Meteorological Authority (TMA), researchers, and Civil Society Organizations (CSOs) facilitated the generation of advisory messages disseminated through an SMS portal and other channels. The web-based SMS portal allows end users to provide feedback through a question and answer (Q&A) section. The positive outcomes from these successful pilot initiatives were observed in distinct villages, namely Ushongo in Pangani district, Mwangoi in Lushoto, Kihangaiko in Chalinze, and Kidomole in Bagamoyo. The local populations have begun benefiting from this program by utilising provided weather and seasonal forecasts to inform livelihood options. Scaling up and replicating these successful interventions together with integrating climate services into local government plans and budget, is crucial for sustainability, ownership, and alignment with the National Framework for Climate Services (NFCS). Consequently, the project is now implementing

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the next phase, expanding to new villages within the project districts. As an integral part of this phase, a comprehensive baseline study was conducted across the new villages namely Mivumoni and Msaraza in Pangani district, Dule in Lushoto district, and Mazizi in Chalinze district. This study aimed to evaluate and establish baseline data on climate service access, knowledge, and utilization, providing essential information to advance the project's objectives.

1.1 Geographical Descriptions of the Target Districts

1.1.1. Chalinze District

Chalinze district council is one of the administrative districts of Coastal Region in Tanzania. The district covers an area of 8,042 km2 (3,105 sq mi). The council has split from the Bagamoyo District Council and was officially announced in Government Gazette No. 301 of 2015. This council officially began its operations in July 2016. Chalinze District is bordered to the northeast by Pangani District, the north by Handeni District and in Kilindi District of Tanga Region. The district is bordered to the east by the Indian Ocean. Chalinze also borders Bagamoyo District, Kibaha Urban District and to the South by Kibaha District. On the western part, the district is bordered by Mvomero District and Morogoro Rural District of Morogoro Region.

The district main socio-economic activities are animal husbandry, agriculture, tourism, petty business, pebble crushing and fishing. According to the 2022 National Census, Chalinze has a total population of 316,759, of which 158,087 are men and 158,672 are women. Chalinze accommodates 84,216 households with an average of 3.8 people per household (National Bureau of Statistics, 2023). The major tribes in the district are Kwere, Doe, Zigua and Zaramo although currently there is a significant influx of Masaaa and Mangati people within the district. The district falls within the "Aw" subtype of the Koppen Climate Classification, indicating a Tropical Savanna climate. The annual mean temperature stands at 78.4°F (25.8°C). February registers the highest average temperature at 82.0°F (27.8°C), while July marks the lowest at 74.3°F (23.5°C). The yearly precipitation averages 37.5 inches (952.5 mm), with April receiving the highest rainfall at an average of 8.0 inches (203.2 mm). In contrast, July experiences the least precipitation, with an average of 0.6 inches (15.2 mm). On average, there are 108.0 days with precipitation annually, with April having the highest count of 16.3 days and June the lowest.

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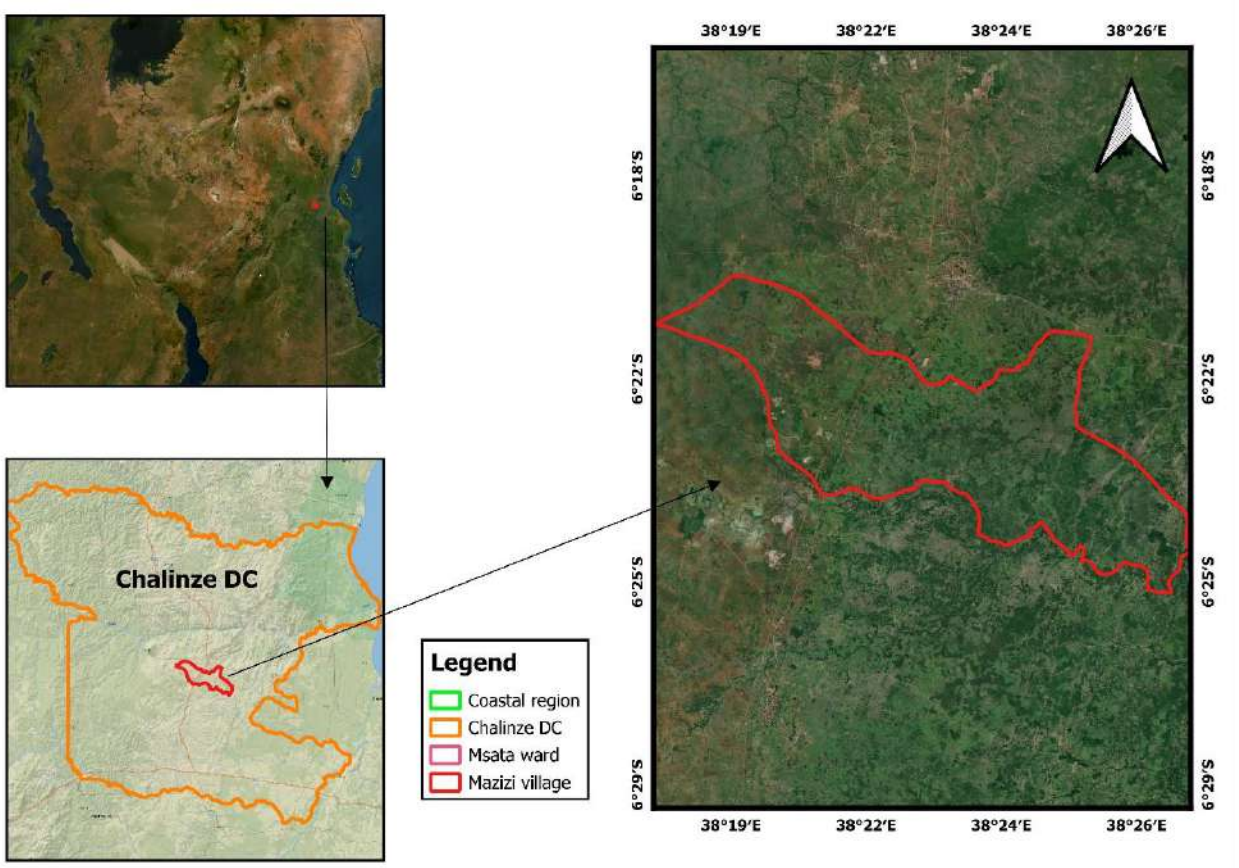

Figure 1:Study Area in Chalinze District Council

1.1.2. Lushoto District

Located in the Usambara Mountains, within the Northern part of Tanga Region, Lushoto District covers an expanse of 2,300km^2 and constitutes about 8.41 percent of Tanga Region. Lushoto is not only distinguished by its lush landscapes and biodiversity but is also home to a population of 350,958, with 160,815 males and 190,143 females residing in 85,149 households, each averaging 4.1 members (National Bureau of Statistics, 2023). The native tribe in the area are Sambaa, Zigua, Mbugu and Pare. The main socio-economic activities in the district are agriculture mostly horticulture, animal husbandry, tourism and forestry products.

Lushoto district receives bimodal rain patterns with the highlands getting an average of 800-2000mm rainfall per annum and lowlands getting about 500-800 mm per year from October to December and long rains s from March to June with the heaviest period of long rains in April.

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The climate in Lushoto is humid and mostly cloudy during the wet season, and mostly clear during the dry season7. Over the year, the temperature typically varies from 50°F to 78°F and is rarely below 47°F or above 82°F7.

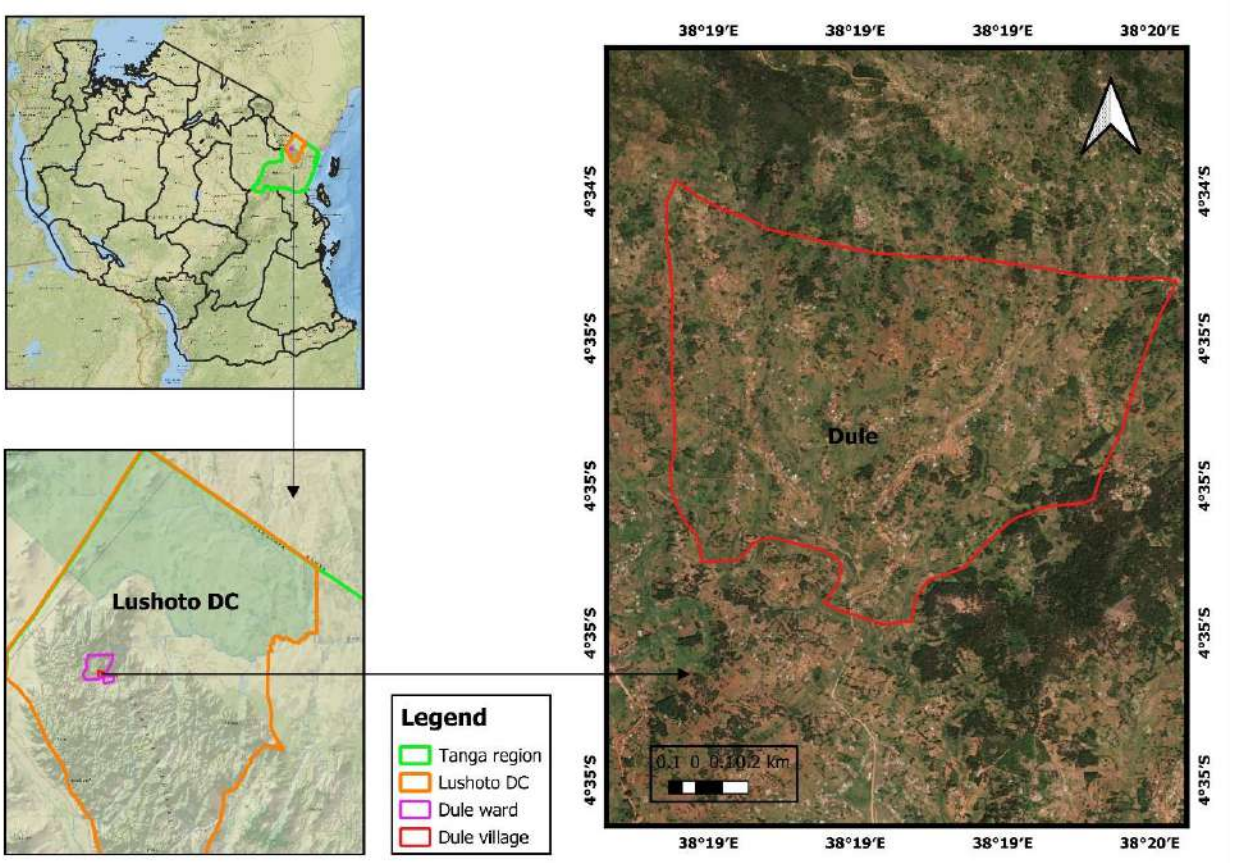

Figure 2:Study Area in Lushoto District Council

1.1.3. Pangani District

Pangani is one of Tanzania's few districts on the Indian Ocean's northern shore, with important socio-economic activities including fishing, farming (commercial and food crops), animal husbandry (indoor and migration practices), tourism, and other petty businesses. Pangani is home to the major native tribes of Bondei and Zigua, as well as a few digo and other settlers from across the country, including Swahili, Makonde, Bena, Pare, Chaga, Arabs, and Indians. The district has recently been invaded by a large group of pastoralists from the Datooga tribe, also known as Mang'ati in Swahili, who are agro-pastoral nomadic Nilotic-speaking people from the Karatu, Manyara, and Singida regions.

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Located at the mouth of the Pangani River, Pangani District is highly challenged with climate change impacts such as shift of rainfall patterns and water scarcity. Climate change impacts challenges the district's population of 75,642 people; comprising of 38,203 males and 37,439 females across 20,254 households with an average size of 3.7 members. (National Bureau of Statistics, 2023). The district's sources of income highly depend on climate sensitive sectors such as crop farming and fisheries, thus jeopardizing both livelihoods and the state food security at household level.

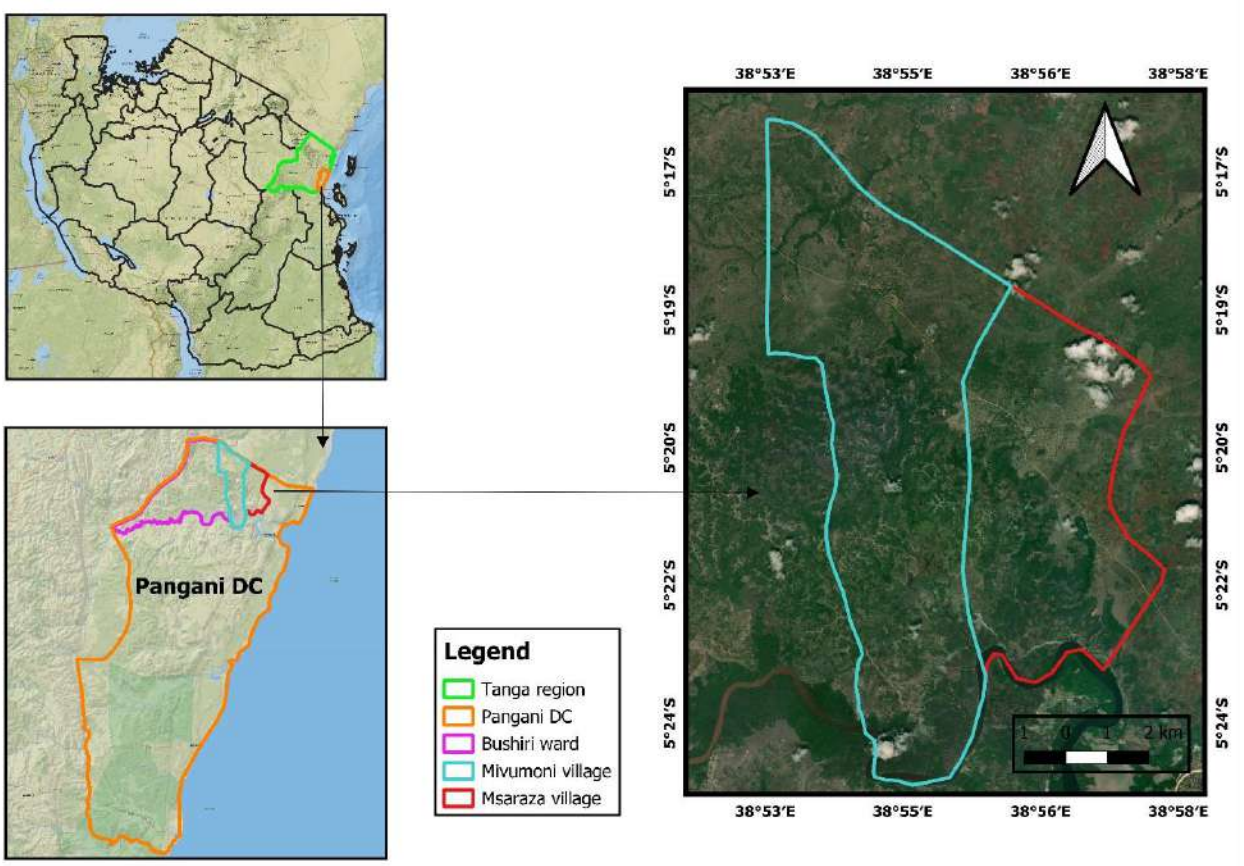

Figure 3:Study Area in Pangani District Council

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CHAPTER 2

2 Methodology

2.1 Study objective.

This study had a broad objective to collect, analyse, and report information about project objectives and indicators as a benchmark to inform project interventions. Aspects of knowledge, attitudes, and practice (KAP) will be recorded during this baseline survey. The information from the study will be the reference and benchmark to inform project interventions that lead to reaching project objectives and indicators The study had the following four specific objectives to be achieved:

a) Assess the major socio-economic and livelihood activities undertaken in the study areas. Understanding of livelihoods shall give an opportunity to design area specific and livelihood specific climate services.
b) Assess the community's awareness of the impacts of climate change affecting their livelihood productivity and adaptation measures taken. The findings from the study will be referred by the network members and partners in integrating of climate change adaptation initiatives in their activities.
c) Assess the current knowledge, attitude, and practices of the community on livelihoods and climate services. The assessment shall document the benchmarks information before implementation of the project. The study will use the initial situation to set target indicators, improve activities approaches and develop the appropriate monitoring framework.
d) Compare and contrast the community's preferences between modern scientific climate services and the traditional services.
e) Analyze gender participation in livelihood planning and decision making. The study intends to explore the causes and effects of gender equalities/inequalities in households and communities.

2.2 Study Methodology

2.2.1 Sampling

A random sampling was conducted whereby to ensure a true representative sample from the project beneficiaries, the survey listed down sub villages which make each project village. The number and names of sub villages were confirmed by the village council members during the Key Informant

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Interviews (KII). Random sampling of households was applied to select community m embers for interview. Each enumerator moved with one sub village leader to ensure that household members are not repeated during the interviews.

2.2.2 Sample size.

The baseline survey was conducted in four newly selected project villages across different districts. These include, Mivumoni and Msaraza in Pangani district, Dule in Lushoto district, and Mazizi in Chalinze district. Since the number of people in each village is assumed to be 2,000, the study assumed the number of mature heads of households to be 1,000. The study therefore decided to abide by 5% of the target population per village. The number of reached community members was 379 though it was above the target sample size.

2.2.3 Data Collection Methods and Tools

From 5th to 9th October 2023, CAN Tanzania team visited 3 districts for data collection activity in the identified four villages of the project implementation. The baseline data collection effectively utilized a mixed method of data collection where both qualitative and quantitative techniques methods were thoroughly used to collect primary and secondary data.

Primary data collection used a triangulation approach to ensure data validity and reliability. Household surveys were conducted using questionnaires to collect information on livelihood activities, climate change effects, available adaptation strategies, available weather information and climate services.

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Plate 1: Household surveys between CAN Tanzania staff and heads of households.

presents a list of the villages that were involved in the study from the three target districts and participants distribution.

Table 1: Number of households reached during the survey.

SN	District Council	Village	Number of Housholds reached
1.	Chalinze	Mazizi	89
2.	Lushoto	Dule	115
3.	Pangani	Mivumoni	92
		Msaraza	83
	Total		**379**

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Key Informant Interviews (KII) were conducted to District Officers from the Department of Agriculture, Livestock and Fisheries to determine the effectiveness of processes during packaging and dissemination of downscaled climate services. A total of 9 key informants were reached and interviewed during this study.

Focus Group Discussions were conducted, whereby each village had 1 discussion group with an average of 8 community members and 1 district officer. To ensure inclusivity and comprehensive representation, , the group participants were deliberately chosen to include representatives from various segment of the community. This encompassed members from women's groups, youth group, socio-economic group, village leadership, ward leadership, elders, people with disability, and government officials.

Focus Group Discussions (FGDs) were undertaken to facilitate cross-verification of information pertaining to the community. Additionally, these sessions provided a platform for the exploration of sensitive topics that might be challenging for individuals to address alone. Such discussions delved into matters encompassing culture, beliefs, gender dynamics, and their intricate interplay with resource utilization and management, ultimately contributing to climate vulnerability.

Plate 2: The Focus Group Discussion during data collection exercise in Pangani District

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The secondary data was collected through literature review to build understanding of the project context and discussion of baseline findings. In-depth literature reviews on the related topic were made to inform the understanding of the situation in the project sites, topic and discuss the findings. Data were collected from various sources including district's reports, academia, and other online sources for recent studies.

In addition to, Key Informant Interviews and Focus Group Discussion the study team also spent time in the field to undertake physical observation on household resources, key livelihood activities, kinds of climate services, IK indicators and current adaptation strategies. This undertaking helped the study team to better understand the socio-cultural, practices, socio-economic and ecological dimensions of the actual situation on the ground upon triangulation of the various data sets collected.

The team used an Open Data Kit (ODK) i.e. n online data collection tool to cover all questions that had been prior prepared based on the objectives of the study. The ODK tool helped to simplify the interview process by using smart phones and/or tablets that linked with server through organizing questions and responses which were automatically synchronized with the server in the office.

2.2.4 Data Analysis and Presentation

Due to the nature of data collected from the field, various tools of data analysis were used accordingly. Both quantitative and qualitative data were collected in this baseline study. Quantitative data, the IBM Statistical Package for Social Sciences 24 (IBM SPSS 24) was used to analyse these data as well as excel. In this software, several computations between variables were deployed through descriptive statistics and associations between variables which are likely to influence each other.

The output from Key Interviews, physical observations and Focus Group Discussions were thematically analysed and interpreted with reference to the project baseline information required. For qualitative data analysis, conceptualization, reflections, reflexivity, examining relationships of issues and authentication of conclusions were made for an informed baseline report.

2.3 Stakeholders' Inputs and Validation Workshop

To ensure and maintain quality standards, a stakeholders validation meeting was conducted in each of the four districts as part of the quality check and quality assurance process. Preliminary findings were

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presented to the stakeholders for feedback and more inputs to the final document. The feedback helps reduce the possibility of being biased with the document, misinterpretation and misunderstanding of the document. To ensure that the findings reach all relevant stakeholders' representatives from the designated study villages in Bagamoyo, Chalinze, Pangani and Lushoto Districts participated in validation workshop. The involved stakeholders encompass representatives from Local Government Authority (LGAs), extension workers, local researchers, Civil Society Organizations (CSOs) and the media personnel.

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CHAPTER 3

3 Study Findings

3.1 Pangani District

3.1.1 Household Status

The survey participants were from different age groups and genders ensuring gender considerations and representations as seen in Figure 4.

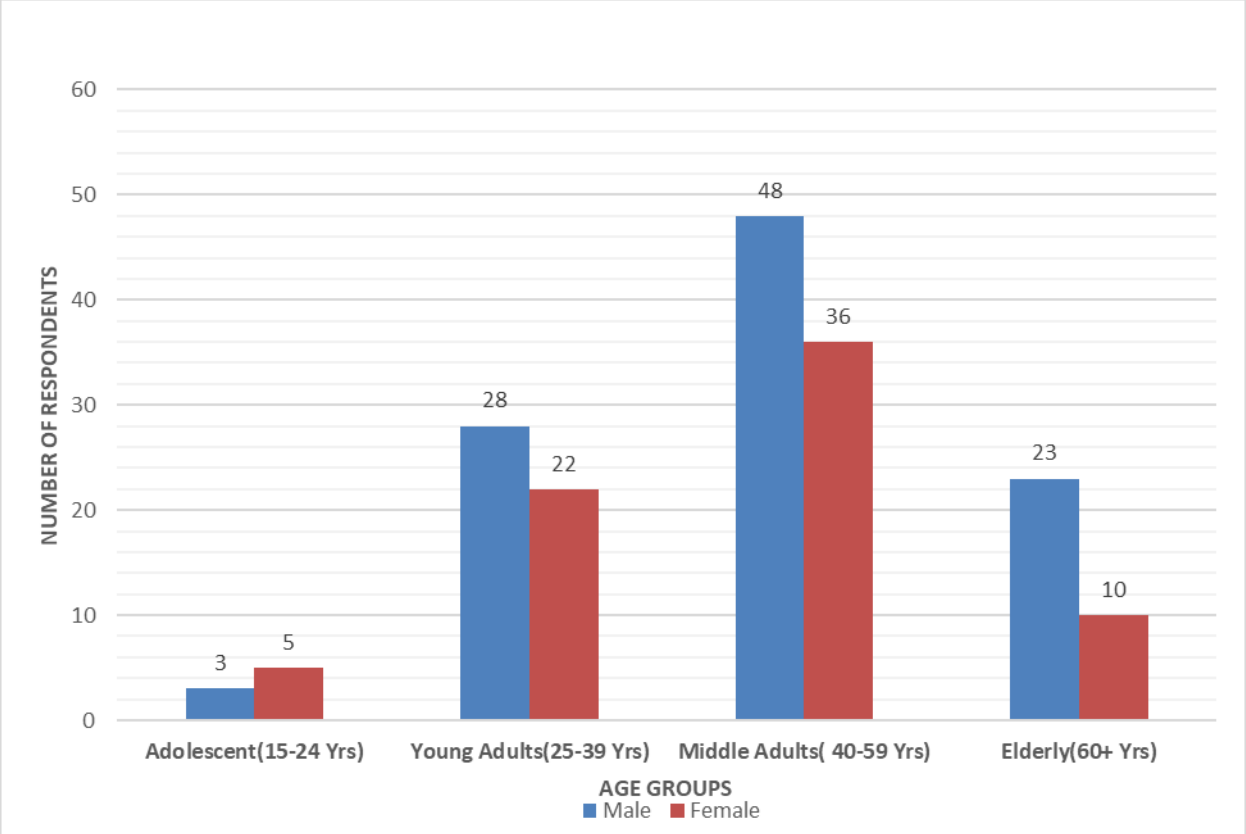

Figure 4: Participants distribution by age and sex.

80% of the respondents were male headed with the remaining 20% being female headed. Among them 75.34% of respondents are married and live together whereby heads of households are men. There were also several divorces, never-married couples, polygamy, and single parents, contributing to the observed 19% female-headed households as seen in Figure 5.

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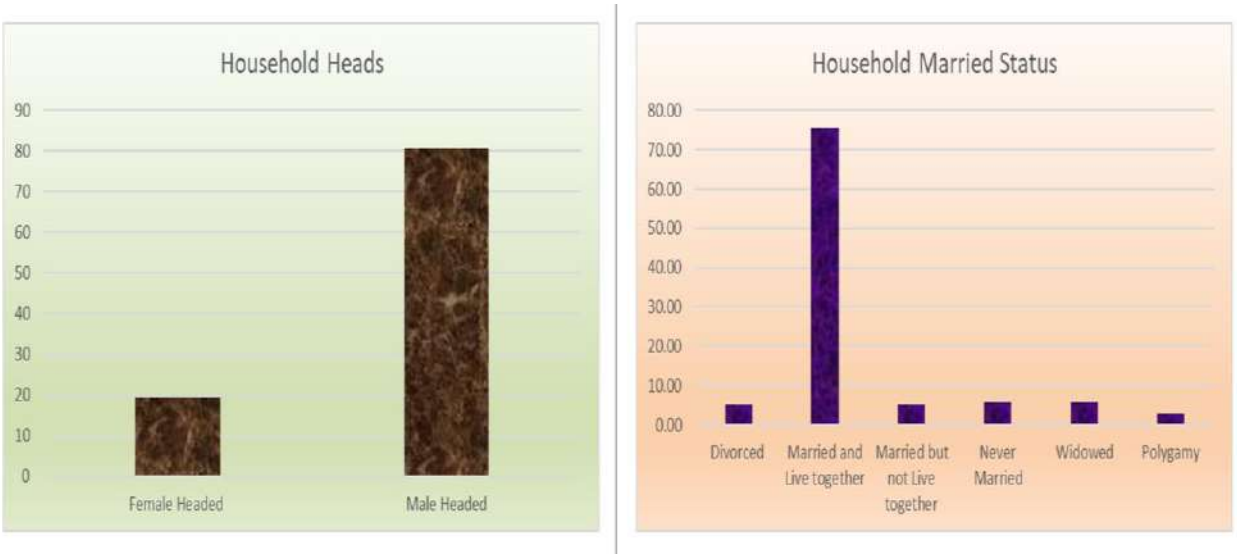

Figure 5: Household head status in the study.

The majority of households that were studied had 3 to 4 and 5 to 6 members, which collectively accounted for 73% of the total, while 17% of the households had more than 7 members, and the remaining 11% had 1 to 2 members as seen in Figure 6. The average household size was 4.2 people, with a standard deviation of 1.9. In terms of dependents, 46.10% of households had 1-3 dependents, 24.82% had 4-6 dependents, and 5.67% had 7 or more dependents. Additionally, 23.40% of the interviewed households did not provide information about their dependents. With regards to their education level, 73% had primary school education, with secondary education accounting for 14%, university/tertiary education (1%) and the with no formal education accounting for 12%.

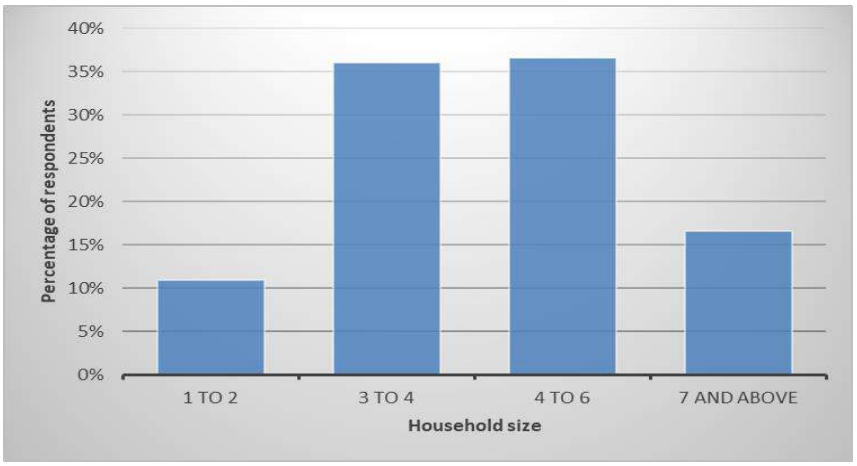

Figure 6: Proportion of respondent's household size.

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3.1.2 Socio-economic and Livelihoods activities

The analysis of livelihoods and socio-economic activities for the villages of Msaraza and Mivumoni revealed some differences and similarities between them. In Mivumoni village, rain-fed farming, animal husbandry, and petty businesses dominate, whereas in Msaraza village, they engage in rain-fed farming, fishery, and petty businesses. Petty businesses includes both product and service providers, such as food vendors, basket makers, casual laborers, salary workers, kiosks, charcoal makers, etc.

In both villages, rain-fed farming is the main livelihood activity, accounting for 41% and 45% in Msaraza and Mivumoni village, respectively. The main crops grown are cassava (Kikombe variety), maize, and simsim. The second most common livelihood activity is the integrated livelihood of rain-fed farming and petty business, accounting for 26% and 20% in Mivumoni and Msaraza village, respectively.

In Msaraza village, this is followed by different combinations of fishery activities with rain-fed farming or petty business and a smaller extent of animal husbandry, as seen in Figure 7. The fishing activities are mainly concentrated within Matakani sub-village, which fishes in Pangani river. Meanwhile, in Mivumoni village, 12% of integrated rain-fed farming with animal husbandry of local beef cows, goats, and sheep species, which are mainly found in sub-villages of Sahanini.

Other livelihood activities are in smaller amounts, as seen within Figure 7 and Figure 8 for Msaraza Village and Mivumoni Village, respectively. Petty businesses play a significant role in both villages as a livelihood activity.

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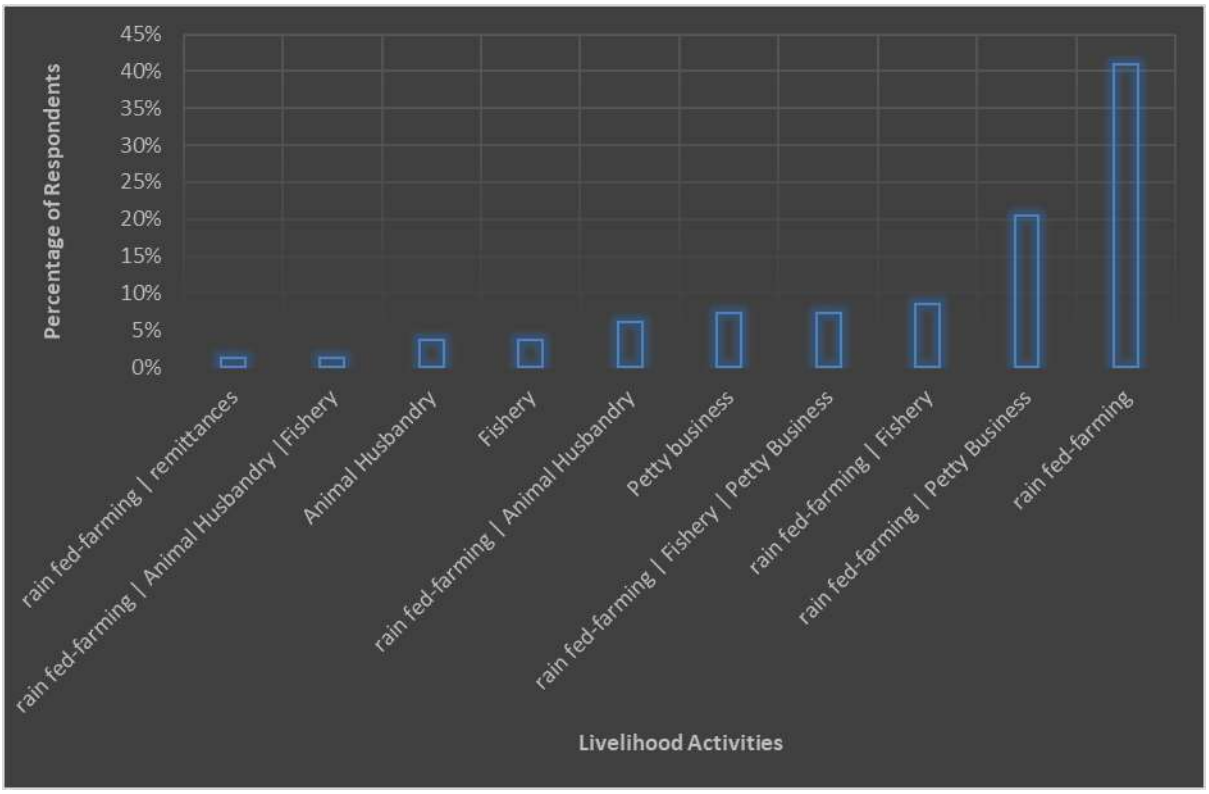

Figure 7: Msaraza Village livelihood activities.

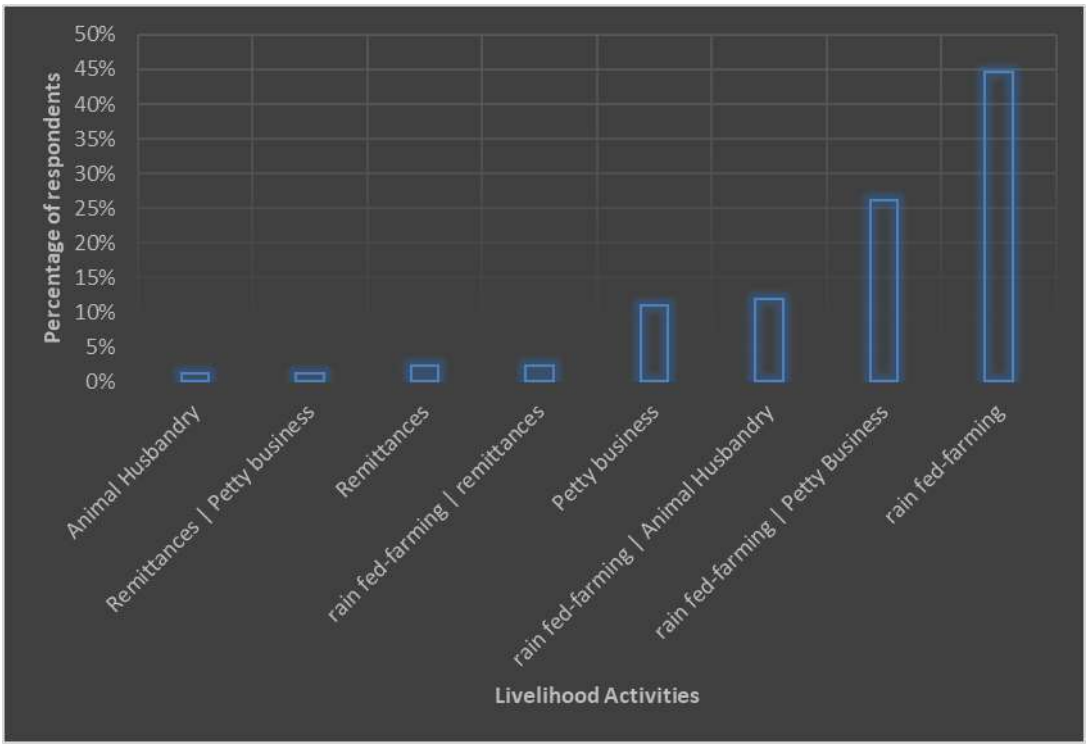

Figure 8: Mivumoni Village livelihood activities.

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Within both villages around 55% of respondents depended on a single livelihood with the remaining having more than 1 livelihood. Those households with single livelihoods activities are subjected to high susceptibility to climate change impacts compared to those households with integrated livelihoods i.e. diversified livelihoods offer a means of not only coping with climate change challenges but also facilitating recovery. This approach provides greater adaptability when compared to relying solely on a single livelihood option. The activities derived from the interviews show the relative distribution of livelihood activities in the study area, which is highly dependent on rain-fed farming practices with integration with other livelihoods, thus indicating a high possibility of livelihood diversification knowledge and options. This was reinforced during the Focus Group Discussion, when diverse livelihoods in the study areas were mentioned, with the majority falling under agriculture, fishery, animal husbandry, and petty business, with the population widely engaged in these livelihoods. Additionally multiple households identified keeping of some poultry mostly less than 10 to for serving the households needs both for food and emergency income.

3.1.3 Gender roles in Socio-Economic and Livelihood Activities

The study analyzed the distribution of responsibilities during undertaking of socio-economic and livelihood activities at household level is presented in Figure 9. The findings show that 45.71% of the interviewed households engage in rain-fed agricultural activities jointly between men and women, with division of labor in the process from farm preparation to seed sowing, weeding, and harvesting. While separately 9.14% and 6.86% men and women engage in farming practices respectively, with 21.14% of all household members, including youth, taking part in the household's rain-fed farming practices as seen in Figure 9.

Meanwhile fishing has been predominately performed by men and petty business by women. Within the FGD it was highlighted women are mostly engaged in processing and selling of fish products meanwhile men are engaged in the fishing/capturing of fish.

Other livelihood activities included fishing (8.57% of respondents), which was primarily performed by men, and petty business (16.57%), which was predominantly done by women. As previously stated, rain-fed farming is a key socio-economic activity in the study area and is thus pursued by most households visited, whereas integrated livelihoods are carried out by specific household members in most interviewed households.

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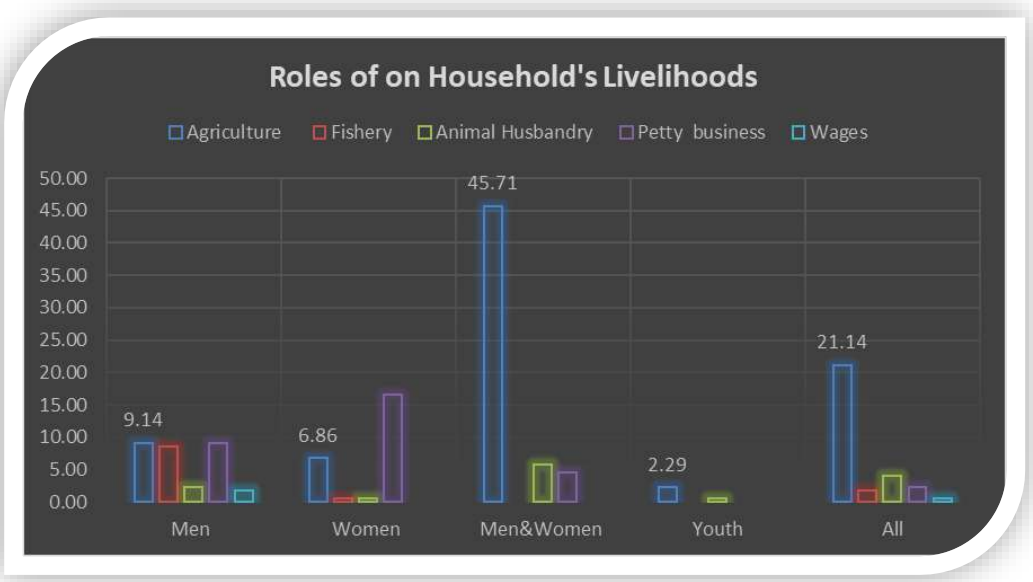

Figure 9: Disaggregation of gender by socio-economic activities.

Households engage in specific livelihoods for a variety of reasons, whether as a primary focus or an integrated or supplementary socio-economic activity. This study delves into the reasons provided by interviewed respondents in the study areas. The investigation unveiled several factors driving this engagement, including, but not limited to 31.43% cited the need for income and food; 30.86% pointed to affordability issues such as subsistence farming requiring capital to undertake and inadequate initial capital that constrains their involvement in alternative livelihoods. 23.43% with the intention to increase income to sustain households' basic needs apart from food which was mostly commonly highlighted for reason in engagement in petty business; 10.86% adhered to their inheritance and cultural practices, particularly notable among pastoralists, who reveal being following their culture and inheritance from their ancestors; and a smaller minority representation 3.43%, indicated their sole motivation for livelihood engagement was the procurement of food as seen in Figure 10. Furthermore, it was highlighted, others keep poultry (less than 10) so as to serve majorly to be sold as emergency fund when needed to support household expenditures.

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Figure 10. Proportion for reason on engagement of Household livelihood.

The findings show that there is a similarity in the trend of livelihood outputs and production of livelihood activities in Mivumoni and Msaraza villages as seen in Figure 11 and Figure 12. Rain-fed farming being the dominate livelihood activities is characterized by a decreasing and fluctuating trend, with Mivumoni village showing a more significant decrease compared to Msaraza. However, there was a small increase in livelihoods identified in Mivumoni village, and this was attributed to the expansion of farming areas among some households.

The livestock rearing activity in Mivumoni village experienced a decreasing trend for those practicing it solely, while those who integrated it with rain-fed farming showed a distribution of 55% decreasing, 36% fluctuating, and 9% increasing trends. Petty businesses were also found to have a more diverse trend, with some (10%) experiencing an increase in salary or income, while others were equally distributed between decreasing and fluctuating.

In Msaraza village, petty businesses had a majority (67%) of fluctuations, while others were distributed between decreasing and increasing trends. Fishery solely experienced a decreasing trend, while those who integrated it with other livelihood activities experienced variation between decreasing, increasing, no difference, or fluctuating trends.

The identified trends were found to be a result of severe climate change challenges, with uncertain weather patterns affecting the primarily climate-sensitive livelihood activities. The participants in the Focus Group Discussion and Key Informant Interview acknowledged the deterioration of livelihoods produced from primary livelihoods because of weather variability and prolonged dry spells from 2016 to 2020. Despite the recent past two years receiving a reasonable amount of

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rainfall in comparison to the previous 4 to 6 years, farming and animal husbandry practices were still impaired.

Furthermore, coconut production within the area was majorly affected by the sea inundation within the farming, causing a decrease in productivity. Additionally, the increase in the number of fisherfolks was identified as a contributing factor towards the decrease in fish catch as a result of over-fishing within the Pangani river.

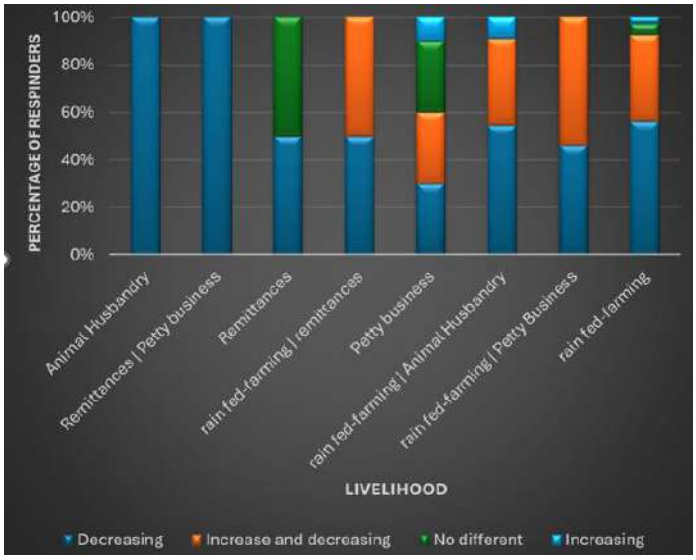

Figure 11:Livelihood Trends in Mivumoni Village

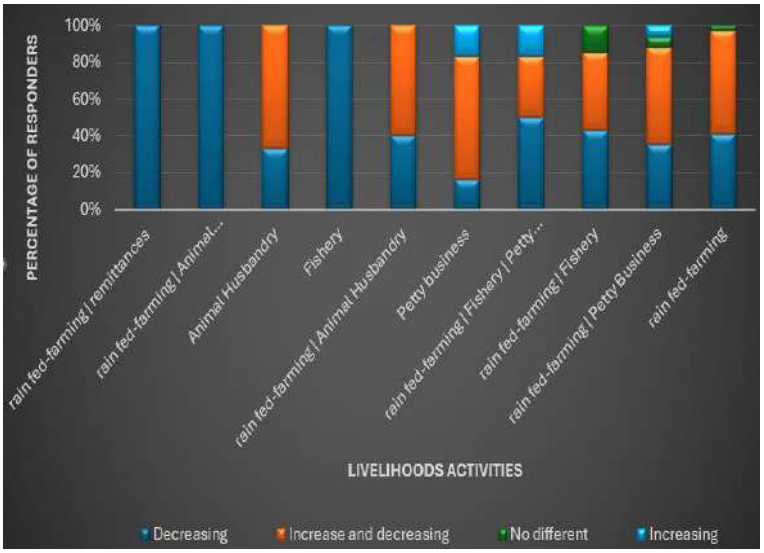

Figure 12:Livelihood Trends in Msaraza Village

Household respondents reported that 37.14% experienced severe effects resulting from the decline in productivity. 57.71% experienced moderate effects, while 0.57% and 4.57% indicated that they experienced a low effect level and no effect, respectively. The negative effects caused by these trends include decreased or lack of pastures for livestock, water scarcity, an increase in diseases and pests, loss of crops, as well as trees of fruits and coconuts. These have led to food insecurity due to insufficient food and the price increase of food, reduction in family income, failure to pay school fees, with severe cases of absconding from school. Additionally, children struggled to support their parents, resulting in a decrease in support provided to elders. It had an overall effect of increasing poverty, food insecurity, and under-development in the community together with increasing the vulnerability to climate change. Conversely, the increase in farm sizes has enabled

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an increase in yields, together with salary increments and an increase in incomes, which are among the positive effects.

3.1.4 Climate Change Awareness and Impact in the community

Pangani District, like other coastal areas, is facing the impact of climate change. The survey's responses found that 93.14% are aware of the changing climate, which has been correlated with frequent experiences and recurrences of climate change-related challenges in the study area as seen in Figure 13. The reported climate-related hazards which are, prolonged droughts, sea level rise, change in rain patter, heat waves, saltwater intrusion into freshwater aquifers, unpredictable sea storms, all of which threaten their livelihoods and wellbeing.

Drought and change in rain pattern have affected the community through drying of crops, pasture lands and water bodies such as river Mcheka causing water scarcity, death of animal and crops, increase of pests, and disease outbreaks thus leading to low agricultural, and livestock yields that aren't sufficient to meet their basic needs such as food and payment of school fees. This contributed to scarcity of food that in turn cause food prices to rise further burdening the community for example maize flour of 24 kg rose from 35,000/= reaching 60,000/=. Furthermore, this has un-motivated farmers following the consecutive losses and un-reliability whereby farmers reduced their farm sizes example one farmer could farm 10-15 acres of maize but currently can only plant 2 acres of maize.

Saltwater intrusion has led to a significant decrease in the productivity of coconut farms. This is due to the detrimental effect of saltwater on coconut trees, causing them to dry out and subsequently reducing the overall yield of the farms. Coconut farming, particularly in the Pangani region, is a major economic activity, often undertaken by community members and investors. These investors have traditionally supported the surrounding communities by allowing them to collect fallen coconuts and coconut leaves. The communities used to sell the fallen coconuts and create woven products such as baskets, providing them with an additional source of income. However, the decline in coconut farm productivity has led to a change in this practice. Farm owners(investors) have started restricting the community from collecting fallen coconuts and have begun selling the coconut leaves. This transition has resulted in some community members to illegally trespassing on the farms, hence caught, and brought to the appropriate authorities(police station) for prosecution on theft charges. The restriction has affected the earning of additional

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income to the community members thus, placing an additional burden on the community, who had previously relied on the generosity of the farm owners for supplementary income especially during hard seasons.

These climate impacts have affected socio-economic and livelihood options in the study area, leading to the general economic underdevelopment of the community in the study area. This in turn affected the trades in the area thus negatively affecting petty business.

The experienced impact varied across households as each narrates the extent to which they were affected. One participant revealed the drying of orange trees led him to loss of his entire 20-acre of orange trees which he had relied upon for his retirement. As a result, he now finds himself compelled to engage in manual labor in his old age. Another one recounted how following the drying of all his farm, she had to steal crops from other farms and from the coconut farms in order to meet their needs and started engaging in charcoal making business that is destructive to the environment.

Rain-fed farming practices are revealed as the major livelihood of the rural population which is more impaired by weather variability in the areas with prolonged droughts (45.71%), eruptions of crops, animals, and human diseases. Climate signpost dimension of the livelihood's trends and effect levels with respect to climate change-related challenges in the study area.

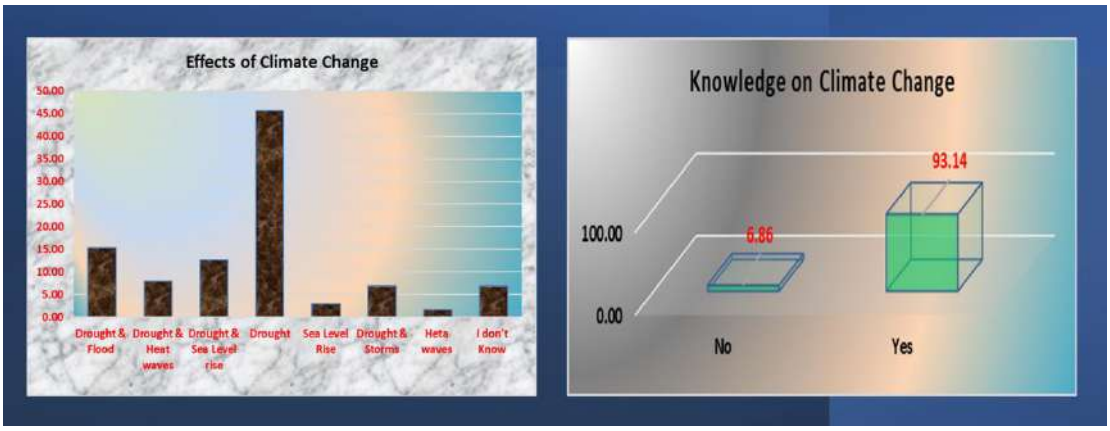

Figure 13:Knowledge of Climate Change and Major Related Challenges

3.1.5 Coping and Adaptation Strategies with Climate Change Impacts

To adapt to the impacts of climate change, communities have adopted various strategies. The frequency by which the adaptation measures are implemented varied. The highest adopted measures included diversification of income by engaging in activities(48%) such as launching petty

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businesses and conducting alternative work such as carpentry and house building. The second highest 22% was undertaking casual temporary employment opportunities such as farming labors, support laborers in millers, sand mining and more. Others have switched to fishing and aquaculture as an alternative, Income generating activity (IGA) with others turning to producing charcoal and firewood while expanding their farming areas to virgin lands, through the cutting down of forests which had a detrimental effect on nearby forests, particularly the Kibubu Village Forest Reserve (VFR) in Mivumoni village causing it to loss more than 50% of its coverage. This was followed by adopting improved farming practices/climate-smart agricultural practices, such as planting short-term and drought-resistant crop varieties, using pesticides. In addition, some community members have migrated with their livestock in search of water and greener pastures mostly heading to Hale where River Ruvu passes through, while other sought alternative income sources in urban areas. Together with accessing water by digging shallow wells and requesting water from different institutions that had water access. Others have cut down on their expenses in various ways, such as reducing the number of meals. However, some community members have chosen to endure the situation, hoping for conditions to improve.

The capacity to cope with and adapt to climate change impact remains a major challenge in the study area, with women and older people being the most vulnerable groups due to socially constructed roles and responsibilities, as well as limited mobility, which limits their exposure to potential and available adaptive options, such as technology and capital.

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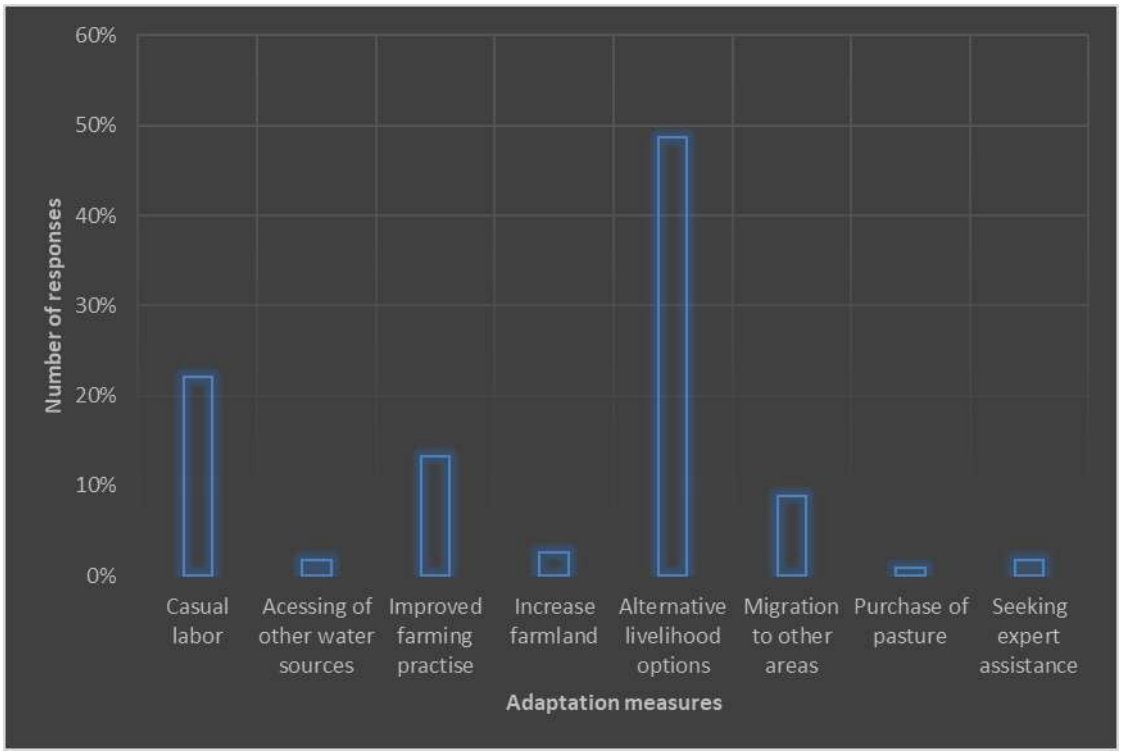

Figure 14: Community adaptation measures.

Apart from the mentioned coping strategies, 49.71% of the respondents claimed of ineffectiveness of the applied coping strategies due to limited options as most of the options are again climate-sensitive so continue experiencing the same challenges. Additionally, the unreliability in availability of casual work and house construction activities coupled with the low pay/salary, did not adequately meet household needs. Older participants also mentioned that they were continuously ageing and, therefore, not able to engage in strength-intensive casual work.

On the other hand, 41.14% of respondents indicated that the coping strategies they applied were effective. The effective strategies were primarily those that diversified livelihood activities. This included integrating small businesses and technical jobs such as carpentry and house building. Some adopted aspects of improved farming practice/climate-smart agriculture, such as the use of drought-resistant crops or migrating in search of pasture and water for animal drinking. Others had additional investments, such as house rentals or savings, which provided them with support, and this was for those households which have a stable labor force with division of labor as indicated in the roles of the household members. *'We do plan and work as a family with diversified livelihoods activity, thus allow us to produce'* said one of the respondents.

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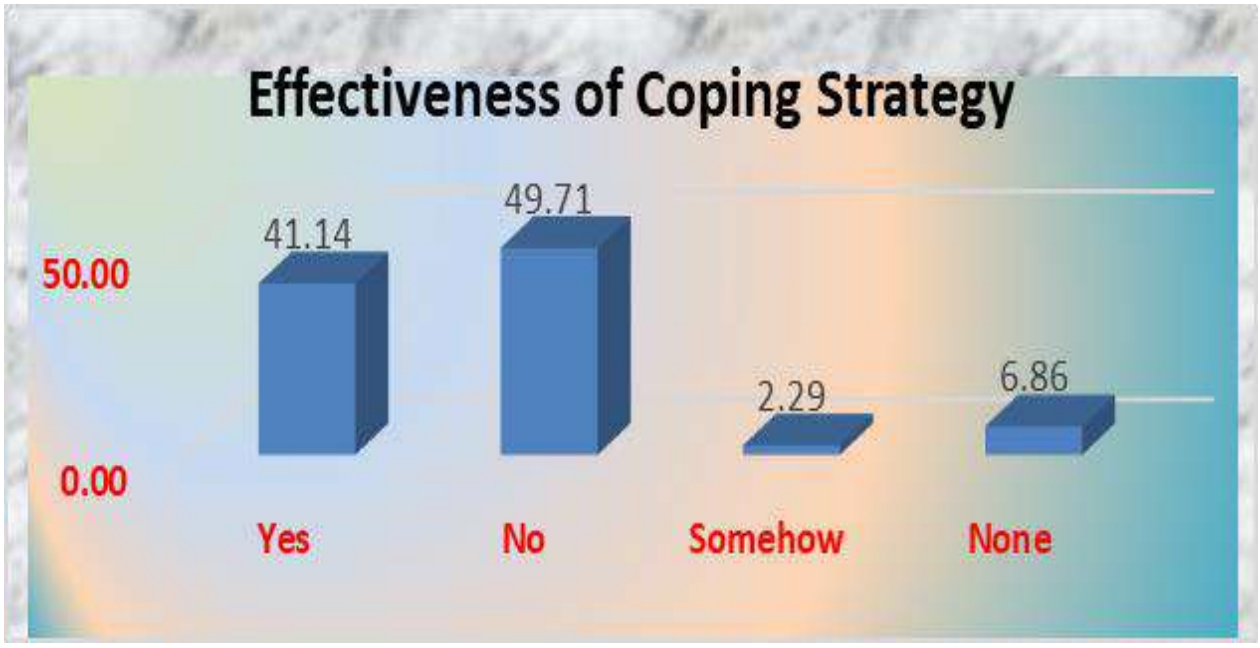

Figure 15 on the effectiveness of available coping strategies to climate change challenges.

The study sought to better understand the alternative coping mechanism that the community think would have assisted but are currently not utilized. The participants identified modern keeping of livestock, growing of vegetables, opening of shops/other business, irrigation farming, fish farming(aquaculture), commercial tree planting, sisal farming and establishing of cattle dip. The identified limiting factors being lack of capital and un-sufficiency of water.

3.1.6 Weather and Climate Services

Weather and/or climate service provides climate information to end-users to assist them in making climate-smart decisions. Some national meteorological services additionally give precise weather information to livelihoods and industries, particularly those involved in transportation and energy, fisheries, and farming. Climate and/or weather services use a collaborative approach to produce, process, package, store, and disseminate weather-related information. This part of the study sought to analyze the state of climate and weather services in the study area in terms of accessibility, sources, usefulness, and reliability which is discussed below.

3.1.6.1 Access and Sources

Temperature, air pressure, cloud formation, wind, humidity, and rain are all weather elements. A slight variation in any of these conditions can result in a different weather pattern. Every weather pattern has a knock-on impact, causing a global ripple effect. The Tanzania Meteorological

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Authority (TMA) oversees conventional weather information in Tanzania, concurrently, some of the local community elders serve as custodians of traditional indigenous weather forecast knowledge within their communities.

The study reveals that 45.22% of the respondents in the study area often have access to weather, with 32.17% and 22.6% sometimes and never received this information, respectively. This information is mostly disseminated daily, decadal, monthly, and seasonally by TMA and majority of the respondent (60.57%) access this information daily to inform decision on their livelihoods planning and executions hence increase their resilience to climate change challenges.

Furthermore, weather information is accessible through an assortment of media, including Television, radio, newspapers, word of mouth during gatherings, and SMS (mobile) as seen in (Figure 17). From the study areas, it has been indicated that weather and climate information are acquired in the following proportions: 57.14% through radio and/or television, 10.86% through word of mouth, 28% through both radio and/or television and word of mouth, and 4% never receive the information at all.

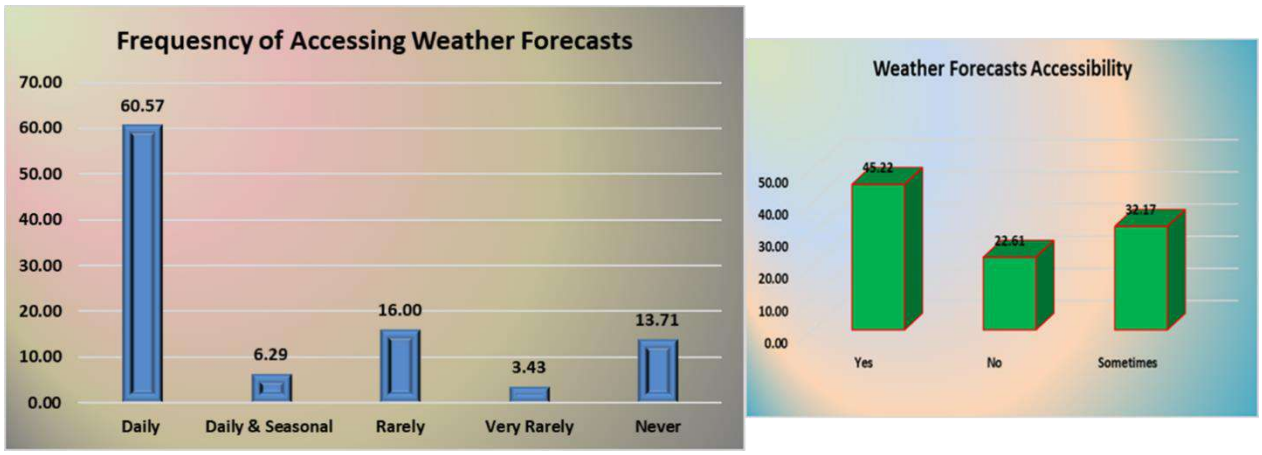

Figure 16: Weather forecasts accessibility and frequency.

The study demonstrated that TMA is the leading source of information of climate and weather services followed by Indigenous knowledge weather forecast. 72% of respondents claimed to get climate and weather forecast information from TMA, 3.41% from the elder (IK), with 8.57% accessing from both TMA and IK and the remaining 16% had no idea about source their climate information.

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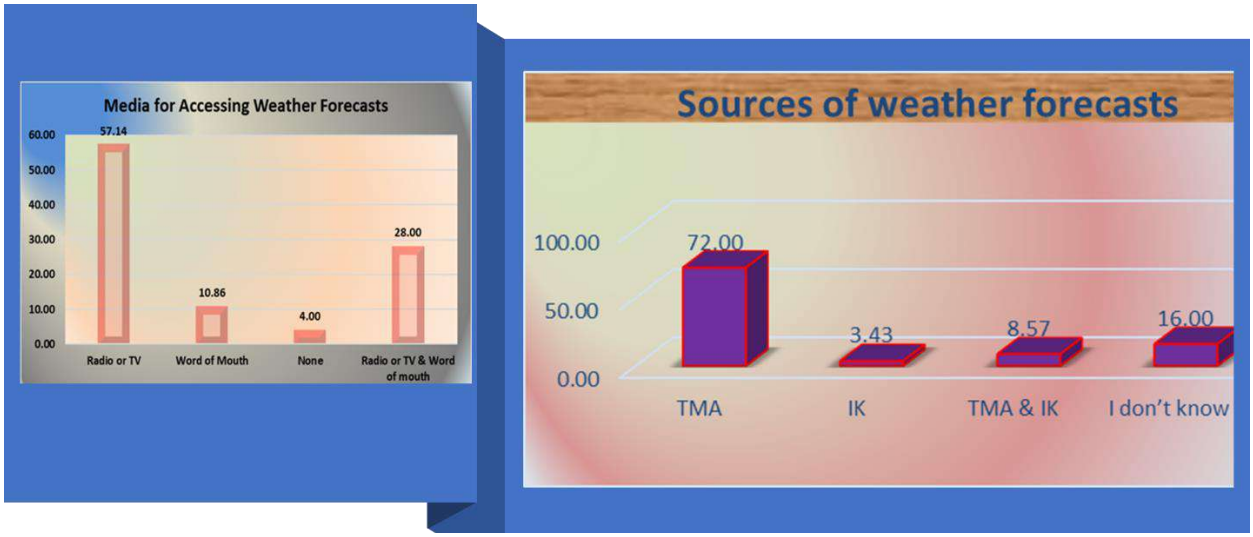

Figure 17: Proportion Source and Means of Acquiring Weather and Climate Information

3.1.6.2 Usefulness and Reliability

Effective and efficient climate information shall ensure the enhanced provision of accurate, reliable, and timely weather and climate-related products and information in an inclusive form during their production, packaging, and dissemination to end-users, while also integrating both conventional and indigenous forecasters. The study showed that conventional climate and weather information from the TMA and those from elders (IK) are useful (42.29%) and highly useful (33.71%) specifically on informing communities´ socio-economic and livelihood activities, with the major one being rain-fed farming practices. With regards to reliability, 82.29% of the total respondents interviewed in this study, affirm the reliability of the shared climate and weather services information from both TMA and IK, while at the same time, 68.57% affirm the contributions of the provided weather information as they had been informing their livelihood decisions during planning and execution (Figure 18).

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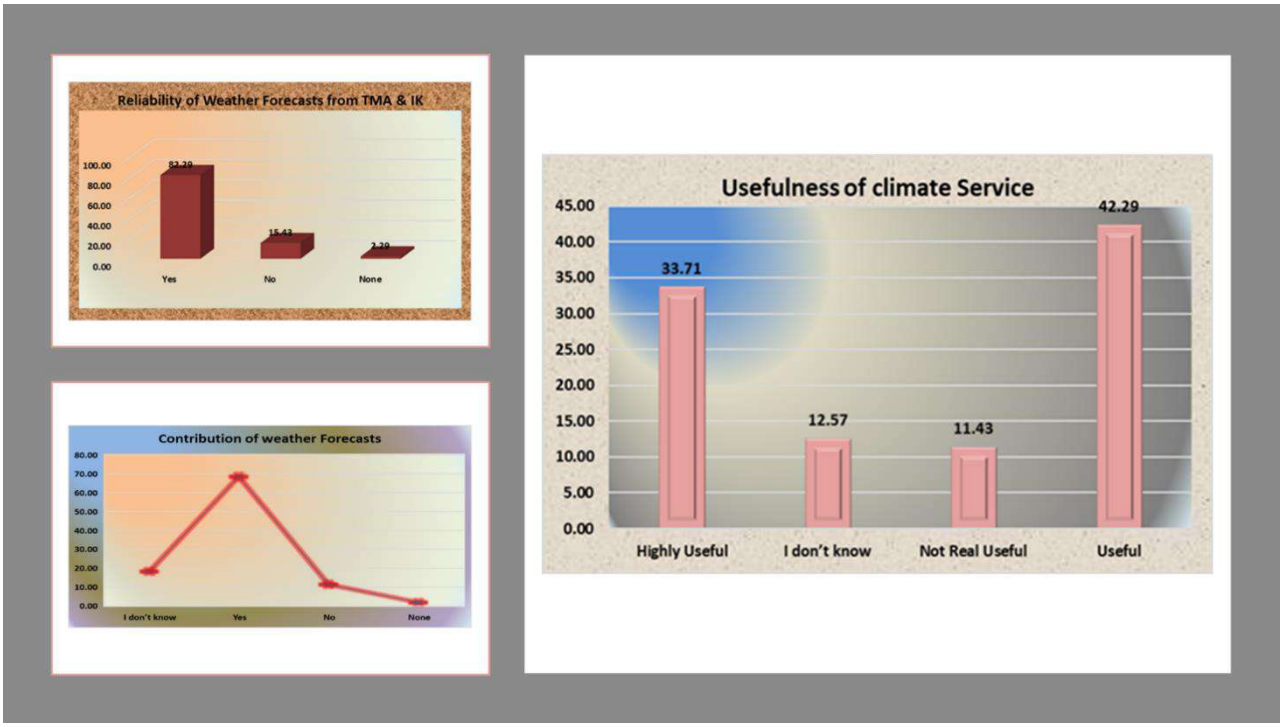

Figure 18: Reliability and Usefulness of Weather and Climate Information from TMA and Elders (IK)

3.1.7 Indigenous Knowledge and Climate

3.1.7.1 Awareness and use of IK on Weather and Climate Forecasts

The study found out that 72.57% of the respondents were aware and found IK to be useful on climate prediction for the informed climate services, while the remaining percent were neither aware on the same as well as never uses them. 47.43% of the respondents reported the usefulness of IK while 24% didn't see the usefulness of IK in informing their livelihoods, with 28.57% not aware. The latter might be attributed to the nature of the households interviewed with their respective livelihoods e.g., petty business or being the representative of the head of the household.

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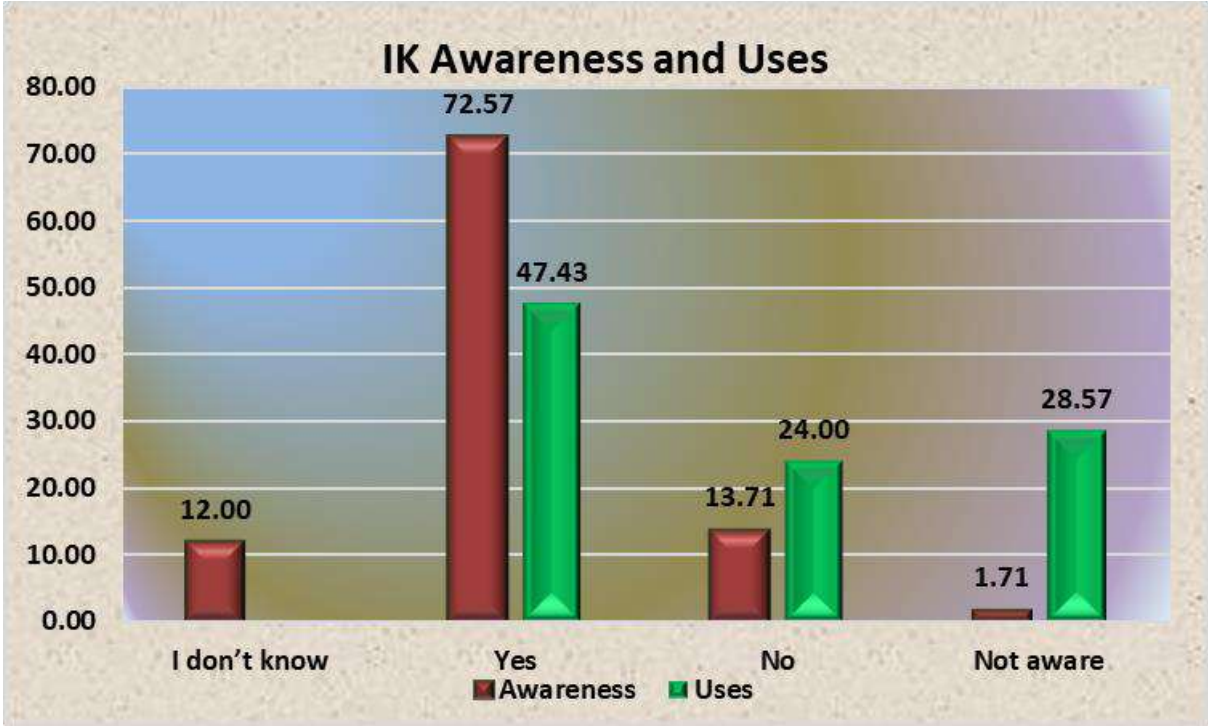

Figure 11. Awareness on Traditional Weather Forecasters and Its Contribution to Local Livelihoods.

3.1.7.2 Sources of IK and Reliability

Accurate, timely, and relevant weather prediction technologies allow communities to anticipate and prepare for future conditions, such as rainfall and drought patterns, as well as minimize the negative impacts and effects of heavy rainfall and prolonged drought, as well as the eruption of crop and animal diseases. However, most of the people in project areas, particularly those in rural areas are unfamiliar with modern weather forecast instruments and techniques. Traditional and Indigenous knowledge is essential for these rural communities to forecast local weather and climate change (Zambomba et al., 2018). Furthermore, these communities have established Indigenous knowledge that assists them in identifying coping techniques for dealing with weather threats such as excessive rainfall and prolonged dry spells.

Indigenous knowledge was based on changes in weather patterns, physical changes in trees (flowering, leaves dropping, etc.), and the behaviors of specific animal species (birds, amphibians, insects, and arthropods). The study found that elders are the primary source of weather and climate forecast information in the study area, particularly for farming, fisheries, and pastoralism activities in the project areas. This is because old individuals , unlike the youth, have witnessed various climate-related events that are linked to key socio-economic activity over time.

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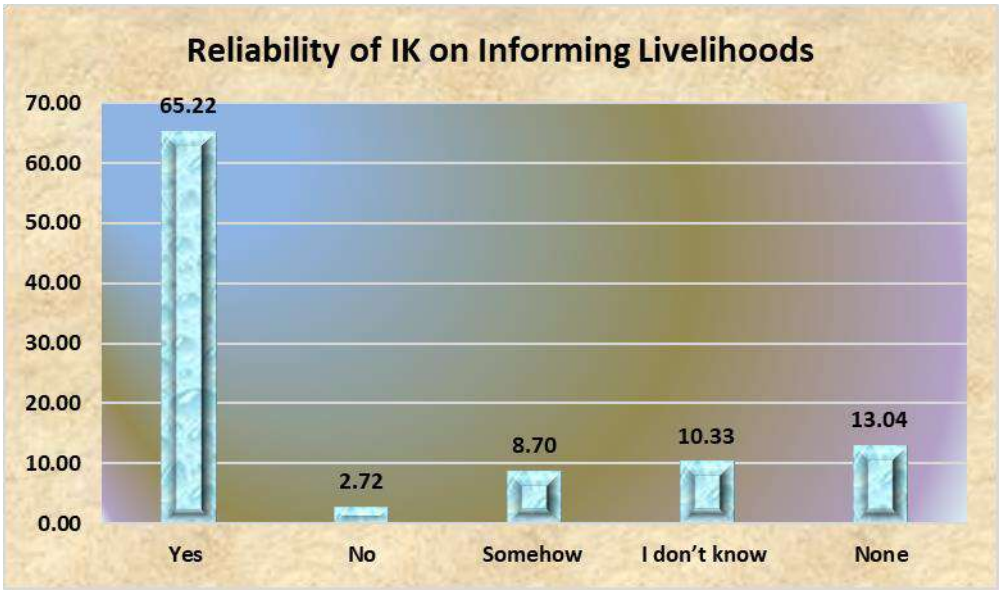

Figure 19: Reliability of IK on informing livelihoods.

It is worth noting that the community perceives the information provided by the IK report on the start and intensity of rains within a given season as reliable (65.22%) and trustworthy for weather and climate prediction in the area, which informs their livelihood planning and execution. Because elders (IK) give timely, realistic, and area-specific information.

3.1.1.1. Indigenous Knowledge Indicators

For an informed understanding, the study sought to document different indicators (signs) that are used by IK on weather and climate prediction. The study found out that birds, insects, animals, wind direction (south and north monsoons), clouds cover, fish coloration, and early flowering of trees are the most common signs (indicators) of IK on climate prediction in the study area. In the study area, animals, plants, birds, moon/sun/winds, and insects ranked high 82.86%, 74.14%, 55.43%, 54.55% and 53.14 % respectively as the most common signs (indicators) used for weather forecasts in the project areas by farmers, fish folks and pastorals (Figure 20).

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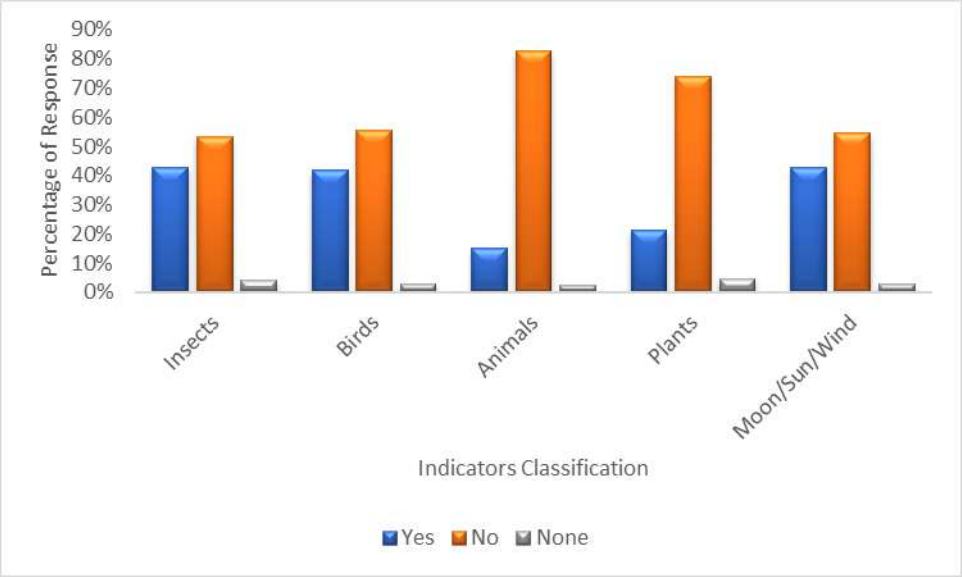

Figure 20: Common Indicators Use for Indigenous Weather and Climate Forecasting

Table 2: Traditional Weather prediction signs and Indicators for fisheries communities in Pangani district

Traditional Knowledge/Indigenous Knowledge indicator	Explanation on weather andseasonal forecasting
Swarm of locusts	**Early warning that indicates a dry or drought year is expected**
The moon rises with a crescent facing up	**Indicates a dry month**
The absence of numerous black swallows	**Absence means there will be no rains**
North winds	**Early warning suggesting a delay in the rainy season**
The calling of birds.	**Signals the onset of a wet summer (plowing) season.**
Frogs making noise (croaking) or their presence in streams	**Signifies rain**
The sighting of numerous black swallows	
Edible ants	

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Playful behavior of cows (especially heifers and bullocks)	**Indicates that rain is very close**
The moon rises with a crescent facing sideways	**Early warning for larger amounts of rainfall**
South and north winds	

3.1.8 Local Government Authority role in weather forecast and climate services.

3.1.8.1 District Engagement in Weather Forecast and Climate Service.

It was highlighted that there were no specific district strategies in place to promote the access and utilization of weather forecasts and climate services to enhance climate adaptability among the community in the district. However, the district is cooperating with other stakeholders such as CAN Tanzania to promote access and utilization of weather forecast and climate service.

Additionally, the district maintains collaborative efforts with the Tanzania Meteorological Agency (TMA) a collaborations that involve monthly collection of rainfall data reported to TMA by the Agriculture department, operation of a rainfall measurement center that shares information with TMA, utilization of TMA forecasts to notify stakeholders, cooperation through CAN Tanzania, and conducting awareness-raising activities for fishermen regarding the use of TMA forecasts in their daily fishing routines.

The informants highlighted available strategies/approaches at the district level in the dissemination of weather forecasts released/shared by TMA to communities and end users included awareness-raising interventions, information sharing by TMA, the establishment of weather forecast stations, and community capacity-building through tree planting and mangrove restoration in government institutions and degraded areas.

3.2 Chalinze District

In the household survey, a total of 89 participants (73% Male and 27% female) were interviewed. The participants were randomly selected while maintaining gender representation and inclusivity as seen in Figure 21. The participants were distributed across different ages and sex groups. 94% of the participants households were male headed with the remaining 6% being female headed. The participants had diverse marital statuses as seen in Figure 23 whereby the majority (82% of participants) were married and living together with their spouses. The average household size in

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the sampled community was 6 which is distributed as shown in Figure 22 with majority found in large family size that is from 5 people onwards. 38% of the household have 1-3 dependents, 33% have 4-6 dependents, 13% have more than 7 dependents and 16% had no dependents within their households.

Regarding the participants education, majority (73%) had primary education, 20% had no formal education, 4% had secondary education and the remaining 2% had either technical education of university level education.

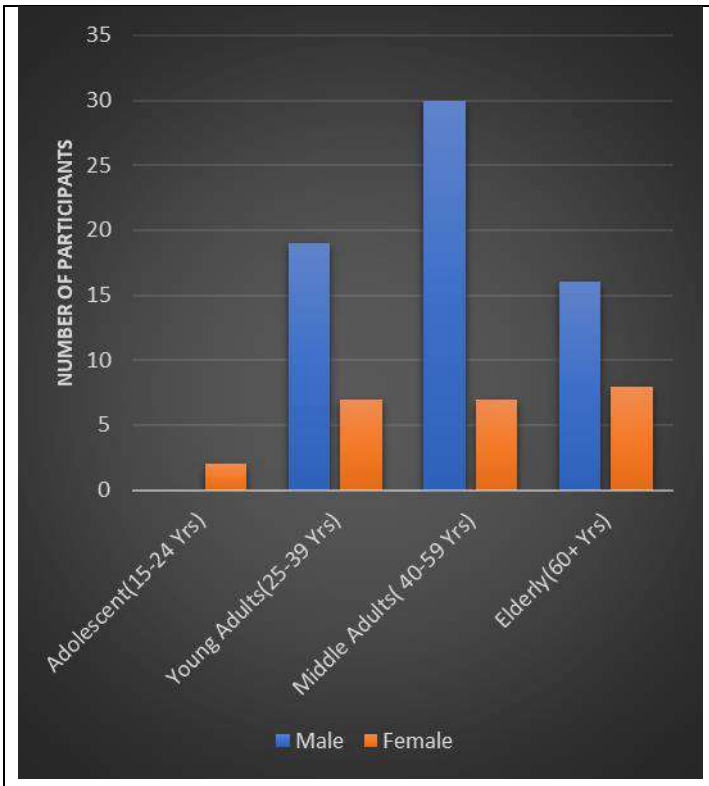

Figure 21: The distribution of study participant by gender and age

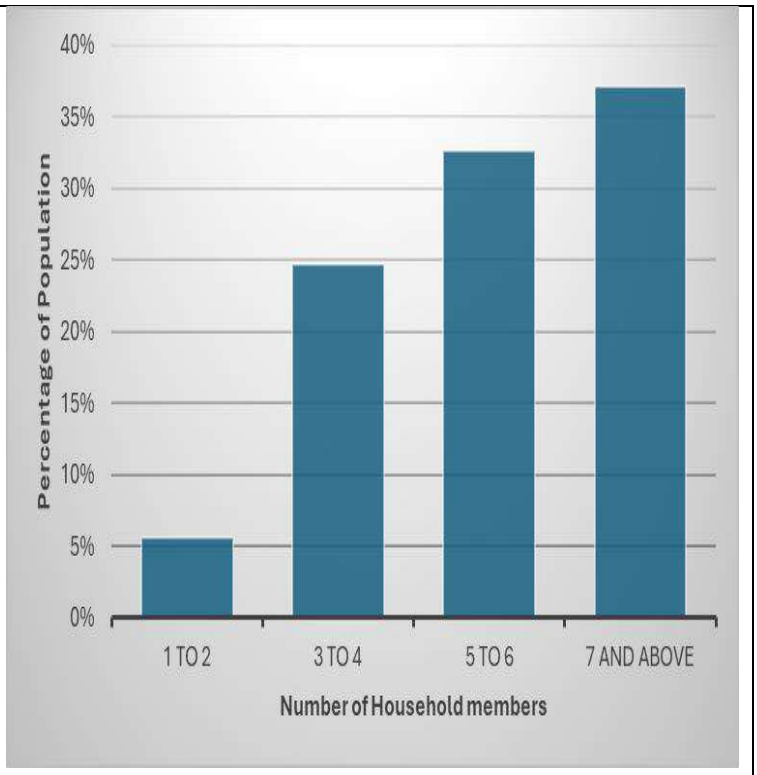

Figure 22: Participants household sizes

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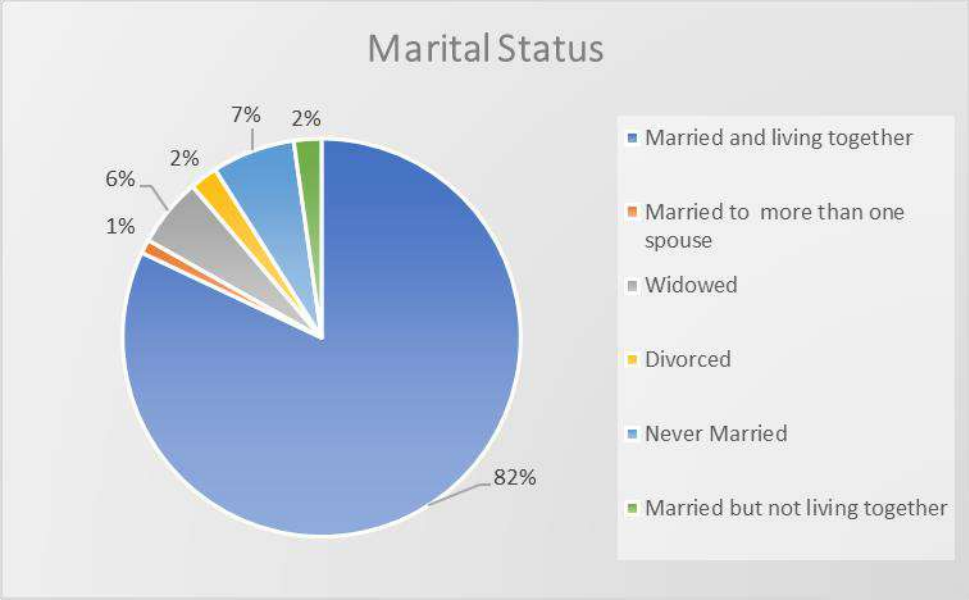

Figure 23: Percentage distribution of Marital Status of participants.

3.2.1 Livelihoods and Socio-economic Activities

The study identified multiple livelihood activities being practiced in Chalinze district within the study area. The major activities were animal husbandry (Cow, Goat, Sheep), petty business and rain fed agriculture whereby the commonly grown crops are maize, potatoes, cassava, millet, cowpea, and sesame. The household survey showed variation in the number of livelihood activities practiced by households within the community. Some of the households only practiced a single livelihood activity meanwhile others have more than one activity. Majority of the participants (49% of the participants) depended on a single livelihood of subsistence rain-fed farming, followed by Subsistence rain-fed farming and petty business (16%), subsistence rain-fed farming and animal husbandry (14%), animal husbandry (9%) only and petty business only (5%), and other options in smaller percentages as seen in Figure 24.

The category of petty business includes food vending related business, kiosks, informal work such as motorcyclist, selling of charcoal/firewood, traders of animal and agricultural goods, Short Term Non-Agricultural Wage Labor (<3 Months), security guard, carpenters, and bus drivers. All these have been categorized into one group in consideration of the nature and size of the conducted business activity being either provision of goods or services in small scale.

To a lesser degree, elderly individuals and housewives relied on internal remittances from their children or husbands to fulfil their necessities. While primarily reliant on remittances, they also

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participated in supplementary livelihood activities to augment their income mostly being rain fed agriculture or petty business.

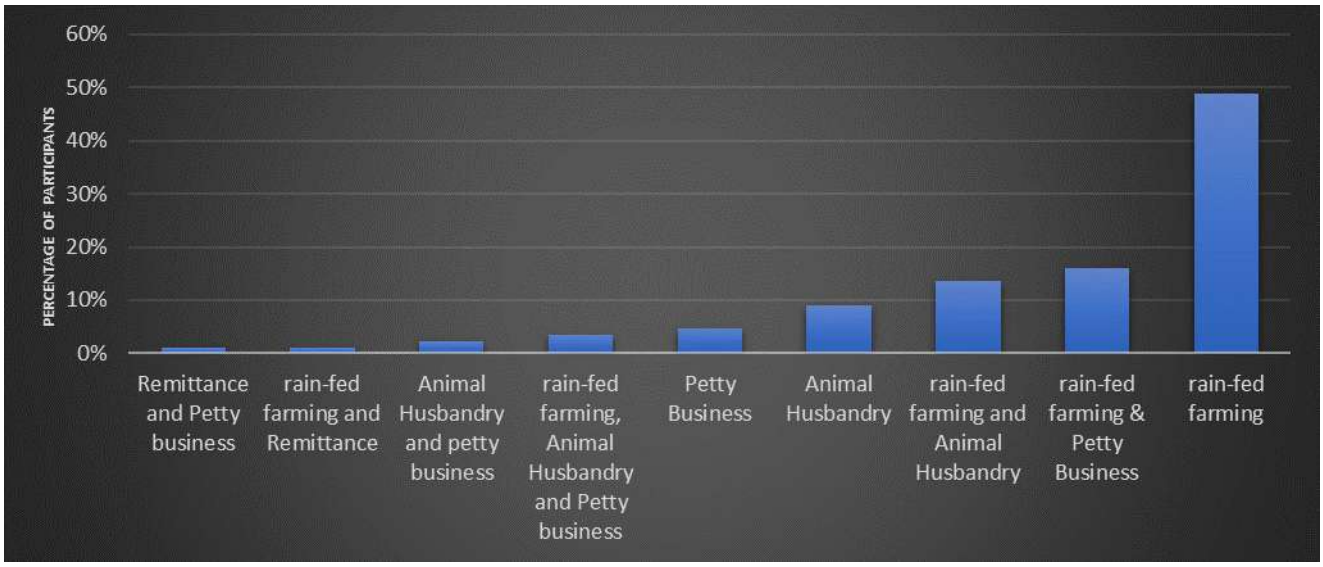

Figure 24: Distribution of livelihood activities undertaken by participants households.

3.2.2 Gender Participation in Socio-Economic and Livelihood Activities

The study analysed the distribution of responsibilities during undertaking of socio-economic and livelihood activities at household level is presented in Figure 25. The study shows agriculture is mainly undertaken by both men and women collaboratively or together with involvement of youths in the households. It has been shown across all the activities there is none that is led by youth, which was attributed to many youths (children of the households) being engaged in schools thus provide only supportive role.

Furthermore, animal husbandry to a larger extent has been dominated as a men activity accounting to 40% and undertaken collaborative by men and women including youth. This has been associated with the Maasai culture whereby men have a greater role to play in the management of livestock while women engage in milking together with tendering to livestock that cannot walk in search of pasture such as calf and sick one. Whereas salary-based employment has been fully dominated by men in the interviewed households. Finally, the distribution of small-scale businesses is nearly equal between men and women, with a smaller percentage involved in cooperative management.

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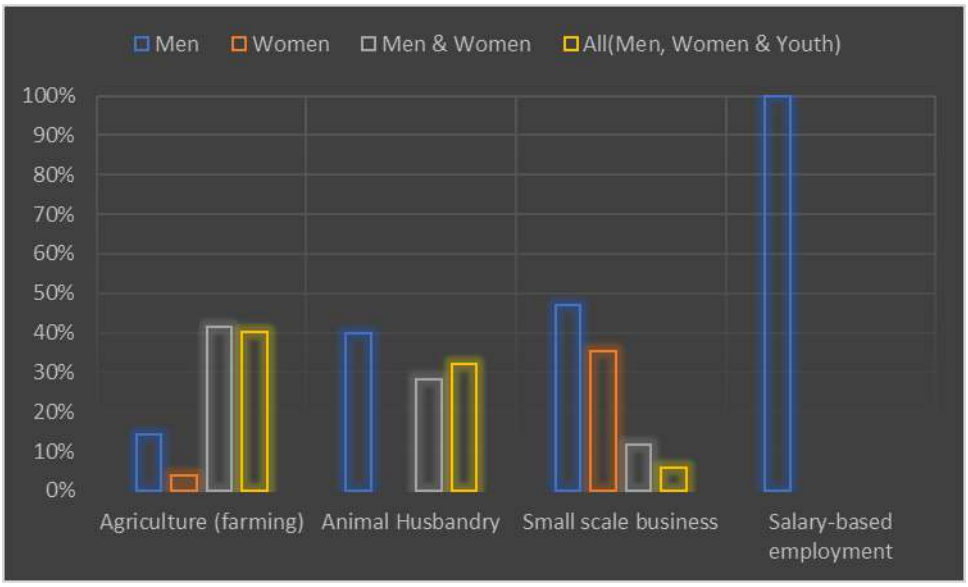

Figure 25: Gender distribution in undertaking of livelihood activities.

To better understand the undertaken livelihood activity, the driving force/reason, and expectations were analysed and presented in Figure 26. The major reasons and expectations were linked with attaining food and income (64%) and food alone (22%). Rain-fed agriculture and animal husbandry being the dominant livelihood activities highlight the major role in meeting food requirement together with income. The high vulnerability associated with the nature (climate sensitive) and approach (small scale with un-advanced technology) used places the community members in a vulnerable situation towards attaining their dairy necessities.

The reasons behind practicing these livelihoods were highlighted to be presence of limitations in capacity and knowledge for undertaking other livelihoods activities basing on one's experience, financial capability and skills being localized only in farming or/and animal husbandry together with lack of other opportunities. Meanwhile other participants highlighted farming being the main activity for attaining security of food thus gives room for engagement in additional activities for income generations.

A smaller percentage, 7%, expected the attainment of income to facilitate the livelihood, this was mostly pronounced in households who engage and depend on petty business. Furthermore, smaller percentage of 4% of the household highlighted the conducted livelihood is related to their culture and has been inherited from the parents. Lastly 2% of the households highlighted the conducted livelihood activity is mainly limited by their financial limitations in undertaking of other livelihood activities. One of the participants highlighted the shifting away from trading maize due to its high capital requirements and is currently selling food stalls that requires less capital.

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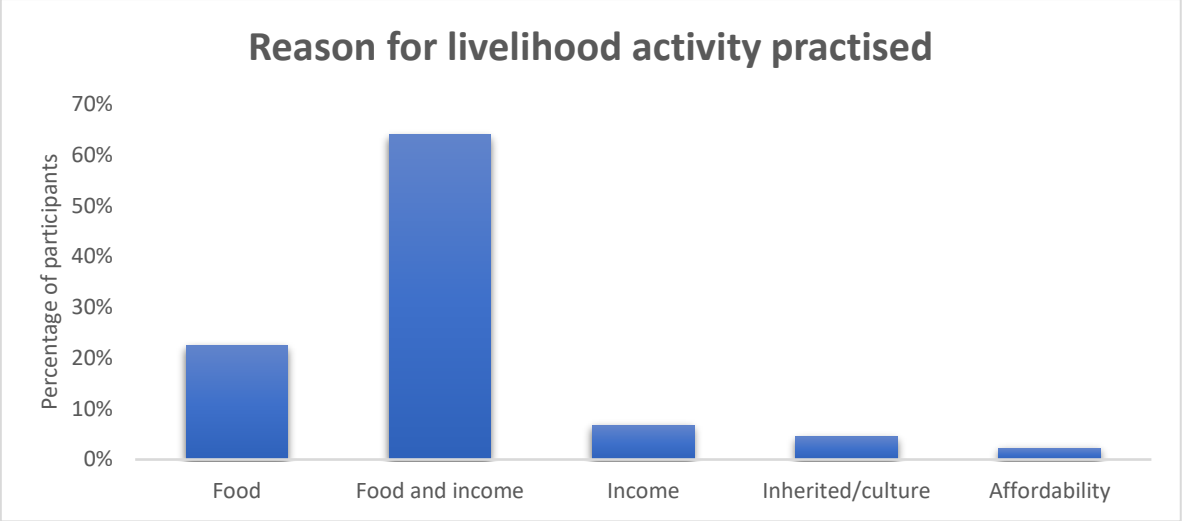

Figure 26: Reason for the opted Socio-Economic livelihood activity.

In the past ten years within the community, the trend of livelihood production has shown fluctuation as shown in Figure 27. Majority of the participants (55%) have highlighted a continual decrease in the productivity meanwhile 42% have revealed mixture of both decrease and increasing. Only a smaller proportion have observed no-difference and increasing in trend. The observed trend in household survey correlated with information obtained from other data collection methods including Focus Group Discussions and Key Informant Interviews. The decline in productivity to the persistent under-performance of weather and season conditions. This has resulted in partial and/or complete losses in agricultural and animal yields.

Furthermore, some participants recognize that, over the span of 10 years, there were certain favourable years when both harvests and livelihood activities thrived in comparison to other years. This acknowledgment helps explain the observed fluctuations in livelihood productivity, with periods of both decrease and increase.

A small percentage (1% and 2%) revealed no change or growth within their livelihood activities, this was prevalent in household depending on petty business and permanent non-agricultural employment. Overall, this trend had varying effect to the households as shown in Figure 28 , whereas the majority experienced either severe or moderate effect.

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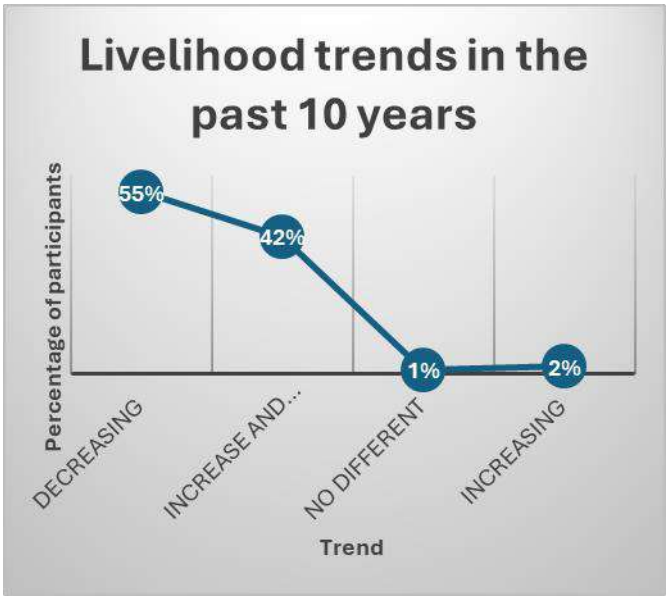

Figure 27: Trend of livelihood option performance in 10 years

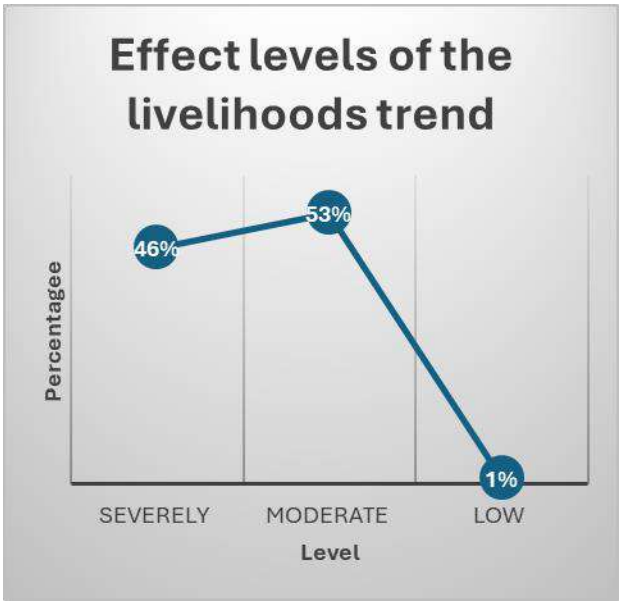

Figure 28: Effect of observed livelihood trends

3.2.3 Climate Change Awareness and Impact in the community

In the studied community, a notable majority (94%) of the participants were aware of climate change and had personally observed its effects. The participants identified multiple climate impact found in the community as presented in Figure 29. The significant climate related impacts within the community being drought related followed by floods and as uncertainty rainfall patterns. The result from Key Informants Interview and Focus Group Discussions has confirmed the observed climate change impacts.

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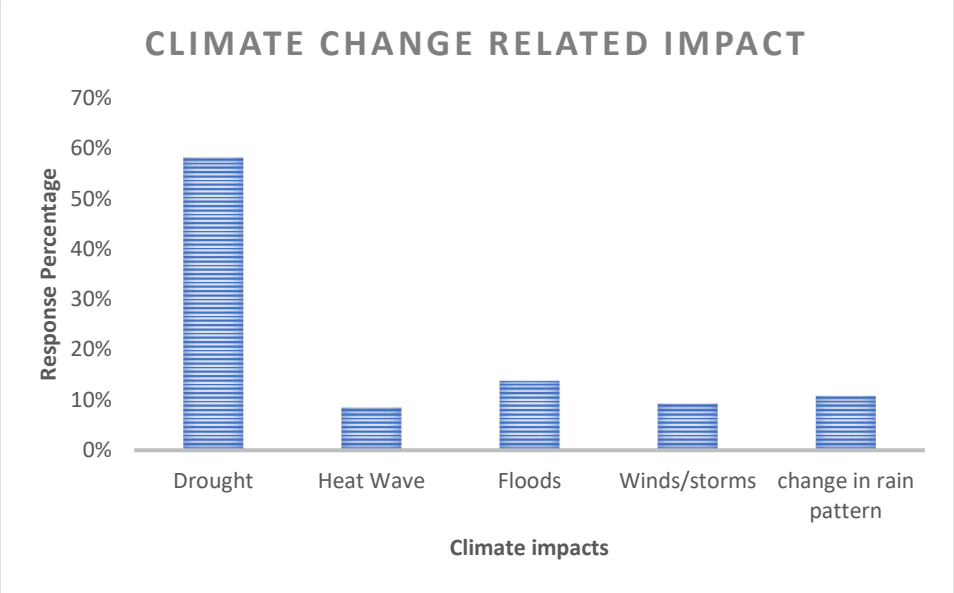

Figure 29: Climate change related impacts experienced within the study area.

These climate impacts had various effects within the community to various degree. The significant effect being the decline of yield from agricultural, animal husbandry and petty business. Participants engaging in farming identified the challenge of drying crops and seeds in the farm together with very low harvest with extreme cases of having no harvest at all. These households not having enough food, let alone having any surplus to sell for income. During these periods, the food item prices increased as result of scarcity and higher demand which further burdens on the already impoverished households. This led many households to be food insecure and with no proper nutrition. They also identified the increase in eruption of diseases and pest such as army worms within the farming season together with drying of pastures.

Furthermore, the yield in animal husbandry has been affected by significant increase in pests and diseases in relation to warming of the environment. The prevalence of pests and diseases has escalated, concurrent with the emergence of new afflictions affecting animals. These diseases and pest are Bovine Theileriosis (East coast fever), Cerebral Coenurosis, Theileria (heart water disease) with the manifest symptoms characterized by injuries around the mouth commonly referred to as Foot and Mouth Disease.

Additionally, drying of pasture and water bodies was a very big challenge contributing to decrease in milk production together with thinning of animals thus lowering their market value. In extreme cases some participants lost cattle's during the pro-longed drought period, one participant of Mazizi village recounted losing of around 150 cattle within a single year.

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Meanwhile petty businesses are essential for the local communities but climate change effects them indirectly through impacting the community which reduces money circulation and availability within the community thus disrupting their operations. This has direct relationship on the purchasing power of the community being lowered thus reducing the sales. The employed operator of the group milk collection centre recounted how they operated with fewer products as there were less milk collected with the price of milk being low greatly affected the business.

The participants identified the year 2003,2016, and last four years (2019, 2020,2021, 2022) being the severe cases of drought whereby many households experienced losses in production and livestock keeping activities.

3.2.4 Coping and Adaptation Strategies with Climate Change Impacts

In response to the effects of climate change various community's members took measures to cope and reduce the impact of climate change effects within their respective capacity. Among the interviewed participants 26% revealed to have not implemented any coping action or mechanism meanwhile 74% have some actions/intervention/mechanisms undertaken as presented in Figure 30 in this report. The participants with no coping mechanisms identified an in-ability to undertake any of the common mechanisms due to old age limiting their available options, lack of water bodies through which they can undertake irrigation, lack of improved seeds within their locality, experience in continuous facing low productivity, lack of knowledge on suitable coping mechanism and cattle continue dying even after using medication.

74% of the participants undertook different approaches to coping with the effect of climate change. The participants utilized various approaches in different combinations. Figure 30 present an analysis of the frequency use of different coping mechanisms whereby around 34% of participants embraced various practices of climate-smart agriculture (CSA). These methods included diversification of crops through cultivating bananas, green grams, and millet instead of the commonly grown maize. They further employed the increased in quantities of fertilizers, pesticides from both traditional and industrial remedies. They also adopted mixed farming techniques, incorporated drought-resistant crops seeds, and diversified by farming different short-term crops variety.

Additionally, others engaged in doing casual labours which included making of charcoal, building of roads, mining of sand and gravel. The next major coping strategy was engagement in some kind of petty business mostly selling kiosks, food related items and charcoal/firewood. Other alternative

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options which were undertaken in smaller quantities include diversification of livelihood options mostly through poultry, migration and conservation of pasture, purchase of animal feed together with request for assistance from family members. Household participants and key informants have highlighted the migration in search of pasture to have contributed to conflicts between farmers and pastoralists due to entry of animals in farming areas.

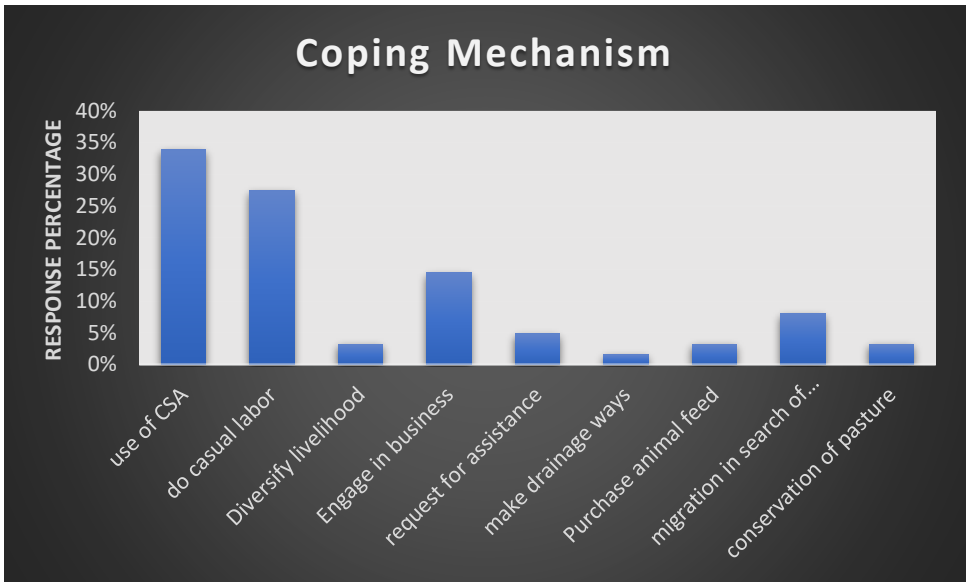

Figure 30: Different Coping Mechanism adopted by the participants.

Various coping mechanisms had different performance in enabling the household coping to the effects of climate change. The sufficiency of the coping mechanism shows that 43% of the participants felt that their adopting mechanism was sufficient while 32% perceived it to be inadequate in meeting their needs and 26% didn't have any mechanism. The participants expressed different reasons behind their given assessment of sufficiency of the coping mechanism which are presented in the analysis.

The use of some form of climate smart agriculture approach/technique has enabled the participants households to get some harvest thus reducing the food scarcity risk, diversify their food choices by the introduction of other items such as banana, millet, and green gram, improve pest and soil management together with early farm preparation in waiting for rains. On the other hand, some participants expressed Climate smart agriculture approaches they utilized not to be sufficient due to the resilience of pests and disease thus continue dying of animals and crops. Additionally, its associated with high input and operation cost for both farming and animal husbandry, they lack irrigation schemes, provided advice not meeting their needs, and personnel issues such as health problems, all these contributed to failure in adopting CSA techniques.

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Participants that engaged in casual labour as a coping mechanism expressed it to be inadequate in satisfying their needs due to the participants aging thus don't have enough energy nor sufficient working opportunities Moreover, the income earned was meagre and inconsistent, making it sufficient only for basic food necessities. On certain days, they went without meals altogether, as they were unable to secure any employment. In addition, the government intervention in restricting the illegal charcoal business placed further burden on those engaging in such business value chain. On the other hand, some participant found casual labours to be sufficient as they could earn fast income which served as their main source or additional to their other sources.

The assessment for those engaging in business was divided equally on its sufficiency. For those who found it sufficient appreciated it as a source for quick earning, its ability to ensure food is on the table and as the only available option. Meanwhile for those who found it insufficient expressed the presence of fewer customers, the earning not being sufficient to cater to their needs and the charcoal business being the only available option they could engage with despite the challenges.

Additionally other adaptations options that were found sufficient include migration in search of pasture by pastoralist, conservation of pasture, storage of food, requesting of assistance from other family members and the selling of cattle's together with creation of water passage mitigating flooding in farms. Although these were sufficient, the participants expressed limitations as many people migrate hence cause competition for the available pasture with cases of conflicts between pastoralist and farmers, some cattle are lost/stolen during the process, the available land for conservation for pasture is limited hence the carrying capacity cannot cater for all cattle's available, the selling price (market value) of cattle was low. In addition, it increased dependency on family members thus being a burden to them, old aging further limits their options and their limited livelihood options within their communities to which they can diversify to.

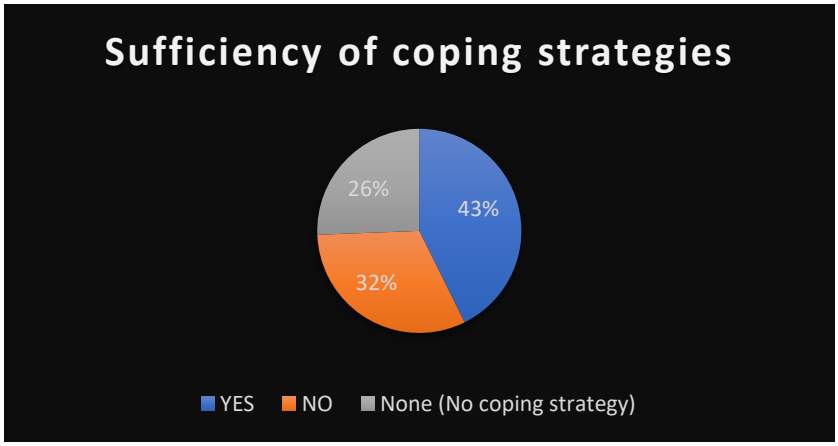

Figure 31: Sufficiency of coping strategies.

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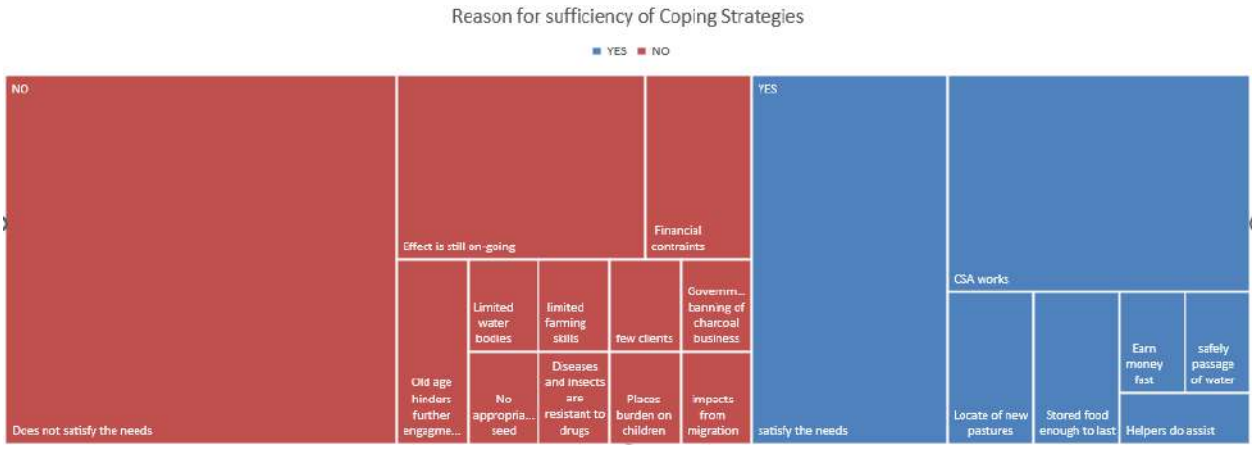

Figure 32: Distribution on reasons for sufficiency of coping strategy.

The study sought to better understand the alternative coping mechanism that the community think would have assisted but are currently not utilized. The finding has been presented below where (52.4%) of the participants expressed lack of knowledge on any other alternative coping strategy that was applicable in their cases. While 47.6% expressed the presence of other potential mechanisms that would have been applicable in their cases such as conducting irrigation, use of CSA techniques and improved modern pastoralists practises, but they are not utilizing them. The major reasons being lack of irrigation scheme/ infrastructure because of lack of nearby water bodies and installation cost. Other being lack of cattle dips, high cost of operation when using cattle feeds, limited pasture-land, existing well drying up in extreme drought and limited job opportunities in the area together with in adequate farming skills.

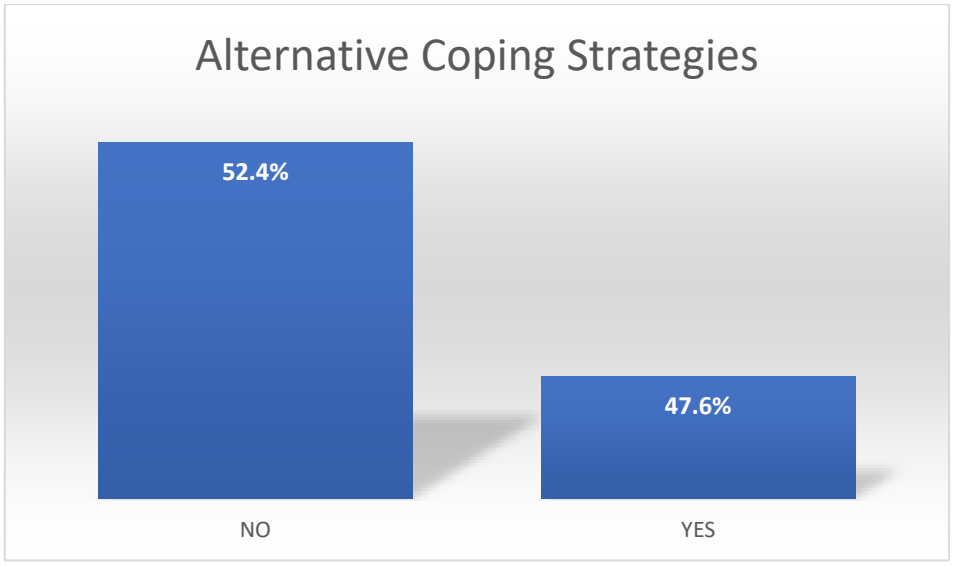

Figure 33: Participants knowledge on alternative coping strategies.

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3.2.5 Climate and Weather Information and Services

3.2.5.1 Access and Sources of climate and weather information and services

Within the interviewed households' participants, 79% of the respondents confirmed having access to weather and climate information while 21% are not. This varied with key informant who highlighted that local communities, especially smallholders, lack access to channels used to disseminate weather forecasts in the districts. They both confirmed the currently used channels by majorly (72%) through radio and television during the news bulletin and others used different channels as shown in Figure 35. Furthermore, extension officers play a crucial role in delivering climate services, with information originating from the Tanzania Meteorological Agency (TMA) and being relayed through district and ward officials. Additionally, village and ward meetings facilitated by extension officers are another avenue utilized in dissemination of the weather and climate information.

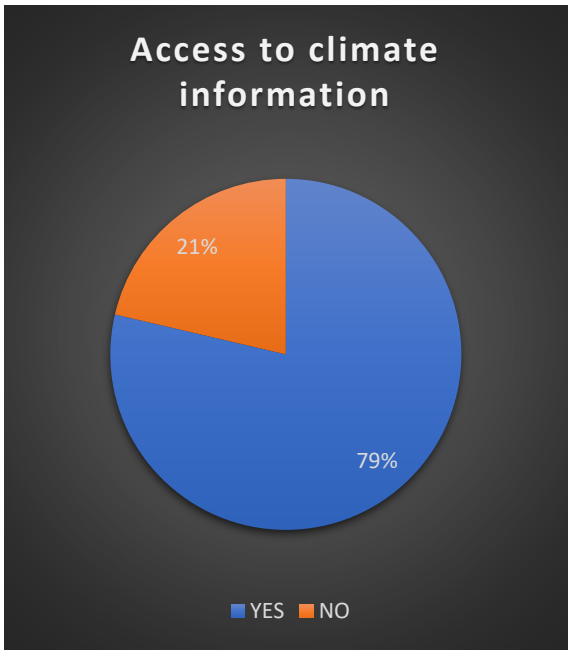

Figure 34: Access to weather information.

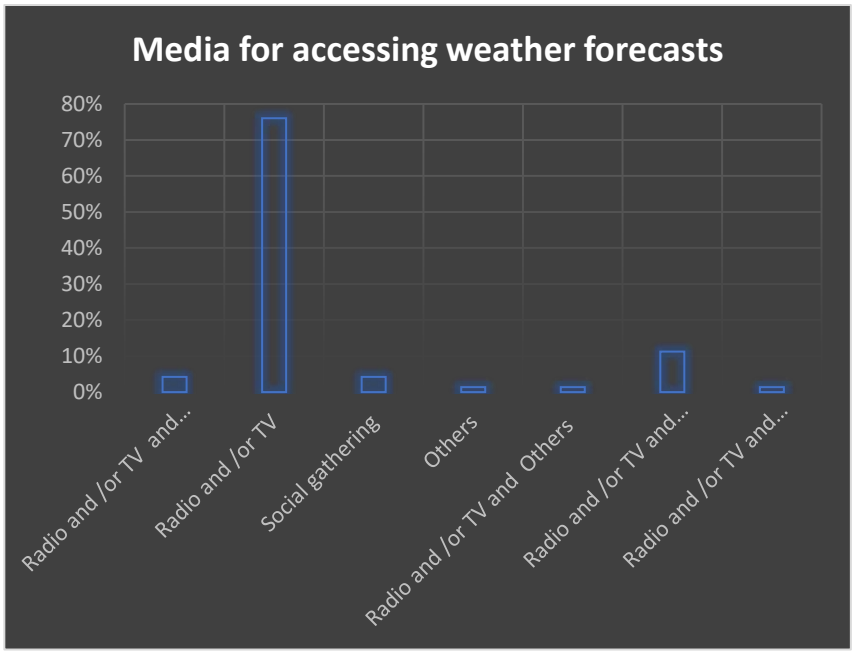

Figure 35: Means of receiving weather/ climate service information.

The frequency in receiving weather information had variation as seen Figure 37. About 31% of participants reported to daily listening for the news and about 33% occasionally listen without a predetermined frequency or arrangement accounting. They occasionally listen due to their busy hard life where there isn't sufficient time to listen as well as varying interest of the participants. For other participants listen during specific seasons (16%) with the rest distributed as seen in the Figure 38. The source of the received weather and climate information is majorly (83%) from

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TMA during the section of weather forecast news time, mixture of TMA and traditional weather forecast (7%), and only (3%) traditional weather forecast.

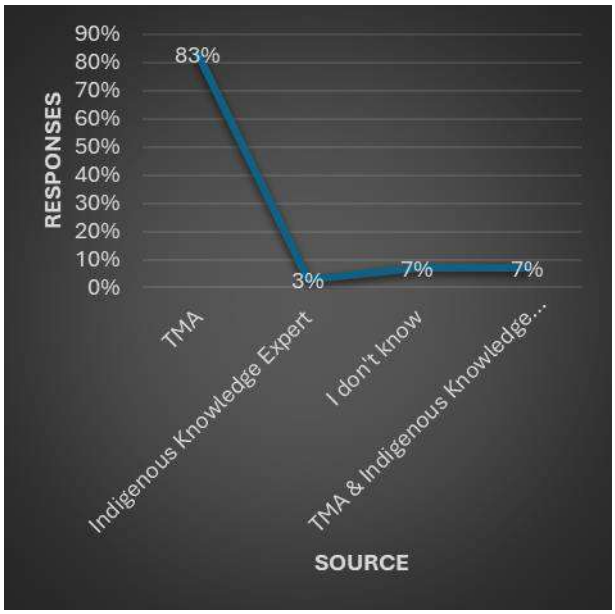

Figure 36: Source of weather and climate information

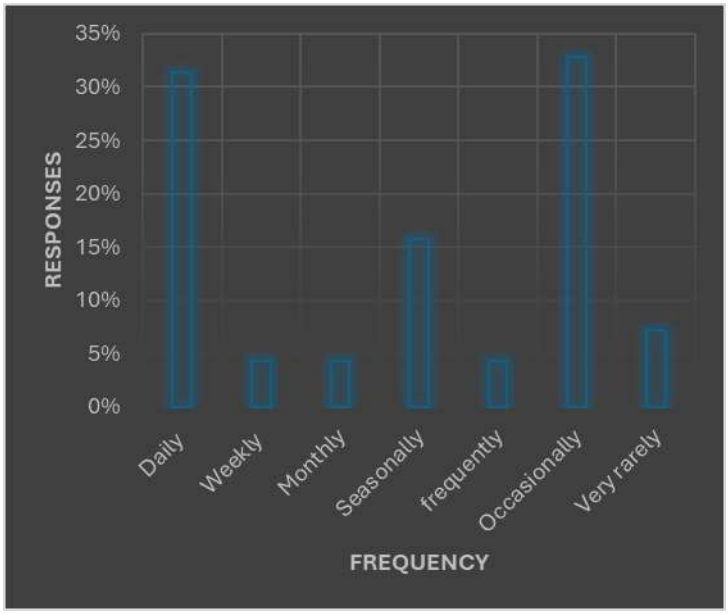

Figure 37: Frequency of receiving climate information

Within the received weather and climate information, 78% of the respondents identified information related to rainfall as useful information they normally take, 11% identified temperature information and 7 % identified they don't use any information from the weather and climate information predictors. Analysis of the distribution of the information utilized across different temporal distribution shows rainfall amount is mostly listened to daily and during different seasons. This aligns with the role of rainfall in enabling different livelihood activities across different seasons. While farming advice and early warning are mostly utilized during seasonal undertaking which is probably to receive advice on undertaking the respective livelihood activity.

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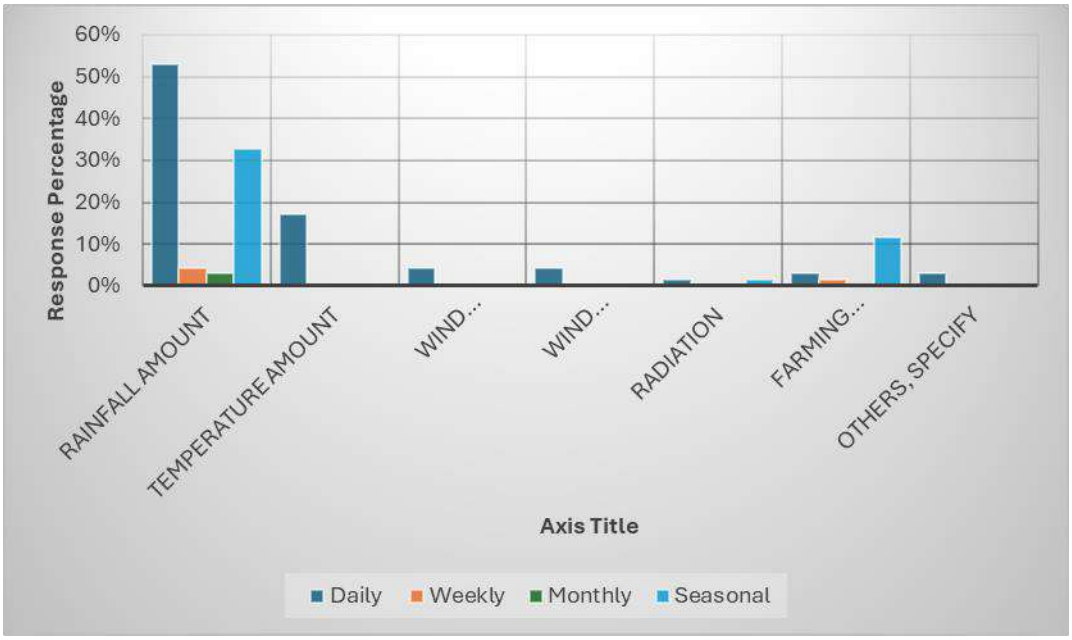

Figure 38: Type Weather information utilization across different temporal dimension.

3.2.5.2 Usefulness and Reliability of climate and weather information and services

The observation of reliability between household, Focus Group Discussions and Key Informant identified the climate and weather services from the TMA and elders (IK) to be reliable and accurately. Focus Group Discussions identified the climate and weather services to be un-reliable meanwhile in household survey had diversified perception with 60% acknowledging its reliability as seen in Figure 39. The remaining 40% found not reliable due to shifting rain patterns and the forecast being a prediction, hence its uncertainty with instances of being wrong. For these participants instead, they follow the normally(traditional) practiced seasonal calendars in undertaking of their livelihoods, i.e., wait till they observe on-set of rain, use their experience and local indicators meanwhile others have no alternative.

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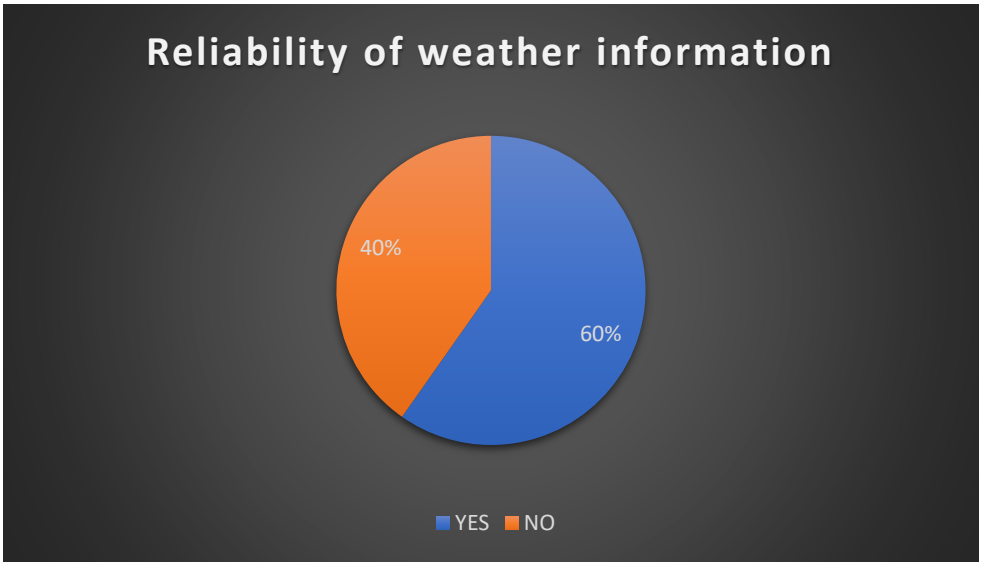

Figure 39: Reliability of weather and climate information.

The study analysed the contribution of the received weather and climate information from TMA in influencing decision-making related to undertaking of livelihood activities. 54% of the interviewed participants acknowledged to have received weather and climate information that has contributed to their decision making on undertaking of their livelihood's activities. Meanwhile 27% and 19% have denied it to have any contribution and not aware respectively as seen inFigure 40. The provided weather information mostly (91%) has enabled informed preparation and planning of farming activities like the selection of seeds and farm preparation. This has also enabled pastoralist migration as an early warning and provision of hope on the next season performance as seen in Figure 41. These has accelerated a positive altitude in the utilization of weather and climate information by the community in decision making processes. The study did not directly assess the impact of the contributions following utilization of weather and climate information.

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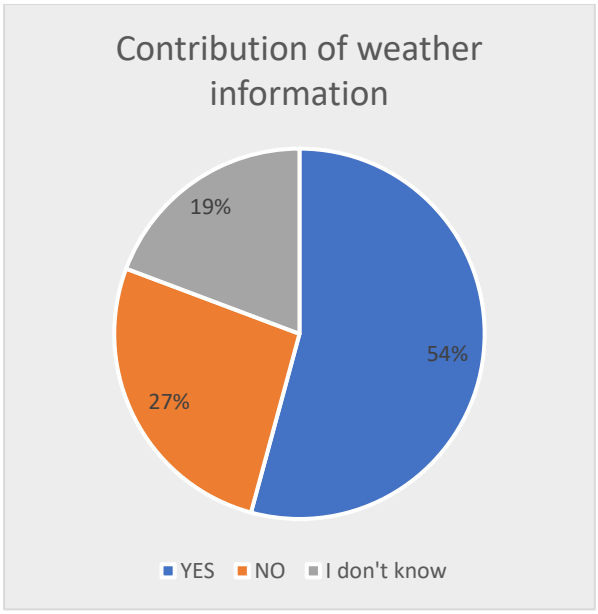

Figure 40: Contribution of TMA weather information on decision making on livelihood activities.

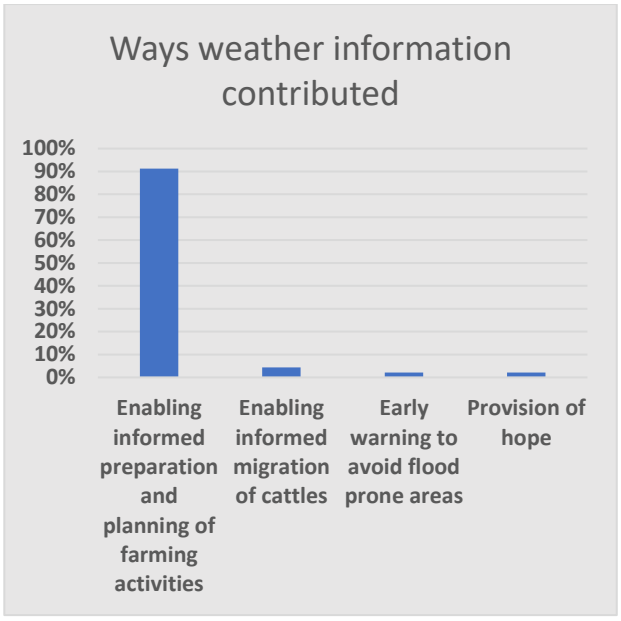

Figure 41: The ways through which weather information contributed to decision making on livelihood activities.

The remaining 46% covers the summation of those who haven't seen any contribution and are not aware of any contribution identified, this is due to the reason presented in Figure 42. The major reason was lack of trust to the provided information considered to be un-realistic due to multiple incidences of predicted phenomenon not becoming true. The provided information is sometimes not matching their agricultural needs, whereby one recommended they prefer extension services which are more tailored and informative. They prefer utilization of indigenous knowledge on weather forecast since the provided TMA information covers a very large area not localized (area specific) and downscaled.

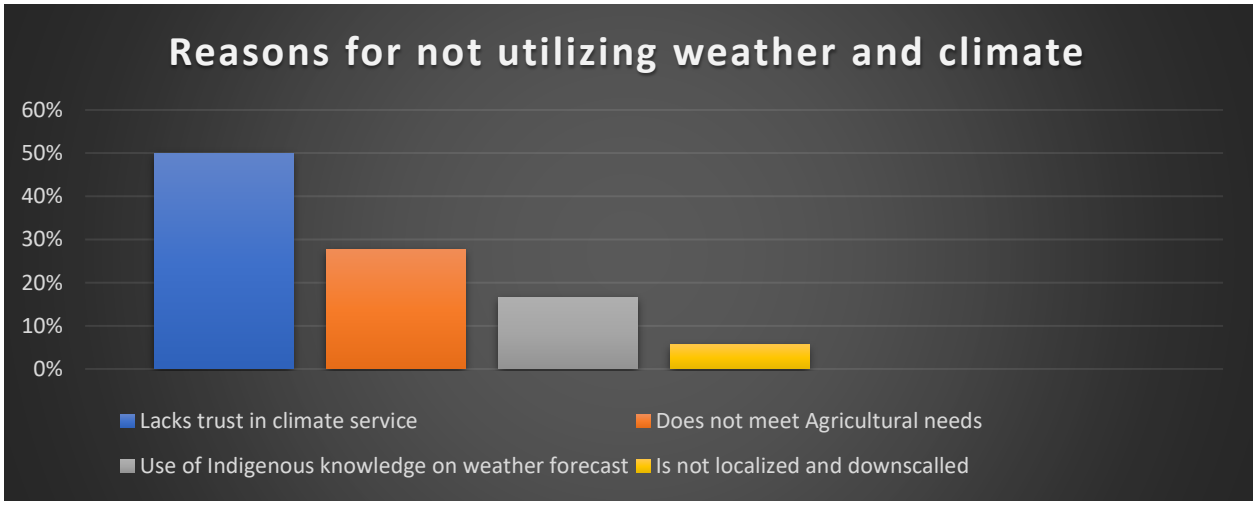

Figure 42: Reasons for not utilizing TMA provided weather and climate information.

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The study considered the usefulness of provided information to meet the needs and expectations of users and stakeholders. The analysis shows 36% found it useful and 20% highly useful totalling to about 56% of the participants appreciating it in addressing their needs. The percentage of participants who appreciate the usefulness of provided information is higher by 2% from those who the provided information contributed to their decision making as shown in Figure 43. This difference has arisen due to some of the participants who were not sure acknowledging the usefulness of the provided information. Meanwhile 30% found it is not useful and 13% were not sure on the usefulness. Additionally, it was identified the shared and received weather forecasts lack information on solar radiation which one among the factor for ensuring optimal plant growth together with absence of information on amount and dates of rainfall on-set and off-set.

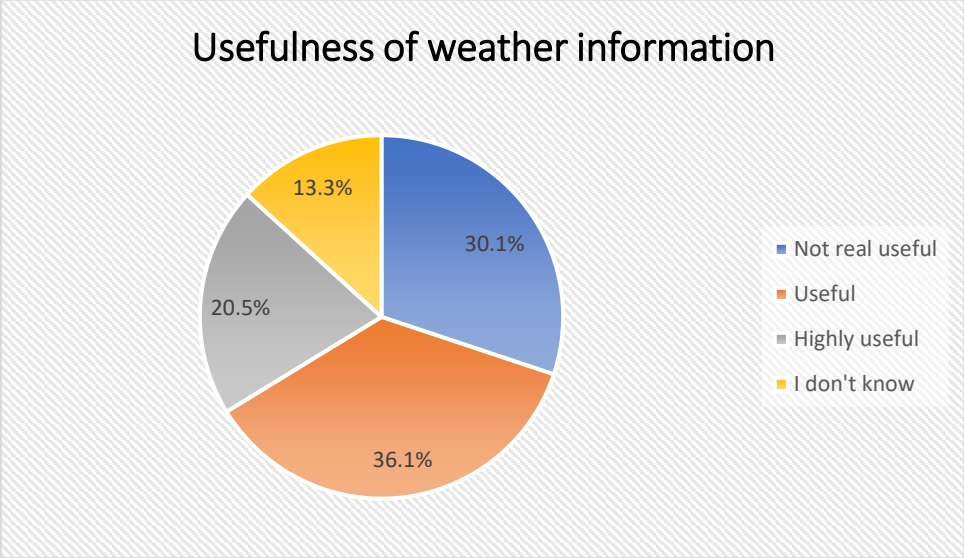

Figure 43: Rating on usefulness of provided weather and climate information by TMA.

The study identified several challenges that were mentioned to hinder the access and effective use of weather forecasts and climate services, including, limited education and understanding among community members regarding the interpretation and utilization of weather forecasts in planning and executing livelihood activities, insufficient downscaling of provided information to cover specific areas and the absence of a specific organization dedicated to weather and climate change management.

3.2.5 Indigenous Knowledge and Climate

3.2.5.3 Awareness and use of IK on Climate

The study found that 60% of the interviewed participants were aware of the tradition approaches of weather and climate forecasting while 32% where not aware and 8% were not sure. Among the participants that

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were aware of traditional weather forecasting only 74% have prior experience in utilizing it and 26% had not.

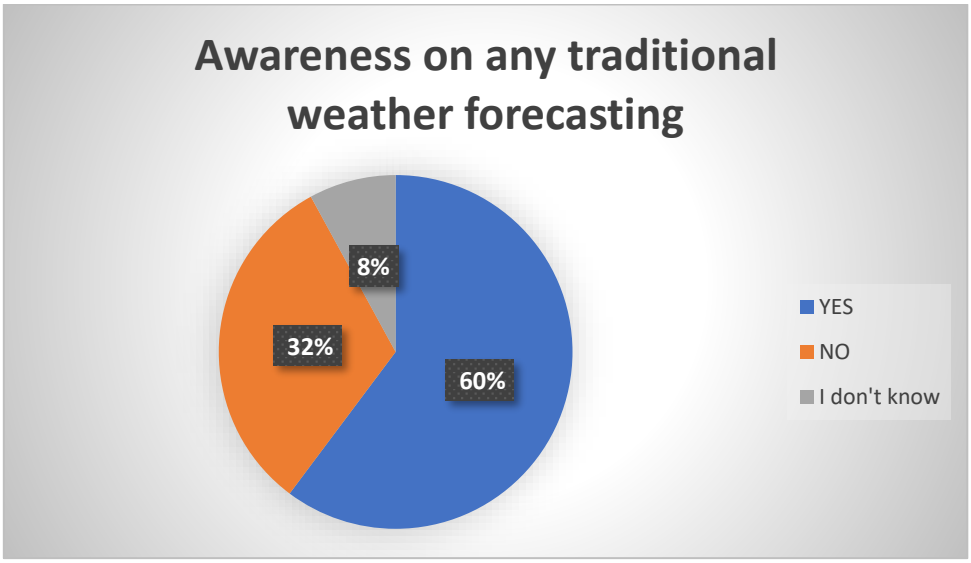

Figure 44: Awareness on traditional weather forecasting.

3.2.5.4 Sources of IK and Reliability

The participants who were aware rated the reliability of traditional weather forecasting as seen in Figure 45. About 45% of the participants agreed on its reliability and 28% expressed in some cases it reliable meanwhile 15% of participants disagreed and 11% were not sure on its reliability. The provided reasons behind its reliability were its ability to forecast where 35% agreed it works well and 14% found it sometimes it works well. Moreover, they identified the relationship between indicators utilized and the expected seasonal calendar that they follow. It was noted the IK forecasts are currently scarce as many people do not know it or are not informed on reliable sources, they can find it. Additionally, it was noted that the indicators used are currently disappearing or not functioning as they used to, for example the disappearance of some bird species. Furthermore, the knowledge on interpretation of the indicators is disappearing with the older generations together with younger generations being sceptical on its utilization by preferring more modern and scientific methods of forecasting.

To better understand the reliability, participants recounted past incidences that were accurately forecasted through IK approach. About 71% of the participants couldn't recall a specific incidence although 29% recalled specific incidences that were forecasted and manifested accordingly. The participants highlighted majority of the needed information can be found within traditional

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weather forecasting although it is missing information of temperature rise and only give general information like upcoming drought, animal death due to any cause but are not very specific.

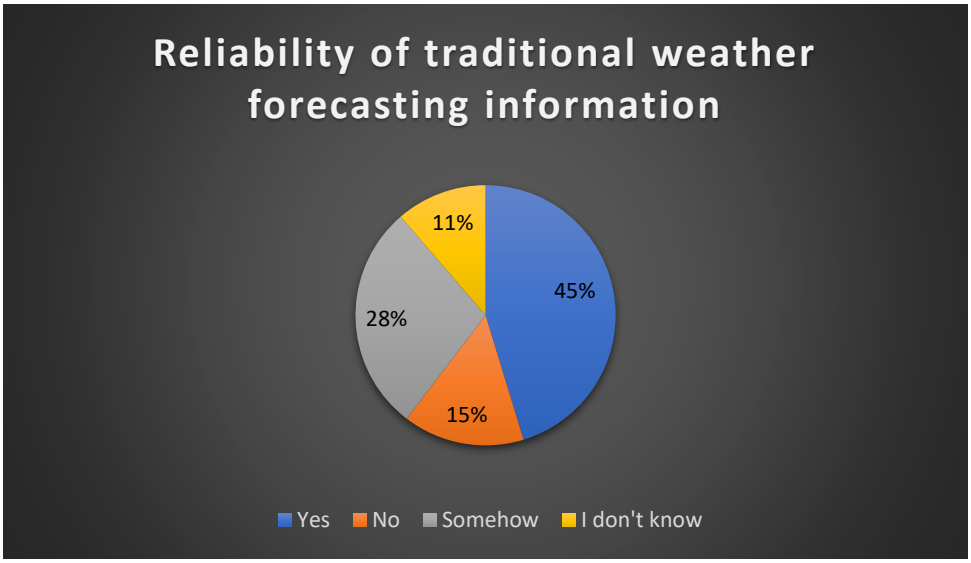

Figure 45: Reliability of traditional weather forecasting information.

The indicators that were identified to be utilized in traditional weather forecasting are.

Indicator	Meaning
Appearance of certain species of ants	The rain season is near
Frogs crying in the river during dry seasons	The rain season is near
A lot of white butterflies' appearance	The rain season is near
Ants carrying eggs and foods	
Flying termites' appearance	The rain season is near
Migration of bees from inland towards the coast	The rainy season is nearby. Their return from the oceans means the rain season is over
A bird called Mumbi in kikwere language producing a certain specific sound	The rain season is near
Ducks have a happy voice	The rain season is near
A bird who's locally called Tetere appearance	The rain season is near
A bird locally knows as Mbayuwayu there appearance in flocks	The rain season is near
A bird with a large mouth that's locally known as Ututu, its appearance means there is rain	The rain season is near

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A bird locally known as Towa (has white and greenish wings) another one called Mlowa and Mumbi, when they cry frequently	The rain season is near
Armadillo eating certain type of offered grains	The type of food croup is determined by the season performance
A certain cow moan	Rain season is near
Cow raising its nose high like its sniffing then it cries	Rain season is near
Elephants show signs of being happy	Rain season is near
Appearance of Hedgehog	The rain season is near
Flowering of Moringa plant,	
Flowering of plants locally known as ndabokha, olangurisiai, Osingwai and Mluwati	Rain season is near
The quantity of mango produced,	higher the number means a dry season is coming and vice versa
Flowering of a tree locally called Mkongowe	The season of rain has started
The germination of Azadirachta indica locally known as Muarobaini	Rain season is near
A plant locally known as Toloisaaaa	Its flowering during sunny seasons means there is rain in the next season
Flowering of a plant locally known as Osenkwai	Rain season is near
The point of new moon is used to predict good and bad season	Position determined good and bad season
shape of moon and star shows the performance of season	
Presence of a cloud ring around the moon	The presence of rain
When the moon is chasing, leaning right means there is rain in that season while Undertake literature review, stakeholders' consultation, and workshop to co-develop seascape strategy. when it is leaning left then there will be drought	Position of moon and stars determined the season performance

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Very hot sun	rain is close
Strong winds and increase in temperature	rain is close
Locally known as Kipupwe and kivuravumbi	Rain is close
Certain clouds cover	Rain is close

3.2.6 LGA role in weather forecast and climate services.

3.2.6.1 District Engagement in Weather Forecast and Climate Service.

The key informants interviewed at district level highlighted the presence of district planned measures to enhance access and utilization of weather forecasts including climate services to enhance climate adaptability amongst the community. These strategies include increasing the number of weather measurement units in each ward to expand coverage. The district normally collaborates with the Tanzania Meteorological Authority (TMA) by receiving forecasts and delivering this information to respective departments and the ward level for use by extension officers during their services.

While the provided forecast information is generally viewed as valuable, although there is a need to enhance its delivery modality to ensure community members can better understand and use it. The information should be more comprehensive, including details such as the amount and dates of rainfall. Lastly timeliness of the information to reach the end users is also a concern, as the current communication media has limitations.

Majority of the participants expressed interest in receiving climate services, which would help them inform community members about planning and executing their livelihood activities and enable adaptation actions based on expected conditions. They recommend the provided weather and climate information should be accurate and reliable together with being accompanied with extension services so as they can be more practical and applicable to them.

Meanwhile others expressed hesitancy and scepticism on use of weather and climate information instead preferring the continual use of seasonal calendar's, relied on their own experience or religious beliefs. Some of the respondents also highlighted the importance of integrating traditional knowledge and local indicators with scientific climate services, involving the elders and the community in the process. The key district informants recommended on the need for training extension officers in weather interpretation and conditions to minimize the impact of climate change. Additionally, establishing weather measurement units in each ward remains a priority to enhance local climate resilience.

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3.3 Lushoto District

3.3.1 Household status in Dule Village

In the household survey a total of 115 participants (53% males and 47%Females) were interviewed. The participants were randomly selected while maintaining gender representation and inclusivity as seen in Figure 46. The participants were distributed across different ages and sex groups.

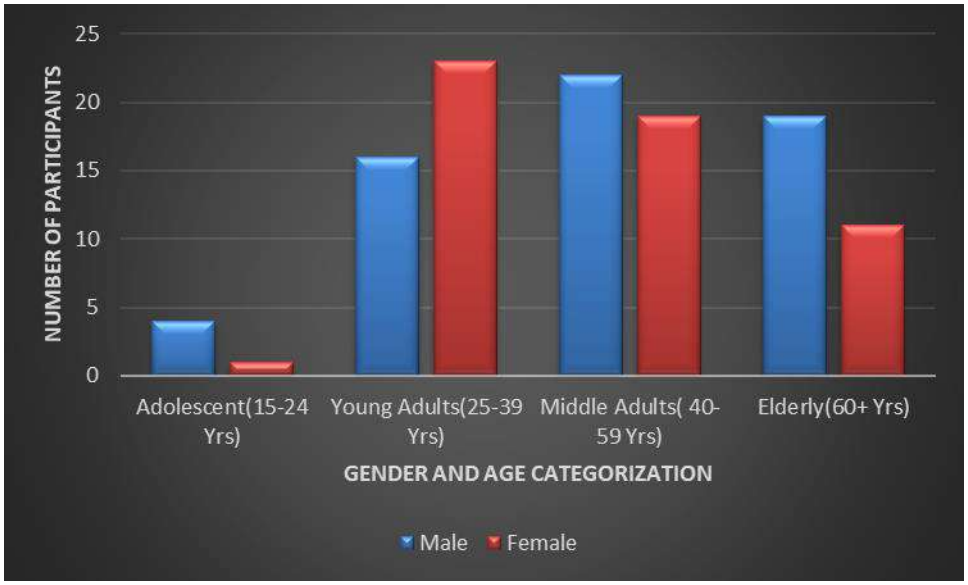

Figure 46: Participants distribution by sex and age.

84% of the respondents' households were male headed, 14% were female headed with 1% being child headed. The participants had diverse marital status with 79% being married, widowed (10%), Divorced (2%), Never Married (1%), and Married but not living together (3%). The respondent households' size were majorly between 3 to 6 which collectively accounted for 72% with smaller size (1 to 2) being 12% and larger size above 7 being 16% as seen in Figure 48. The dependents within the households were as follows; 28% had no dependents, 45% had 1-3 dependents, 26% had 3-4 dependents, 3% had 7 and more dependents meanwhile 2% didn't respond. The education level was mostly of the interviewed participants was mostly primary school (89%) with secondary/high school (6%), technical specialization (1%) and No formal education (7%).

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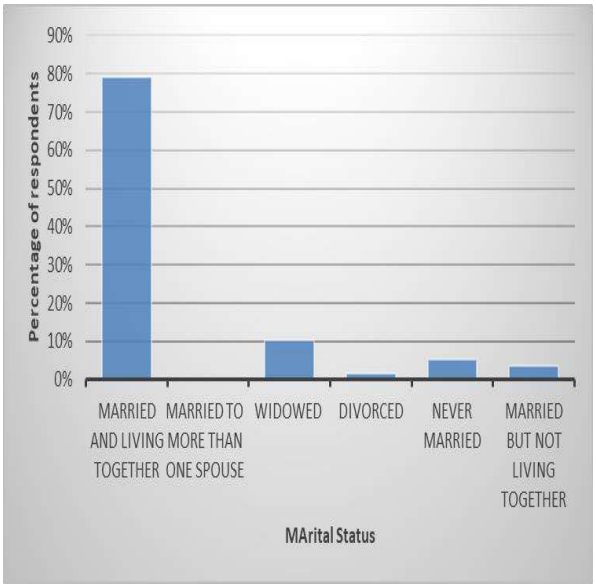

Figure 47: Participants' marital status.

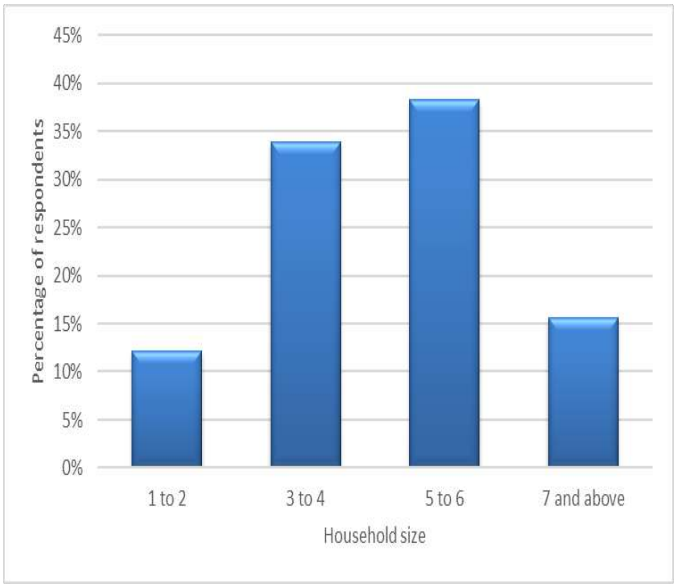

Figure 48: Participants' household sizes.

3.3.1 Socio-economic and Livelihoods Activity

Most of community members (50%) in Dule village integrate rain fed farming, irrigated farming and keeping dairy cows. Maize is grown during short rain season (October-December) for home consumption and sales if the harvest is good. The average harvest is 1,200 kg per acre if good agronomic practices are applied. Beans is grown during short rain season and long rain season (March-May) for complementing home consumption or for cash. The average harvest is 600 kg per acre if good practices are applied. Cash crops are vegetables, specifically cabbage and tomato. The average harvest is 12 tons/acre and 14 tons/acre of cabbage and tomatoes respectively. Households keep 1-3 dairy cows which produce the average of 8 litres per day during rainy season and 5 litres during dry season.

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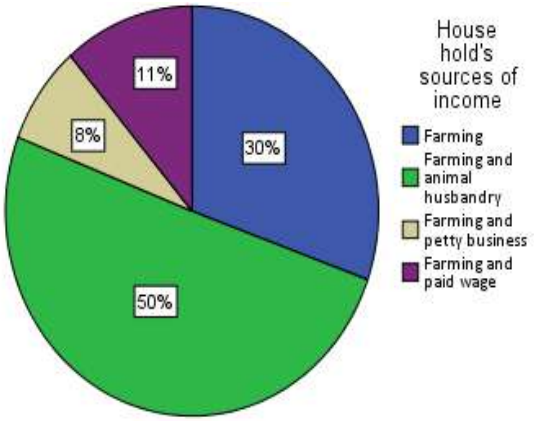

Figure 49:Livelihood Activities practiced in Dule Village

8% of the sample population are engaged in petty business as a standalone activity or complementing other activities related to agriculture. Such businesses include food vending, cooking for children at public schools, local technical masonry, shopkeeping, driving, tailoring, casual labour, and handcraft. 11% of the population were earning cash through government employment, short-term casual labour or receiving remittance from sons and daughters. The combination of both primary and complementing livelihood activities revealed that the majority of respondents (59%) engage in two livelihood activities while 4% have three sources of income. Only 39% rely on one livelihood.

3.3.2 Gender Participation in Socio-Economic and Livelihood Activities

The study analysed how responsibilities are distributed among household members during socio-economic and livelihood activities. The results showed that in most livelihood there is higher cooperation among both sex in conducting the livelihood activities. Apart from the households that work together in agriculture, there are more household were women participate more than men, meanwhile in Livestock rearing and small-scale businesses, men tend to participate more than women, seen in Figure 50.

Collaboration between men and women, however, shows great participation in diversified livelihood options of farming and animal husbandry. The driving forces behind collaboration include family basic needs especially, responsibility for education fees, timing for rain season and available milk demand from the collection centre. With reference to Figure 51 for age groups, youths (18 -35 years) spend more time in doing petty businesses such as shop keeping, vegetables

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retail and driving of motor vehicles. As they grow to maturity age group (35 – 55 years and above), household members practice irrigation farming to grow cash and food crops for family resilience.

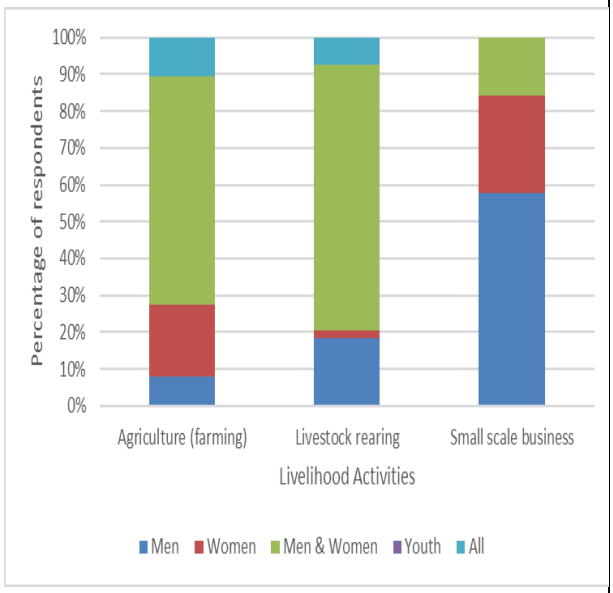

Figure 50: Distribution of livelihood activities undertaken by participants' households.

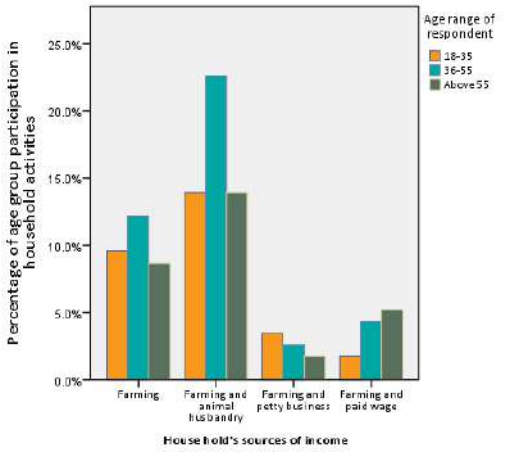

Figure 51: Gender participation by age group

The survey participants provided various reasons for engaging in their livelihood as shown in Figure 52. Nearly half of them (49%) mentioned the need to earn both food and income. 13% said that they were primarily focused on getting food, while 15% said that their main goal was to earn income for their households. 21% of the participants reported that their current livelihood was the only option available to them due to location, financial limitations, limited skills, low capital requirements, and ease of undertaking. A small percentage (3%) reported that they engaged in their livelihood due to their love of farming, family business or because it was a family tradition passed down from their parents.

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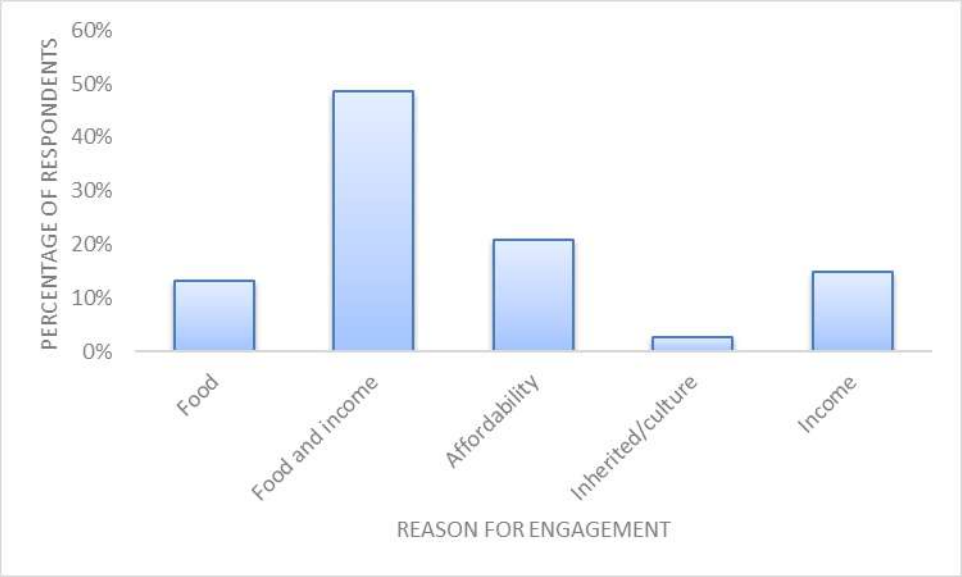

Figure 52: Participants reasons for engagement in livelihoods.

3.3.3 Livelihood productivity

In the past ten years within the community, the trend of livelihood production has shown fluctuation which varies according to sub-villages as shown in Figure 53. Field crop production and keeping dairy cows depend on the productivity of land, seasonal performance and sensitivity of community members to use resources sustainably. The difference in the trend of livelihood production among sub villages is affected by application of good agricultural practices, utilization of technologies, accessibility of climate services, available water for irrigation and market for crop produce.

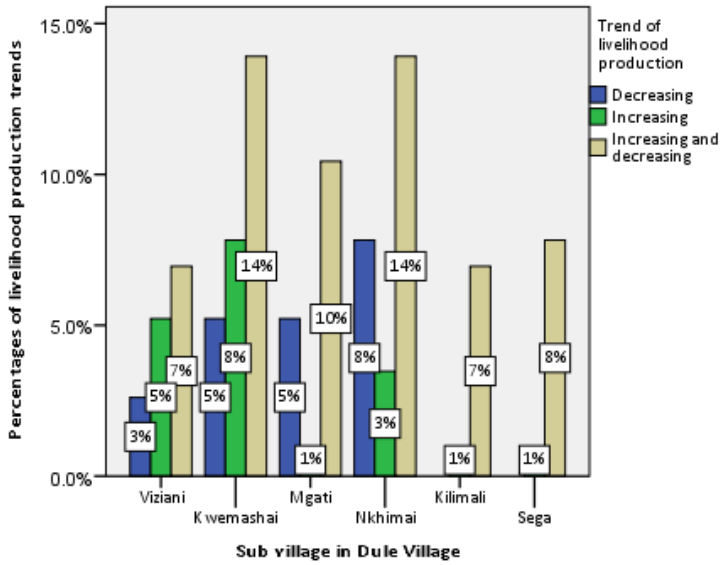

Figure 53: Livelihood productivity trend.

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With reference to Figure 53, Viziani, Kwemashai and Nkihimai showcase fewer amount of decreased livelihood compared to those having increased or fluctuated. Farmers in Viziani and Kwemashai utilize water from two water sources of *Bombo* stream and *Umba* to irrigate vegetable farms during dry season. The increase in production for Nkhimai is the least compared to Viziani and Kwemashai because farmers depend on only one water source of Umba river to irrigate vegetable crops during dry season. This enabled these three sub-villages to have two farming seasons and increased resilience to seasonal performance thus enabling more production. The decreasing trend was reported mostly by households located further downstream of the rivers. As the dry season progresses, the river water does not reach them since they are located further downstream. Well-off farmers with pumps can pump water to reach them, but farmers who cannot afford pumps are unable to utilize the rivers as the dry season progresses. With the increasing change in rainfall season performance, the seasonal river's ability and duration have fluctuated thus further impacting them when the dry season is longer, there is delay in starting of the rain or the rain is not adequate enough to fill the rivers. The positive impact of increased livelihood production includes accumulation of capital, ability to invest in other opportunities like dairy cows, expanding the existing projects, accessing credit from SACCOS and improving living standards. Despite the positive production, they have reported a market challenge whereby their produces get low prices following over supply of the produce as majority of them harvest along similar timelines. Furthermore, the fluctuation and decrease trend had negative impact which are failure to reach production targets, decrease in household income, in-ability to buy all agricultural inputs in next seasons, un-reliability of securing income and food, food insecurity and increase hardship in life.

On the other hand, there was very small sign (1%) of production increase and being dominated by fluctuating productivity in Kilimali, Mgati and Sega sub villages due to dependence of rain fed as they lack of access to water from the two sources. They depend on rainfed agriculture during rainy season which is neither effective nor sustainable. The negative effects of fluctuating production trend impose challenges such an inability to reach the production target, low income to support basic household needs, low yields, food insecurity and increase in poverty level.

3.3.4 Climate Change Awareness and Impact in the community

In the studied community, a notable majority (69%) of the participants were not aware of climate change meanwhile 31% knew about climate change. Most of the youths in Dule have less awareness on evidence of climate change as compared to mature age group and elders. Figure 54 indicates that awareness gets higher as the age groups graduate from youths to maturity because

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they experience the effect of climate change while participating in farming activities. Elders have a better knowledge and history, but they lose memory as they grow older due to poor vision and less ability to move from one place to another.

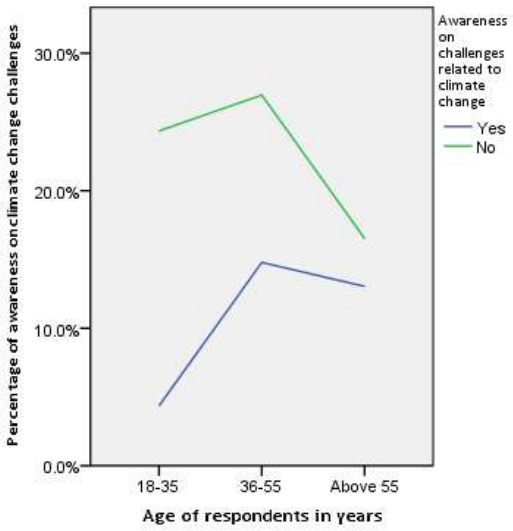

Figure 54: Community awareness of climate change challenges.

The household participants identified drought, strong winds and un-certain rainfall as the major climatic event in the areas which has caused eruptions of diseases, drying of pastures, drying of crops and rivers. With reference to the answers from Focus Group Discussion in Dule village, there are extreme events which have been occurring in Dule village. Such events include heavy rain between 1993 and 1997 which caused landslides, 2019/20 floods which destroyed UMBA river, 2016 heavy rains which destroyed field crops, drought of 2022 which caused the drying of crops. Plants were previously growing well but the recent harvest trends shown to decrease. Farmers realized the harvest of 10 bags of maize per acre 10 years ago without application of pesticides or industrial fertilizers, but the current harvest may range between 3-6 bags for farmers who don't apply good agricultural practices. '*The natural vegetation was a blessing to humans because they got basic needs from indigenous trees such as medicine and dry firewood. Every time we waked up we enjoyed the green colour, fresh air and sound of birds from the mountainous forest'* said Imran, one of the elder of Dule village.

The major hazards faced are drought and uncertain rainfall, which have significant economic and social implications. Prolonged droughts and uncertain rainfall have led to a decline in the productivity of land, reduction in river capacity, loss of biodiversity, loss of pastures and crops, and a decrease in casual labour opportunities with the value chain of farming and livestock keeping. Additionally, farming and livestock keeping have become more expensive with a decrease in milk

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and agricultural yields together with emergence of new diseases for animals and plans. Social impacts include destruction of ritual sites.

3.3.5 Coping and Adaptation Strategies with Climate Change Impacts

The community has undertaken various measures to adopt to the changes. From the participants that were aware of climate change only 86% implemented adaptation measures with 14% not implementing any measure. Out of the implemented measures, 76% implemented measures related to climate smart agriculture practise, with other implementing better water management practises in irrigation, engaged in casual labours, adopted dairy farming as alternative livelihood, purchased food items or requested family support. Farmers are currently improved by planting improved seeds varieties and are working with extension officers/experts in the area to adopt. Maize farmers have changed from planting local varieties to DK 9089 and DK 777 and others transitioned to planting of Irish potatoes and sugar cane depending on the season. After facing low soil nutrients, farmers have started to invest in the application of manure in farm plots before the start of rain season, but others add industrial fertilizers with sources of Nitrogen and Potassium. The extension officer informed that beans are not well managed. '*Farmers say that this crop was given the fertilizer by God, there is no need to invest much*". Their belief may be supported by nitrogen-fixing ability of all legumes, but land productivity may decline if supplementary nutrients are not added in legume farms. With regard to vegetable farmers, they have changed from growing the older variety (*Tengeru 97*) to *Dhahabu F1* which does well during rainy and dry seasons. Gloria F1 is the cabbage variety which was tested and accepted by farmers in Dule with a production potential of 12 tons per 0.25 acre.

Utilization of Umber River streams has been organized by setting schedule of 1 week per sub-village but water becomes scarce from July to September. Farmers with ability use diesel powered pump to irrigate throughout the year. Other created furrows to control water flowing and conducted rainwater harvesting.

Other adaptation strategies include contour farming which incorporates trees and grass in farm boundaries to prevent soil erosion and provide nutrients as dairy cow feeds together with planting of grass in lowlands and storage of fodders to use during dry seasons.

The respondents highlighted the effectiveness of the adaptation measures implemented varies with 50% of the respondents reporting them to be effective, while 50% reported them to be ineffective. In the agriculture sector, the effective measures include the use of Climate-smart agriculture

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practices, which enable the killing of pests using pesticides, ensuring that farmers gain harvest from diversified farming, and keeping the soil in good condition. Additionally, planting grass and keeping fodders has prevented the loss of livestock during dry seasons. However, the ineffectiveness was attributed to several factors such as the need for further improvement of irrigation structures, increase in operational costs, continual decrease in water availability in rivers, large family size making it expensive to maintain, low yields, and use of more efforts, low pay from casual labours, among other things.

In the survey, 47% of the respondents reported being aware of potential adaptation methods, while the remaining 53% were not aware of any additional measures that could be taken. The identified potential adaptation methods include the use of drip irrigation and better agricultural inputs, government provision of subsidized inputs, educating farmers on farming and animal husbandry, empowering extension officers, constructing stone walls on steep slopes to prevent soil erosion, hiring more labourers, building water storage facilities, reforestation around water sources, and adopting alternative livelihoods.

3.3.6 Climate and Weather Information and Services

Provision of Climate Information and Services (CIS) to end-users involve the collection, organization, packaging, tailoring, and distribution of weather and climate information. CIS packages often include short, medium and/or long-range weather and climate forecasts and advisories. Based on end-user needs, CIS may include other information such as improved seed varieties or other locally appropriate climate smart agricultural practices. Investment in CIS has overall cost benefit analysis of 1:10 (World Bank, 2016).

The baseline study focused on forms of climate services which were provided and utilized in Dule village. The study analysed the decisions made by the households based on climate services to improve their livelihoods.

3.3.6.1 Access and Sources of climate and weather information and services

The household respondent survey showed that 44% of respondents access and use weather forecasts, while 32% occasional receive and use while 23% have no access to such forecasts. Of those who receive weather forecasts, 77% use scientific information released by the Tanzania Meteorological Authority (TMA), 3% use Indigenous Knowledge (IK) sources, and 17% access both with only 2% of respondents don't know their information source. The community accesses this information through various channels, with radio and television being the most popular. The

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categorization of channels for accessing weather information based on the source in Figure 55. The weather information from different sources pertains to rainfall, temperature, and wind.

The common frequency is accessing the weather information is daily through radio and television every evening after the news session. The information is generalized to region level and only includes the name of the expected event (e.g. cloud, sunshine, rainfall) in the Tanga Region which adds more complexity in planning and decision making at village level. There are no details about the amount of the event, its time period, or specific location. Only the sunrise and sunset are specified by time and location. There is a missing downscaling process and packaging of area-specific information to aid new ways of implementing agricultural activities.

At the district level, the research team found monthly weather information that is delivered to the department of agriculture, livestock, and fisheries. During a meeting with key informants in Lushoto, the head of department suggested timely delivery of information from TMA, and more explanation from TMA to describe scientific terms used by district officials so they can extend the information to wards and villages.

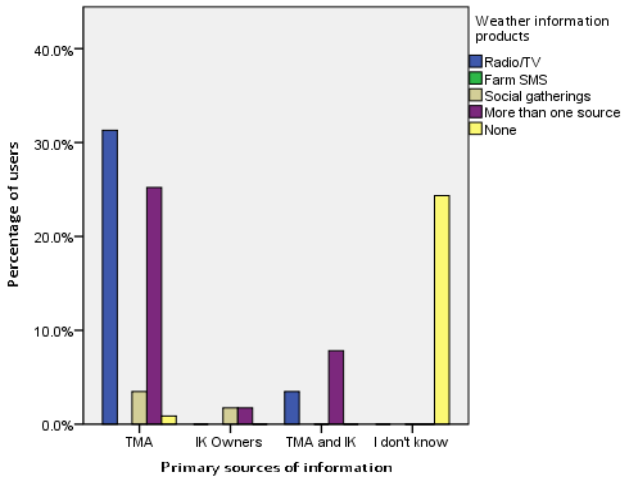

Figure 55: Weather information sources and products.

Other forms of climate services

Key informants identified Kilimo Resources Mwangoi centre where forecasts and climate services are distributed to the respective community together with learning of different farming practises. However, few beneficiaries, especially group members get access to the resources. The leadership of the resource is not active to organize farmers field schools to learn new crops, new varieties, new species or new hybrids of animals. On the other hand, there are few government initiatives

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which provided climate services for agro-pastoralists to respond to climate change effects and improve livelihoods.

Dairy cow farmers have a historical relationship with external support from Participatory Agriculture Development and Empowerment Project (PADEP). Groups of farmers were offered start up species of Friesian dairy cows to the first farmer. The first farmer was then required to give she-offspring to another household and the chain extended to almost all interested farmers in Dule. Dule communities utilize available swampy areas as sources of grass, but others store crop husks and stalks to feed dairy cows during dry seasons.

The observations and shared information from the focus group discussions showed that access to climate services is based on individual effort to search for information. Besides local farm groups in Mwangoi Kilimo, other opportunities such as Village meetings, farmers field schools' facilitation meetings, radio programs and mobile phone technologies and reading material s have not been utilized. The 10 days and monthly weather forecast in form of bulletins are not reaching the target end users.

3.3.6.2 Usefulness and Reliability of scientific weather information and services

According to a survey, 76% of the respondents found the weather information provided to be reliable, while 24% found it to be unreliable. Those who found it unreliable relied on traditional farming and seasonal calendars, along with integrating irrigation, when the season underperformed. When it comes to the contribution of weather information toward improving decision-making, 63% confirmed its contribution, while 13% denied any contribution. The remaining 25% were unsure or didn't know. The main uses of weather information to aid decision-making are early preparation of farms, deciding on planting time, planning farm size and location, preparing for water runoff ways, planning harvesting dates for vegetables, timing for spraying fungicides, crop selection according to expected season, and taking better care of animals. The most frequent use is for early preparation of farm preparation, with other uses mentioned fewer times.

52% of the participants found the weather information useful, while 31% did not. 17% were unsure of its usefulness. The uncertainty and perception of limited usefulness were due to occasional situations where the forecast was wrong and limited usage of the weather information among participants. TMA provides seasonal outlook information to inform users of possible dates for rain onset, expected amounts within the range of normal-below normal, below normal-normal, normal-above normal, and above normal-normal. The terms used to inform the expected amount

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refer to the average rainfall of the specific area. However, FGD members did not agree with the average of reference since the sources of data to calculate the average rainfall per season were not collected from Dule or adjacent villages. The decadal and monthly weather information helps users plan interventions for the next 10 days or month, but this information was not known by community members of Dule. The daily weather forecast was the only known information by most of the respondents, though it was not specific for Dule village.

Traditional weather information

Elders are the main owners and sources of Indigenous Knowledge (IK). Generations inherit this knowledge from stories, ceremonies, dances, paintings, mother languages and songs during social meetings between elders and young community members. The owners of IK have different indicators that they use to forecast the expected weather and season

3.3.6.3 Awareness and use of IK on Climate

According to household survey findings, 50% of the participants are aware of traditional weather forecasting. Out of those, 64% have used it before, while the remaining 36% have never used it.

Sources of IK and Reliability

When it comes to its reliability for informing farming and agricultural activities, 39% agreed that it is reliable, 35% found it to be somewhat reliable, 16% found it to be unreliable, and 11% were unsure about its reliability.

The participants highlighted that the accuracy in predicting expected weather, the high level of experience of elders in forecasting, and its historical use were the reasons behind its reliability. On the other hand, the changing context of weather and the absence of knowledgeable elders as the older generation had not transmitted their knowledge to new generations, together with the preference for scientific weather forecasts, were the reasons behind its unreliability.

To better understand the reliability, participants recounted past incidences that were accurately forecasted through IK approach. About 60% recalled specific incidences that were forecasted and manifested accordingly although 40% of the participants couldn't recall a specific incidence. The participants highlighted all the needed information can be found within traditional weather forecasting.

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Birds which are locally known as *dudumizi, kiulimaji, shundi and njiwapori* are referred as the beginning of the season when they start producing sound. Flipping wings of ducks and running in a zigzag direction is an indication of starting the rain season. Flowering of mango trees is a common indicator for starting of the rain season. Many communities describe a good season if mango trees have less flowers and vice versa. Some communities, however, are losing trust on this indicator because the interference of exotic to indigenous mango species has changed the flowering characteristics. Flowering characteristics was named for other trees locally known as *mtandaa, mueti, msongoma, mvumo,* avocado and coffee trees.

Figure 56: Insects feeding on castor tree few days before the start of rainfall.

Traces of wet soil under the indigenous trees, locally known as *Mshai* and *mbono* (Castor tree) are the indicator of the beginning of rain season. The wet soil is caused by fluid drops from the castor tree which reacts after insects in Figure 56 feed on the bark while breeding. The indicator is trusted because it takes approximately 5-7 days to start raining soon after tracing wet soil.

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4 Discussion

This chapter seeks to explore the implications of the study's findings, critically examining them within the broader context of the field and the existing literature.

4.1 Household Status

Across the different study areas, common trends and contexts can be observed. A significant portion of the households, more than 50% within all areas are large families with more than 5 members and households have more than 70% dependents. The participant's education levels were mostly either primary or secondary education with fewer numbers having university, tertiary or no formal education. Numerous studies have demonstrated a direct correlation between family size and resource consumption. Specifically, larger families require more resources such as food, housing, and income to meet their daily needs. The capacity to procure these necessary resources is influenced by several factors, including but not limited to, the number of income earners, education level, the economic situation, and the productivity of livelihoods. This study did not evaluate the role of these dependents in production or their contribution to fulfilling the family's needs. The level of education plays a contributing role in socio-economic development and in addressing the understanding of complex issues such as climate change.

4.2 Socio-economics and livelihood activities

It was observed within the same villages, across the sub-village the intensity by which a given livelihood is practised varied. Based on the respective overall study area findings across different areas there are observed variations and similarities among the practised socio-economic and livelihood activities. Within the study areas in Pangani district for example the dominant socio-economic and livelihood activity were rainfed farming, petty business, and fisheries. While in Chalinze districts study areas was rainfed farming and animal husbandry and Lushoto study areas were farming and animal husbandry. The natural resources available and culture have direct influences on the type and nature of practised livelihood activity in each village. For example, in Dule Village found in the Lushoto district as a result of the availability of rivers (water bodies) there is developed irrigation farming in comparison to its counterparts the majority rely on rain-fed.

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Within the study areas, a similar trend has been observed whereby majority of the participants are engaged in a single livelihood option in comparison to those with two or more activities. The major socio-economic and livelihood activity engaged in was either farming, animal husbandry or fishing, this is attributed to meeting food and income requirements. Multiple studies have shown households reliant on a single livelihood activity face heightened vulnerability to the impacts of climate change in comparison to those with diversified or integrated livelihoods. This is due to the fact that most of the livelihood activities are more susceptible to climate change shocks, often experiencing greater difficulties in coping or recovering from these challenges. Conversely, diversified livelihoods offer a broader range of options and resources, enabling households to better withstand climate-related adversities. The presence of multiple income sources not only helps in immediate adaptation but also enhances the overall resilience and adaptability of these households in the face of ongoing climate change challenges. The factors that contribute to the selection of livelihoods undertaking are the need to acquire food and income, ability to afford (access to capital), knowledge and experience of the households and cultural/inherited practices.

The productivity of livelihoods and socio-economic activities was found to vary depending on modality of their implementation. Climate-sensitive activities such which are rain-fed farming, animal husbandry and fishing were reported to have decreased or fluctuated over the time frames of 10 years. In study areas of Pangani, Chalinze and some sub-villages of Lushoto which depend on rain availability experienced a high decrease or fluctuation in their livelihoods following the weather performance. Meanwhile sub-villages in Lushoto practising irrigation farming reported an increase and fluctuation in productivity. This difference showcases the vulnerability of dependence on weather performance for undertaking livelihood activities. For participants depending on pension, remittance and salary workers reported the least fluctuations or increases.

Meanwhile petty business reported more variations with some having increased, fluctuated or decreased. This can be attributed to the nature of the business concerned and the community's socio-economic conditions such as community purchasing power. Participants engaging in casual labour reported a decrease in job opportunities in linkages to the performed livelihood activities thus indicating a general decrease in overall socio-economic conditions. It is of importance to note, with the span of 10 years some major activities occurred which had national and sectorial impact such as the COVID-19, Russia-Ukraine war, Change in government leadership and more. These impacts though not identified by the participants but it is expected they also a contributed to the observed trends to a given extent.

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4.2.1 The distribution of gender in socio-economic and livelihood activities

When it comes to the roles that men and women play in social, economic, and day-to-day activities, there was variation between livelihoods and location. In communities that rely on herding animals (pastoralist communities), men usually own the economic resources and are more actively involved in taking care of the animals, while women participate in milking together with tendering to livestock that cannot walk in search of pasture such as calf and sick one. In agricultural activities, there is more joint efforts in undertaking of the livelihood together meanwhile in fisheries, the men are mostly engaged in fishing with the women in processing and selling of the fish. Although in petty business, women have shown more engagement over men.

4.2.2 Climate Change in the study area

All the project sites have been impacted by climate change in different levels. The commonly observed climate change impacts are drought, unpredictability of rain seasons, floods, and heat waves. The Pangani coastal region additionally faced sea level rise, saltwater intrusion, and coastal erosion. The impacts of climate change have had significant effects on the community, leading to a series of adverse effects in the study area. These include the loss/decrease of agricultural and animal husbandry yields, increase in pest and diseases for crops, animals, and human being. These effects have collectively led to food and nutritional insecurity, economic losses, and increased poverty levels in the community. The common trend observed of community dependence on single livelihood activity or multiple activities that are climate sensitive has increased their vulnerability and extent to which they are impacted by climate change extreme events. The difference in vulnerability between areas depends on the weather performance to undertaking their livelihood activities, this was mostly pronounced in with Dule Village of Lushoto whereby the sub-villages with access to water for undertaking irrigation farming reported less impacts compared to their counter sub-villages parts who depend on rain-fed farming. This is further reinforced by the participant's household who engaged in petty business reporting lesser impacts and even some reporting an increase in trend of livelihood.

4.2.3 Knowledge, Attitude, and practice on climate change

The rising frequency of extreme weather events in the study area, such as prolonged droughts, floods, and sea level rises, revealed significant vulnerability and exposure among smallholder farmers, pastoralists, and fisher folks. These challenges are impacting various aspects, including food production, water supply and accessibility. Since, most community livelihoods are climate

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sensitive, any change in rains and temperature is quickly sensed and absorbed. Some of the challenges are linked to low productivity which leads increase food prices and food insecurity. As revealed in chapter three, all study areas are experiencing climate change challenges. The majority of respondents from all project areas confirmed the presence of climate-related phenomena ranging from uncertain and unpredictable rainfall patterns and seasons, reduced rainy intensity, and floods that have increased disease and pest outbreak for crops. In addition to the above impacts, Pangani, being as a coastal district faced additional climate change threats including sea level rise, severe coastal erosion, wind speed variability, unpredictable sea storms, coral bleaching from increased sea surface temperature and saltwater intrusion into freshwater aquifers. Evidence from this study shows that the four study districts are already experiencing resource use conflicts resulting from decreasing resources against increasing resource demands and partly population increase. This experience was particularly evident in the Chalinze district between farmers and pastoralists. The elderly in the community expressed concern on their adaptive capacity as they are gradually losing energy as year progress that limiting their ability to work. This led to high dependence on their children and communities thereby making them a burden.

According to these responses, the vulnerability of these communities to climate change challenges has been exacerbated by over-dependence of climate-sensitive sectors including farming, livestock keeping and fishing. Meanwhile, the modality in undertaking the livelihood activity has demonstrated a relationship with the vulnerability of the said livelihood. This case has been demonstrated in the Lushoto district where the farmers engaged in irrigation farming reported more resilience than farmers conducting rain-fed farming. Within the project district, a good number of households use traditional agricultural, livestock and fishing practices characterized by less use of mechanisation, less use of modern practises, high dependence on weather performance and environmental conditions in the undertaking. This increases their exposure to impacts of climate change.

Despite being aware of the changing climate and experiencing firsthand its impact, the community's adaptation has varied. **Invalid source specified.** highlights the relations between climate vulnerability, community adaptive capacity and livelihood assets and activities. He demonstrates dependence on climate-sensitive sectors increases the vulnerability toward climate vulnerability and other challenges meanwhile Access to different capitals and assets (i.e. natural resource, financial capital, human capital, social capital and physical capital) were found to affect the range and choices of livelihood activities available to households as well as their ability to cope and adapt to existing and new risk. In Pangani and Chalinze districts a good number nearly half of

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the participants did not implement any adaptation action or were not aware of climate change. Although a different case was experienced in Lushoto study areas which showcased more adaptations compared to their counterparts. Basing on livelihoods, In Pangani and Chalinze agriculture showcased the most adaptation action which consisted of adopting climate-smart agricultural practices, such as planting short-term and drought-resistant crop varieties, using pesticides. Meanwhile animal husbandry mainly migrated in search of pastures, dug shallow wells or requested water from institutions which had water. Meanwhile fisherfolks they displayed the least adoption within their livelihood with exception to waiting for calm weather prior to fishing and adopting alternative livelihood options. The communities displayed least adaptation to impact of floods, sea level rise, seawater inundations whereby their only option was seasonal migration and seeking alternative livelihoods. The top three adaptation measures taken in Pangani and Chalinze study areas are use of some climate-smart agriculture practise, adoption of alternative livelihoods and conducting casual labours. The adopted alternative livelihood consists of petty business, skilled professions such as carpentry, motorcycles services, charcoal making, house-building and more. It is important to note the scale of these alternative livelihoods is mostly small scale as they are constricted by their financial capacity which in turn puts into questions their ability to support the households in to overcome and recuperate following climate disasters. As reported in each respective district's findings, the adopted measures had different degrees of effectiveness. Analysis of the reason provided for effectiveness showcases their focus was on surviving/overcoming the situation without considering its potential to support household development. When conducting a comparison of the currently implemented measures and potential measures that are viable in their locality which they could undertake to adapt it is evident there is still much that could be undertaken. This includes the building of resilience within their current livelihoods together with adopting of alternative livelihood that are resilient and environmentally friendly. It is of importance maladaptation measures such as the cases of Pangani where they shifted to charcoal production leading to deforestation are not promoted nor adopted by other areas.

A different case was demonstrated in Lushoto, where the different sub-villages displayed differences in vulnerability and adaptation measures. For sub-villages without access to rivers have one crop season meanwhile their counterparts with access to seasonal rivers have 2 crop seasons. The presence of seasonal rivers has supported them to undertake farming activities where a good number of farmers have reported increasing or fluctuating trends in their productivity which is different to farmers in sub-villages with no rivers who experienced majorly fluctuating with few

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decreasing trend. Additionally, it is important to note, farmers of Lushoto demonstrated the use of good agricultural practise that is seen from use of various methods which contributed to their resilience. The livestock practice is also seen to be more advanced as they have adopted the storage of feeds, and the low number of livestock can be supported by the available resources such as water and grass in swampy areas. With the increased intensity of climate change, environmental degradation and expansion of production the ecosystem will be more strained whereby the existing river might fail to support the community. Of current the existing river's capacity is greatly reduced as the dry seasons progress the water is ratioed between villages with more far way sub-villages missing water as the dry season progress. With increasing erratic rains, droughts and Lushoto becoming warmer, the existing rivers will fail to support the community farming practises which is their major livelihood activity. These cases studies demonstrated the need for sustainable interventions for coping with the changing climate and securing livelihoods through practical and affordable climate response solutions.

4.3 Weather and climate services

One way to minimize the impact of extreme weather is by improving weather forecasting and better communication of weather warnings. The ability to provide timely and precise weather forecasts offers the potential to reduce the vulnerability of people to the impacts of extreme weather.

4.3.1 Access and utilization of climate services

The information from TMA is accessed in form of scientific set up with the coverage of region level. The downscaled information to district level is published according to rainfall pattern zones to inform users on seasonal outlook. All communities within the study area access weather and climate information from TMA through Television and radio. The scientific information from TMA (meteorological data) is still challenge for people at the village level (end users) to understand and make informed decision. This is because the meteorological terms used are not explained in a way that is easy for non-experts to grasp. The indigenous knowledge on the other hand is accessed through word of mouth from neighbours during social gatherings though some indicators are not reliable for most of information users.

To enhance the effectiveness and efficiency of climate services, it is crucial to incorporate both scientific and indigenous knowledge in a comprehensive manner during production and packaging of downscaled climate services. This ensures that the information is inclusive and accessible to a broader audience. Dissemination of downscaled information that reaches the end user should not

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rely only on radios, television, and word of mouth. CAN Tanzania observed few climate services products that were designed to serve the specific village, but they were not detailed enough to qualify as weather and climate services products. Better approach is expected to simplify weather information and improve tailor made weather information products that focus on specific livelihoods. Such information products as bulletins and posters with detailed information, especially crop information tables, livestock information options, fish information table and other livelihoods options are essential. The study advises to improve accessibility of weather information products by reaching all informal meeting areas and arranging formal meetings at sub village level between extension officers and users of weather information before, during and after the rain seasons.

A study by Chang'a (2010) undertaken in the south-west highland reported about community being relying on forecast information from IK than that from the conventional weather forecasting here in Tanzania referred to TMA. These findings disclose the demand for the downscaled weather forecasts by smallholders specifically fisheries as of its location specific. However, the country systems (TMA) continue to encounter challenges, including technology investments that impede the timely reliability and accuracy of shared forecasts, potentially affecting livelihood planning, particularly for smallholders. Given the country's size and remoteness, traditional and indigenous knowledge remain the only hope and option in the context of informed climate services for enhanced adaptation to climate change and enhancing resilience, particularly for the rural population. This presents an opportunity to initiate the downscaling process by establishing committees at the village and district levels for improved advisory and accessible climate and weather information products.

During discussions with key informants, focus group discussions (FGDs), community members they requested improved approaches to disseminate climate services to the village level. They suggested several ways to achieve this, including holding village meetings specifically for climate services, utilizing local media, arranging on-field visits from experts, disseminating reading materials and conducting outreach campaigns. It is crucial to raise awareness and involve young people in utilizing technology such as social media to communicate weather information, current crop species, animal welfare solutions and agricultural production techniques. The government, in collaboration with development partners, should invest in text message-based climate services to downscale weather information at the village level to meet the demands of small-scale farmers, pastoralists, and fishers. This will help better adapt to and mitigate climate challenges.

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Traditional and Indigenous knowledge

The Paris Agreement recognizes that adaptation efforts should be based on current research as well as traditional knowledge/indigenous knowledge, and local knowledge systems. The IPCC Working Group II Sixth Assessment Report states that these knowledge systems provide "useful climate change information, observations, and solutions" and enable more effective adaptation outcomes. Traditional and Indigenous knowledge plays a vital role in predicting the weather, understanding climate risks, coping with climate impacts, informing, and improving responses to climate change and variability, and identifying adaptation options (Radeny et al., 2019). The economy of the population in the study areas is highly dependent on climate-sensitive natural resources, such as rain-fed agriculture, fisheries, and pastoralism. The people in the project area have remarkably close links with their ecosystems and biodiversity; consequently, the country is highly vulnerable to the impacts of climate change and variability. Indigenous Knowledge has been defined by the (Radeny et al., 2019) as "knowledge that refers to the understandings, skills, and philosophies developed by societies with long histories of interacting with their natural surroundings".

Local weather and climate are measured and projected using locally observed elements and experiences, such as wind direction, plant phenotypes, animals, insects, and astronomical indicators. This part intended to establish the link between IK and climate prediction as it relates to community awareness and socio-economic endeavors. Indigenous knowledge on weather and climate forecasting is primarily used by indigenous, particularly fishery communities, pastorals to understand and make critical decisions for their livelihoods in the face of climate change-related weather variability.

IK weather and climate forecasting remain the most accessible and affordable source of weather and climate information in the study area of pastoralists and farmers. Elders not only safeguard records of weather and climate scenarios encountered, but they also receive input from a constantly changing relationship for visible variables and indicators, as well as undetectable changes in weather and climate, to constantly update and develop their expertise. Even though the inheritance of this knowledge has been confronted by technological development facts, especially among youth, they continue to disregard this type of knowledge from their elders.

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CHAPTER 5

5 Recommendations

Based on the study findings and analysis, the following are the recommendations categorized according to stakeholders involved.

5.1 Recommendations for Ministry, Departments and Agencies

Below are some recommendations for the Tanzanian Government through the Ministry of Transport and Works, to improve the accuracy and reliability of climate services, as well as promote the institutional capacity for climate change coordination and mainstreaming mechanisms in all strategic sectors and the community:

1) Invest in the Tanzania Meteorological Authority to improve data collection and interpretation, which will contribute towards improving the accuracy and reliability of provided forecast and climate services.
2) Establish proper mechanisms to enable institutional integration of scientific weather forecasts and traditional weather forecasts, which will enable the downscaling of weather forecasts, making them more useful, accurate and reliable. The project recommends that TMA cooperate with Local government authorities and community members (traditional weather forecasts) to undertake the integration process at the district level.
3) Use SMS and local/community radios to improve dissemination of climate services within the community. The project recommends TMA to engage with the central government, telecommunication companies, and private sectors to establish a sustainable SMS-based dissemination approach. It is also recommended that TMA collaborate with LGAs (Local Government Authorities) and local/community radio channels to disseminate weather and climate forecasts. Local radio channels offer a unique advantage in tailoring forecasts and advisories to suit specific community contexts, thereby increasing their practicality and actionable nature.

5.2 Recommendations for local government

Below are some of the recommendations for local government to improve its co-production and dissemination of climate service to enable community informed decision making.

1) The project study that the local government provides support for the preservation of traditional weather forecasting knowledge and facilitates transparent information flow

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between the community and district-level leadership. To achieve this, the project suggests promoting Indigenous individuals who possess this expertise and creating communication channels to collect and give feedback on traditional weather forecasts. Moreover, strategic efforts should be made to ensure the transfer of this vital knowledge across generations and raise community awareness to counter the negative perception associated with Indigenous Knowledge (IK) and witchcraft practices.

2) District and Ward Extension Officers play a crucial role in providing extension services and advising the community on livelihood matters. However, they face several challenges, with one of the key issues being a limitation in their capacity. To address this, the study recommends enhancing the capacity of District and Ward Extension Officers to enable them to better assist smallholder farmers in interpreting weather and climatic information services. Additionally, the study aims to empower them to generate advisory services that support farmers in their livelihood activities.

5.3 Recommendations for communities.

The study provides the following recommendations for building community resilience within the community:

1) The study reveals that natural water sources, such as Umba and Bombo springs, are essential for irrigation farming in Dule and nearby villages. However, farming near these water sources poses a risk to rock aquifers in the future. Therefore, the study suggests that the community should take regular initiatives to preserve and safeguard these water sources through collaborative engagement with LGAs and development partners to ensure their sustainability.

2) For the project areas of Pangani and Chalinze, the study proposes the development of a comprehensive, community-led adaptation plan to combat the adverse effects of climate change and promote development. This entails a participatory assessment of climate and disaster risks in conjunction with opportunities and barriers for development. The resulting plan will guide various actions that can be taken at different levels to promote community resilience, guiding the actions of households, stakeholders, and local governments.

5.4 Recommendations for development stakeholders such as NGOs

1) The study recommends the various development stakeholders to partake in and facilitate the process of promoting the co-production, dissemination and utilization of climate service

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within the community. This is to be done in conjunction with building community ability to implement provided climate advisory services such as support the establishment of field schools for learning climate-smart agriculture practises, training on improved livestock keeping, and more.

2) The study also recommends that the stakeholders to advocate and support the transformation of smallholder farming, livestock keeping and fishing toward a business-led approach. The adoption of a business-led approach will enable the smallholder to realize more benefits/income from their activities which will incentivise them to invest and take more action toward resilience. Additionally, the realization of more benefits/income will support development of the smallholders and the community at large.

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