Original Research Article

Exploration of Knowledge, perception and adaptation strategies of the Mbita Fisher Community to CC/CV.

ABSTRACT

Decreasing livelihoods of fishers communities is blamed on consequences of global warming and climate change impacts. Food security and livelihoods of the world's 36 million fishers and the nearly 1.5 billion consumers rely on fish for their dietary animal protein. Past studies concentrated on fisher communities and climate variability in marine waters and oceans; mainly investigating the impact of climate variability on fish distribution and production. Limited research has addressed the interaction between impacts of climate change on the fishing activities on inland and fresh waters such as in Lake Victoria and how the fishers are coping and adapting. This article discussion focuses on Lake Victoria shore location of Mbita where the livelihood activity of local community is fishing. The interactive field study was guided by these two research objectives to: Determine the fishers' knowledge and perception of climate change and variability in Mbita sub-county. Establish the effect of gender in climate change adaptive activities among the Mbita county fishers. The study used a constructivist epistemology and the mixed methods research design to help it achieve its findings. Yamane's formula (1964) is used to get the sample size of 388 respondents from a population of 13191 fishers. Primary data was collected through use of questionnaires, interview schedules for KII and FGDs. Secondary data collection was collected through reviewing of documented information, such as the fish catch data and climate (temperature/rainfall data) of Mbita for the last 30 years data to get the trend of these elements and to determine climate variability and change. Content validity of the instrument was done through experts; supervisors. Reliability was attained through test and re-test ~~Data~~ data analysis was accomplished through use of computer based software (SPSS). Presentation was done in descriptive and inferential statistics. The findings were:_-there was gender discrimination in access and control of key fishing resources which support adaptive activities that makes women more vulnerable to CC and CCV hazards and disasters. The study found that majority fishers had clear perception of CC but only 46% had knowledge of CC. The fishers relied more on indigenous knowledge and meteorological forecasts were too technical and considered irrelevant. The study further found that erratic variations in temperatures and rainfall were greatest stressors with statistical significant p-value = of 0.02. Wet seasons destroyed infrastructure, increased weather-borne diseases and endangered the fishers' lives while dry and hot season resulted in insufficient fish catches and near starvation food consumption. Statistically loss life and access to food were significant at p-value of 0.001 and p-value of 0.000 respectively. The study found that CCA requires access and control of factors of production which were traditionally under the control of male fishers making women more vulnerable and susceptible to surviving through

chamas and table banking activities. Statistically access to and control was significant to adaptation at p-value of 0.000. The study concluded that lack of alternative livelihood opportunities/options is the major constraints to adaptation for people living in the Lake Victoria region escalated with limitation of skills outside fishing industry, limitation of other employable professional skills including lack of capital. The study recommends a transdiciplinary consientization of adaptive strategies which can translate into flexible and sustainable CCA gender inclusive livelihood activities. Future research should explore participatory action research on environmental influences affecting CCA by comparing findings across other beaches.

Key Words: Gender; climate change and ~~Livelihood~~ livelihood adaptation

1. Introduction

FAO (2011) defines the term gender in reference to masculinity and feminity; staying clear of biological differentiation. Basically gender is socially constructed roles stereotyped on men and women girls and boys. It is a central organizing principle of societies, and often governs the processes of production, reproduction, consumption and distribution. Many communities in Africa use biological gender as a development planning tool for accessing and controlling livelihood resources.

On the other hand, the importance of fish cannot be ignored. Fish is the main source of dietary protein for over 1 billion people worldwide. FAO (2012) reported that global fisheries sector supports up to 43.5 million people directly and over 200 million in associated fishery industries with the majority of these persons being in developing countries. Barange and Perry, (2010) found that fisheries employ around 10 million people is the only source of animal protein for over 20 per cent of the population in Sub Sahara Africa.

Globally fisheries are under intense pressure from habitat destruction, biodiversity loss, overfishing, pollution and ocean acidification and this situation is getting further complicated by the impacts of climate variability. IPCC (2014) observed that small scale fisher folk in the developing countries will be most vulnerable to climate change and variability due to high reliance on fisheries and poor adaptive capacity. It further stressed that climate change and variability will have a significant and long-term risk to fisheries in many tropical developing

countries particularly in Sub Saharan African ultimately undermining the benefits gained from the development of fisheries sub sector.

A number of studies have investigated the vulnerability and adaptive capacity of the fisheries dependent community to climate change and variability but there has been little emphasis at the local scale on how impacts of climate change and climate variability is affecting the lives and livelihoods of the majority of small-scale fisher folks, who make up more than 90% of the world's fishers and fish trade (Badjeck et al.2009). LVEMP study (2011) further confirmed that little has been done to establish the influence of climatic variability on fishers and their adaptive livelihoods in Lake Victoria region.

World Bank (2016) reported that the Lake Victoria Basin supports a population of 40 million providing a variety of economic and development opportunities from fisheries and tourism. This implies that all livelihood opportunities around Lake Victoria are under threat due to a number of environmental problems including pollution of the lake, biodiversity loss, habitat destruction, soil erosion and new impacts of climate change and variability. PREPARED (2014) added that the lake's shallowness, limited river inflow, demands on outflow, and large surface area relative to its volume make it highly vulnerable to climate variability.

1.2 Problem statement

Past studies of nexus of climate change and fishing livelihoods have had differing focuses. Odhiambo (2013) focused on effects of weather and climate variability affected fishing activities and fishers' adaptive capacity in Mbita Sub-county using survey method. His finding was that weather and climate variability has significant effect on fishing and livelihood activities, however he did not explore the construct gender. Sidi (2015) studied the adaptive capacity to climate change and food security among artisanal fisher folk in Rorya District, Tanzania using mixed methods. Her study found gender inequalities and disparity in access to and control to resources and education which accounted for disparities in adaptive capacities of the target study community but did not interrogate the implications of culture in these disparities. Daw *et al*. (2008) found that most inland fisheries are under intense pressure from overfishing, poor management practices, pollution and introduction of alien species. They further observed that the challenges were exacerbated by climate change impacts. The current study interrogated the influence of gender on climate change adaptation by the fisher community in Mbita, Homa Bay County, Kenya. Lake Victoria Basin is home to a population of 40 million persons yet over the

last four decades the region has faced a number of environmental problems which could jeopardize the stability of their livelihoods.

1.3 Study Objectives

i. Determine the fishers' knowledge and perception of climate change and variability in Mbita by gender.
ii. Determine the influence of gender in the current coping / adaptation to CV/ CC among the fishers in Mbita.

2.0 Literature Review

2.1 Gender and Climate Change

Gender is a socially constructed on roles, responsibilities and opportunities between men and women; boys and girls which governed by local societies and their cultures. In contemporary times gender has become a developmental planning tool for resource access and distribution as well as of organizing communities in traditional societies. It governs the processes of production and reproduction, consumption and distribution of resources (FAO, 2015). In relevance to this study gender differentials are expressed in terms of access and control of climate change adaptive resources among fishers in the study area.

Vast literature report that culturally stereotyped gender roles inhibit women access to and control of resources making them more vulnerable to impacts of climate change than men. According to Denton (2004), women are the primary resource managers yet they have less access than men to productive resources like land, credit, agricultural inputs, decision-making structures, technology, training and extension services which deepen their vulnerability to extreme climatic events.

2.2 Fishers' Knowledge and Perception of Climate Change and Variability

Swai *et al.* (2012) state that knowledge is a background factor that influences a person's attitude toward a certain behavior and thus a clear perception and scientifically correct knowledge of the causes and impacts of climate change is imperative for successful adaption to the effects of a changing climate. Neville and Mohammed (2010) state that if people are equipped with the knowledge of the changing weather patterns and understand that extreme weather events will occur more often, they will be able to debate the issues with their families and communities and discuss the risks and possible courses of actions to enable them adapt more effectively.

Nhemachena and Hassan (2007) observe that gender plays a role in perceptions of climate change and variability. They state that generally, women have limited access to information due to traditional social barriers, so they are less likely to perceive changes in climate leading to differential exposure to climate shocks and adaptation than the men. Ospina (2011) conducted a similar study– using– a gender lens and found that availability, access to and dissemination of information and knowledge remains the most challenging aspects of communicating climate change information particularly to women who least go to community gatherings where information about climate change may be– shared. He further reported that other related limitations to communicating climate change information included the abstract nature of climate change; lack of qualified personnel; lack of documentation; and limited information on climate change. In short there is a lack of useful information which is scripted in simple enough language responding to local needs and priorities of alternative livelihood options

2.3 Fisher communities coping and adaptation strategies

Climate change and variability is viewed to have its greatest impact on poor households because they have the lowest capacity to adapt to changes in climatic conditions (Salau *et al*., 2012). The ability of individuals and communities to adapt to climate change depends on their vulnerability, exposure and adaptive capacity (Amwata *et al.,* 2015). In turn, this is related to their financial and social capital, such as social networks. Their exposure and vulnerability to climate change impacts is also related to the existing infrastructure and institutional framework, including government sponsored social safety programmes. Their adaptive capacity also depends on their ability to acquire assets, such as insurance, technologies, and knowledge (Bene 2011).

Studies have illustrated that fishers adapt to the impacts of climate variability and change in various ways. When faced with declining yields, income and food security, fishers may seek alternative resources. For example, in West Africa, when coastal fisheries resources are scarce, fishers adopt alternative livelihood strategies including hunting for bushmeat (Brashares *et al*., 2004). On the Lake Malawi area the fishers cope by diversifying into farming and pastoralism while others migrated in response to the decrease in fish catches that followed the drop in lake levels (Njaya *et al*., 2011). On Lakes Kyoga and Albert in Uganda the fishers shifted from using gillnets to mosquito seine nets in the Mukene fishery (Ogutu Ohwayo *et al*., 2013). Despite variability in climate and vulnerability of the fisher-folk community in Mbita Division, no systematic studies have been carried out to determine the impact of weather and climate

variability on their fishing activities and how they are coping. This study therefore sought to establish the impact of weather and climate variability on the fishing activities of the fisher-folk and the coping and adaptive strategies of the fishing community in Mbita

Williams and Rota (2010) propose that adaptation responses to changes in the fisheries sector must center on boosting adaptive capacity and resilience of both communities and ecosystems on which they depend. They suggest adaptation should not focus on altering catch size and effort only but on building communities to adapt and allow taking advantage of new opportunities in coping with climate change consequences.

3 Conceptual Framework

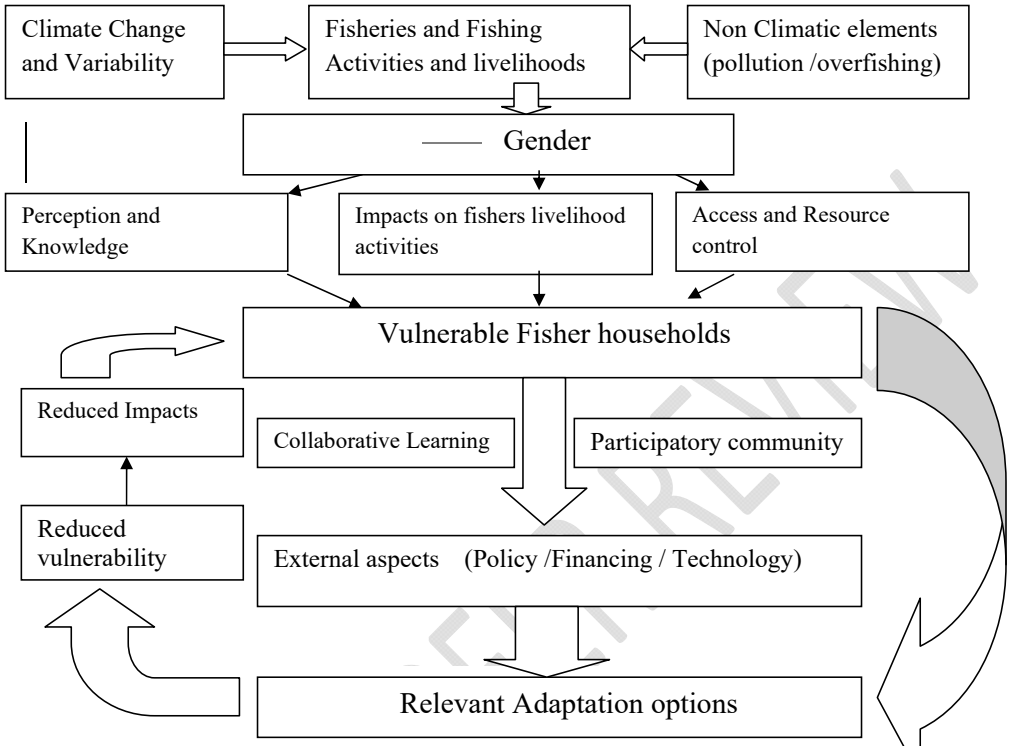

Fig 1 - Conceptual framework by researcher 2019.

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The operationalization of the conceptual framework brings a holistic approach to comprehending the influence of gender on climate adaptation by the fishers in Mbita. It integrates the social constructivism research paradigm and the sustainable livelihoods together with the transdisciplinary research methodology. The framework identifies that climatic and non-climatic elements influence fish, fishing activities and fishing livelihoods from the volumes of catches, varieties caught, the catching, processing and marketing of the fish. The outcome of this complex situation interacts with the dynamics of gender which used here as a differential planning tool that is strictly observed by the local cultural norms and values within the fisher community. These norms mediated with gender interface interact differently with perception and knowledge; livelihood activities and resource access and control accounting for the different levels of vulnerability. Navigating to sustainable livelihoods requires the participatory community

processes involving all interested persons for the reasons of bringing their knowledge ,considering interests and perception of constraints, as well as to implement an empowering process which would translate into diversification of livelihood activities .This reinforced with collaborative learning will help bring consensus on the threshold of plausible adaptation activities which will then reduce vulnerability and thus the impacts forming a cyclic pattern through which the fisher community can address CC instigated shifts to attain a more sustainable adaptation.

3.2 Area of study

The study focuses on Mbita in Home Bay County, a small, rural town located along the shores of Lake Victoria, near the southwestern border of Kenya, located on a peninsula, with water on three (3) sides and surrounded by picturesque islands between latitudes 0^{o} 21' and 0^{o} 32' south and longitudes 34^{o} 04' and 34^{o} 24' east (-HCIDP, -2017). PREPARED (2014) projected temperature increase in the Lake Victoria Region (3 to 4°C) by the end of this century a state that would further affect the region's rainfall regime. This coupled with dwindling fish stocks due to overfishing will increase the pressures on the fishers' livelihoods.

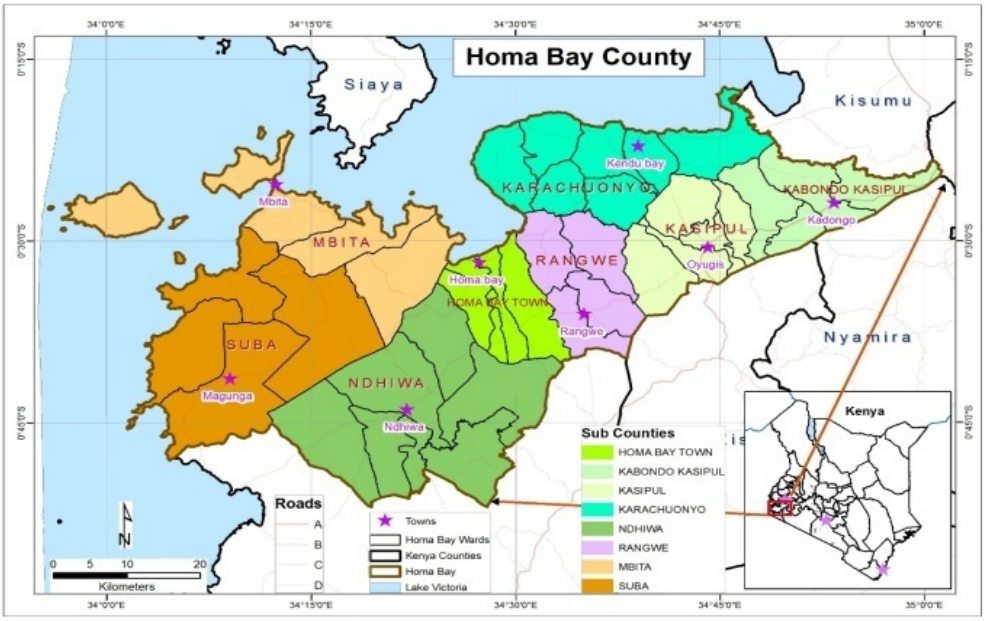

Figure 2 : Map of study area.

Source: GoK (2013).

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3.3 Study design

The study used mixed methods research design. Tashakkori, and Teddlie (2010) explain that mixed method enables researcher to complement qualitative approaches with quantitative ones in order to allow for more complete interrogation of the study variables

3.4 Target Population

The study targeted 13191 who are scattered across the Rusinga and Mbita (Lake Victoria Fishers frame survey, 2016).

3.5 Sample size and Sampling Procedure

The sample size was calculated using Yamane's formula: Yamane (1967) states, for a 95% confidence level and p =0.05, size of the sample should be $n = \frac{N}{1} + N(e2)$where, N is the population size and e is the level of precision. In using this formula to get a sample number from our population, in which N =13,191 with ±5% precision. Assuming 95% confidence level and p =0.05, we get the sample size of 388.

3.6 Data Collection Procedures

The researcher obtained all required permits from the graduate school of UoN. Quantitative data was collected using semi structured questionnaires while qualitative data was collected using FGDs and KII interviews. –Secondary data consisting of published peer reviewed scientific articles focusing on climate variability and change perceptions, impacts of climate variability and change on fisheries, adaptation in the fisheries sector will be consulted.

Meteorological data from the Meteorological station in ICIPE to get the temperature and rainfall trends and data on fish production will be accessed from the Fisheries Department in Homa Bay Fisheries office and the BMU offices in Mbita will be analyzed to give further insights into the study.

3.7 Data Analysis and Presentation

Data was analyzed using computer supported software SPSS –and presented in descriptive statistics while qualitative data was analyzed thematically and presented in prose.

4 FINDINGS AND DISCUSSIONS

4.1 Socio-demographic characteristics of the respondents

The study found that the majority (65%) of the fishers' respondents were male while 35% were female. On age distribution, only 3 % were <19years of age; 32 % were between 19-28 years of age ; 40 % were between 29-38years of age; 16 % were 39-48 of age; 5 % were 49-58 and 1.9 % of them 59+ years. The age group (19-28) yrs. represented the most energetic and economically productive segment who undertakes tedious activities of fishing processing and vending fish and fish products as well as taking care of the very young and old age groups. This finding is consistent with (Odhiambo, 2013; Lwenya *et al.*, 2009) whose findings showed that the average age of fishers in Kenya was can be averaged at less than 35 years old.

On marital Status, it was found that 77 fishers making up 25.1% of the sample were single; 55 of whom were males and 22 females; 118 making (38.5%) of the sampled married of whom 80 males and 37 females; 26 (8.5%) of the sample were divorced 15 of whom were 11 females and 4 were males; 57 (18.6 %) of the sample were separated 34 males of whom 23 were females and 11 males and 28 (9.2%) of the sample were widowed/widowers whereby 15 were males and 13 females .

On education level of the sampled fishers the study found that 11(3.5%) had no education at all: of these 7 male and 4 females; 155(50.6 %) had primary education of whom 93 males and 62 were females; 120 (39.2%) attained secondary education of who 84 were males and 36 females; and finally 20 (6.5%) acquired some tertiary education of whom 17 males and 3 females . These results were consistent with Odhiambo (2013) who found that (49%) of his sample had attained primary education; 42% attained secondary education; and 6.3% had tertiary/middle college education while 2.7% of his sample no formal education. The finding is also consistent with SEDAWOG II (1999) that found that more than half of fishers in Lake Victoria have at most primary level of education. Idrisa, *et al.*, (2012) found that education plays an important role in creating awareness in fishing communities therefore educated people are better equipped to source information. Thus the profile of education of the sample mapped the trend of the levels to which climate change information could reach the fishers.

On household's headship the study found that 195(63.7.9%) were male headed; 97(31.7%) female headed and only 4(4.6%) child headed in proportion of 2female and 2 male (child headed) households. Out of the female headed household (29.8%) had open-access fisheries which enable widows and unemployed youth make a living from it. This finding is similar to that of Egbule (2010) who found that 65 % of the fisher households were male headed 34 %female fishers in the Niger Delta region of Nigeria.

Concerning household size, the study found that 175 (57.1%) of the sampled households of whom 112 males and 63females were living with between 0 - 3 people in their houses; 123(40.2 %) of whom 82 males and 41 females were living with 4 - 7 people in the household but 8 (2.6%) reported that they were living with 8+ people in the same household: of these 7 were male and 1 female supports the earlier findings by Lwenya *et al.* (2012) who found that in Kenya, on average, majority of fishers in Lake Victoria have 4 children per family and dependents ranging between 4 to 12 people per fisher.

4.1.2 Livelihoods and Livelihood activities

The study found that 204 (66.6%) of the sampled fishers solely depended on fishing as their main source of livelihood of these 134 were male and 70 female. The study established that next dominant source of income was mixed cropping and fishing accounting for 71 (23.2%) comprising of 48 males and 23 females; 17 (5.5%) engaged in livestock rearing distributed in 13males and 4 females and 14 (4.5%) of the sampled fishers engaged in other activities of whom 6 were males and 8 females.

On roles taken in the fishing activities 27 (8.8%) the respondents owned or made boats disaggregated into 19 males and 8 females; 137 (44.7%) of the respondents were either fishermen/boat crews and were all males. It was found (68.1 %) of respondents had direct fishing roles were males; while 105 (34.3%) composed of 79 females and 26 males engaged in fish marketing.

Study sought to establish the duration of time the respondents, 64 fishers (20.9%) of the sample reported that they had been involved in fisheries for <5 years; of these 43 were males and 21 females; 134 (43.7%) of the sample had been in fisheries for a period of 6-9 years in distribution of 85 males and 49 female; 62 (20.2%) of the sample had been in fisheries for between 10-14 years in distribution of 38 males and 24 females; 29 (9.4%) of the sample had been in fishing for

between 15-19 years distributed into 21males and 8females and 17 (5.5%) of the fishers stated that they had been in fishing for a period exceeding 20 years. They comprised of 14 males and 3females. –From the trend all the sampled fishers had been in the trade long enough to take note of significant changes in the climate as it affects their fishing activities and livelihoods. These results were consistent with those of Odhiambo (2013) and Sidi (2015) who found out that most fishers had been in the fisheries for periods between 5-15 years.

On estimated of monthly incomes; 161(52.6 %) respondents comprising of 99 males and 62 females made (0- 4999) Ksh a month; 80 (26.1 %) comprising of 56 males and 24 females made (5,000 – 9 ,999) Ksh a month; 33 (10.7%) of the sampled fishers made 10, 000 - 14999 Ksh a month in the distribution of; 16(5.2%) comprising of 24 males and 9 females made (15,000 to 19,999) and 16 (5.2 %) in distribution of 9 males and 7 females made Ksh20, 000/- plus in month. This findings supports (Omwega, 2000) that found that that the average boat owner earned in the range of US $ 65 per month in Lake Victoria Kenya; and in a good week, fisher folk earned approximately Ksh.7,750, while in a bad week they earned Ksh.1, 822 a week .These findings confirm that majority (52.6%) earned a fairly low income and this could be a constraint to effective adaptation to climate change.

On social groups and Information sharing the study found that the fishers belonged to a variety of social groups with majority 266(86.9%) comprised of 177males and 89 females belonged to Fishers/BMU; 163 (53.2%) comprising 102 males and 61females were in gender and loans savings and loans groups (GSL) through which they shared information relevant to their activities. The learned from FGD that other groups ranged from church, agriculture to welfare 111 (36.2%) comprising of 42 males and 69 females were in church groups, 109 (35.6%) comprising of 63 males and 46 females were in economic credit group and remaining 24 (7%) made of 18 males and 6 females were in other undefined groups. The finding on groupings was consistent with Weeratunge *et al*. (2014) who found that rural dwellers belonged to organizations that would help them in satisfying their innate need for belonging and affiliations that would assist them in solving their problems through collective efforts. This implies that information on fishing and climate change issues can be disseminated quickly to members of the different social networks whether economic or religious.

4.2 Knowledge and Perception of Fishers towards temperature and rainfall changes

4.2.1 Observed changes in temperatures in the last 10 years based on Perception

Perception elicited divergent responses from the respondents concerning perception temperature and rainfall patterns over a period of 10 years. The majority 208_(68%) of the respondents comprising of 139 males and 69 females agreed that they observed seasonal increases while 226 (73.8%) comprising of 148 male and 78 females of the respondents appeared not to have noted any marked decreases however; 13 (4.3%) comprising of 9 male 4 females were categorical that they observed decreases in the annual temperatures. The majority 229 (74%) of the respondents associated hotter months with dry months conversely 215_(70.2%) of the respondents agreed that it was coldest during the wet months. The men who actually went in the lake finishing had the clearest notion of changes in temperature while women processors were able to associate fish catch volumes with the changing temperatures.

4.2.2 Observed changes in rainfall in the last 10 years during

Responding to changes on rainfall onset trends, 283_(92.4%) reported that the onset had become unpredictable over the last ten years and this made it challenging on their livelihood activity planning. Majority 284 (92.8 %) said the onset came consistently later than expected out these, 209_(68.3%) of the respondents explained that the rains would come late and was much higher than expected associated with havoc to fishers. Overall, 273_(89.2%)_of the respondents comprising of 183 males and 90 females confirmed that rains have become more erratic and that there had been consistent change in rainfall pattern associated with flash floods and devastating weather disasters.

From the FGDS respondents demonstrated that they were fully aware that climate is changing and rainfall becoming low and inconsistent with unpredictable onset dates and haphazard distribution; the temperatures were becoming increasingly higher. The fishers observed that extreme weather events such as droughts and floods are the most important climatic stressors with negative impacts on their households. Extremes of temperatures and occurrence of flash floods translated into decline in fish catch, sizes and types. Most fishers stated that they could no longer predict when the rainy and dry seasons were going to start or end. Many fishers also stated that there were more unusual patterns with winds with more sudden storms arising over the lake, endangering their lives all which were evidence of the climate variability in the study.

4.2.3 Scientific Climatic Trends in Mbita Division between 1987-2017

Presented below are graphical image constructed from 30 years period climatic raw data sourced from ICIPE Meteorological station. This was a critical indicator for confirming the phenomenon of weather and climate variability in the region as can be seen on the graphs displayed below.

Rainfall Trends

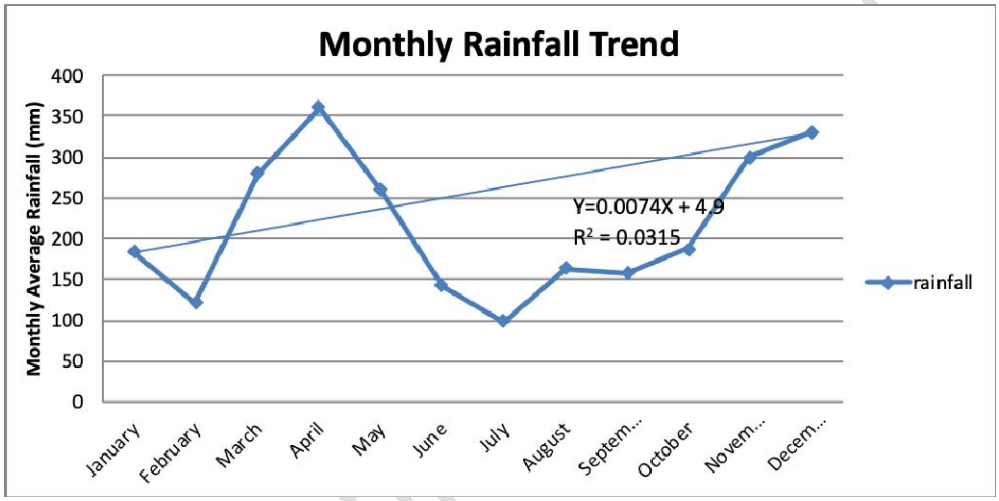

Figure 3 - Monthly trends of rainfall data for Mbita: 1987-2017.

Source: Data from Mbita ICIPE Meteorological Station.

4.2.4 Monthly rainfall trends

The recorded monthly data on rainfall from 1987 to 2017 depicted two rainy seasons March-April-May Long rains and from September-October-November short rains. April had the highest amount of rainfall over the years recording an average of 206.5 mm; February recorded the lowest rainfall over the years with an average of 55mm, with the analysis showing the monthly rain had decreased by about 27.92 mm as per table 1 below confirming the area is already experiencing rainfall variability .

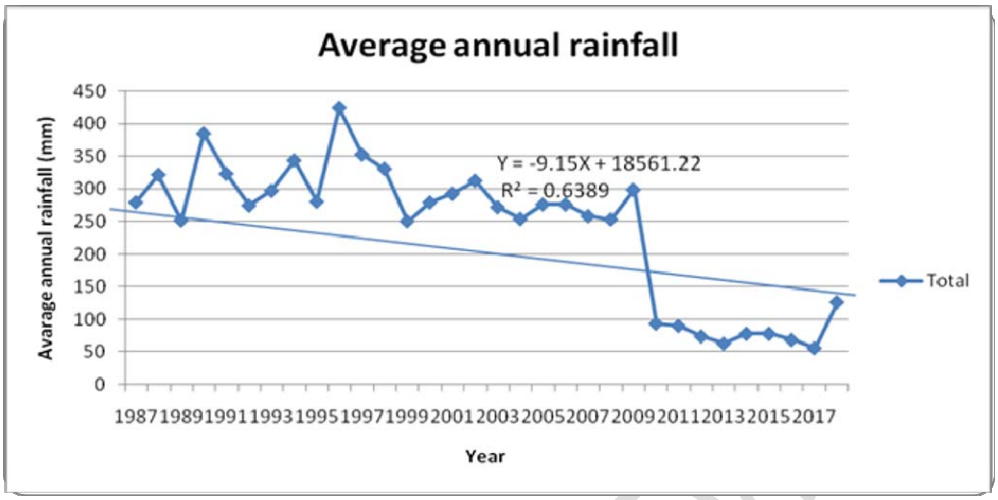

Figure 4 - Annual rainfall trends for Mbita: 1987-2017.

Source: Data from Mbita ICIPE Meteorological Station.

4.2.5 Annual rainfall trends

For the 30 years under consideration 1987 to 2017 showed a highly variable trend of rainfall as by Fig 4 There was an overall decrease in annual rainfall by 5.1 mm during the period (Table 1). During this period .Between 1987-1988 the rain showed an increasing trend from 900 -1000 and a rise between 1989-1990 before a sharp fall in 1991 before levelling back in 1993.Thereafter the rainfall was highly variable with rises and falls in annual totals till 2017 as shown in fig 4.The irregularity in rainfall pattern from these records points a clear indication to weather and climate variability with some years like 1997, 2002 and 2006 have exceptionally high average rainfall of over 140mm, while others have lower than 100mm.

Table 1: Analysis of rainfall data from 1987 to 2018

Rainfall	Monthly	Year
Mean (mm)	215.5	237.7
Standard deviation (mm)	86.7	107.4
Trend (mm/year or month)	0.00	0.00

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Total change calculated from the trend_(mm/30 years)*	**-27.92**	**-5.1**

*Total change is the difference between the trend line value of the last and first year.

Temperature Trends

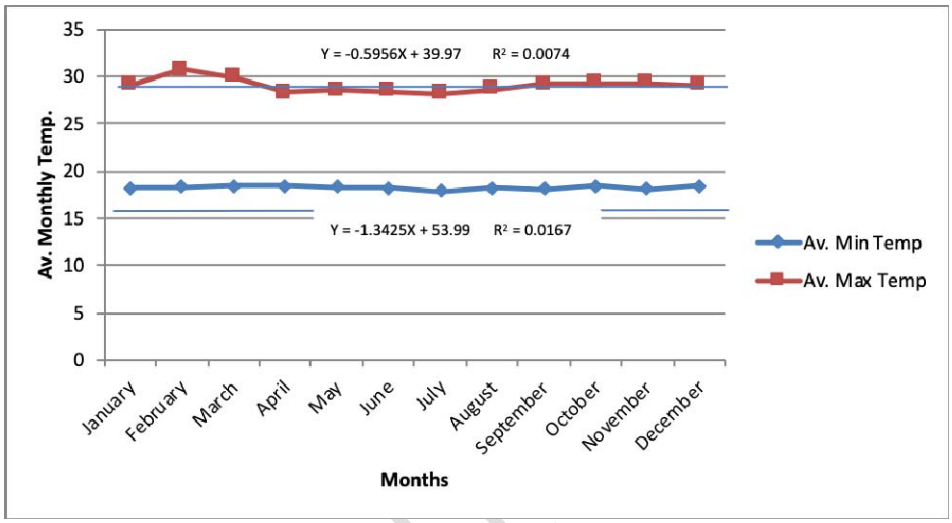

Fig 5 ÷ Monthly trends of temperature data for Mbita: 1987-2018

Source: Data from Mbita ICIPE Meteorological Station.

4.2.6 Monthly temperature trends

For the period between 1987-2017 February is the warmest month of the year with temperatures averaging 23.6 °C with the lowest temperatures In July, with average temperature is 21.6 °C as shown in Fig 5 above.

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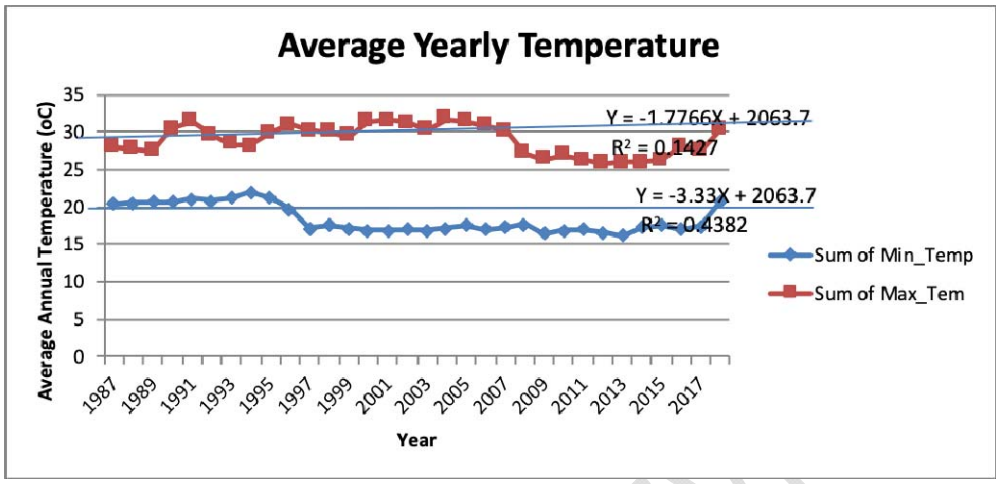

Fig 6 ÷ Yearly trend of temperature data for Mbita: 1987-2018

Source: Data from Mbita ICIPE Meteorological Station.

4.2.7 Annual Temperature trends

The yearly temperature distribution over the thirty year period shows patterns of unstable temperatures for both the maximum and minimum temperatures (figure 5 with the statistical analysis of temperature data for Mbita between 1987 and 2018 showed an increasing trend. The minimum temperature had risen by around 0.07 0C but the maximum temperatures had decreased by 0.007 0C (Table 2) below while the annual minimum temps had gone up by 0.007 and the maximum by 0.07.This depicts a warming trend in the area although statistically the trends were non-significant thus this is attributed to climate variability and not change.

Table 2 Statistical temp analysis

Temperatures	**Monthly**		**Yearly**	
	Min	**Max**	**Min**	**Mix**
Mean (^{O}C)	18.2	29.0	18.3	29.0
Standard deviation (^{O}C)	0.35	1.4	1.8	2.0
Trend (^{O}C/year or month)	0.962	0.973	0.974	0.77

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Total Change calculated from the trend (^{o}C/30 years)*	**0.03**	**-0.03**	**0.007**	**0.07**

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Source: Mbita ICIPE Meteorological station 1987-2018 data:

*Total change is the difference between the trend line value of the last and first year.

Table 3 - Statistical significance of Perception of the fishers to Climate Change

	Agree		Don't Know		Disagree		p-value
Perception	**Male(Yes%)**	**Female(Yes%)**	**Male(Yes%)**	**Female(Yes%)**	**Male(Yes%)**	**Female(Yes%)**	
Rise in annual temperature	70.56	65.71	29.44	30.48	0	3.81	0.021***
Lowering in annual temperature	6.6	11.43	22.34	21.9	71.07	66.67	0.345
Hotter during hot months	71.07	80.95	25.89	17.14	3.05	1.9	0.171
Hotter during cold months	62.44	50.48	32.49	36.19	5.08	13.33	0.020***
Rainfall comes earlier	5.13	0.95	10.26	9.52	84.62	89.52	0.176
Rainfall comes later	89.74	96.19	4.62	0.95	5.64	2.86	0.123
Total rain higher than usual	62.37	64.76	30.93	29.52	6.7	5.71	0.9
Rain more erratic	83.76	84.76	13.71	12.38	2.54	2.86	0.939

***Statistically the fishers agreed to having seen a rise in the annual temperatures due to climate change with a significant p-value = 0.02. This is a clear indication that change in climate was causing rise in annual temperature according to the fishers. A similar trend was also seen on if climate change led to hotter weather during cold months which gave a significant p-value of 0.02 an indication that the fishers thought climate change had led to hotter weather during cold months. Although climate change had some effects on all the other variables such as; lowering of annual temperature, hot weather during hot months, earlier rainfall, and later rainfall, total rain that is higher than the usual one, and a more erratic rain, the effects were not statistically significant registering A p-value < 0.05.

4.2.8 Knowledge of climate change and variability

Responding to knowledge kevel of effects of CC, 132 (43.1%) had heard about climate change and that it had effects on fish catches. The remaining 174(56.9%) of the respondents claimed no knowledge of CC phenomenon. Statistically tested for its significance on the fishing activities the regression display show a p value of 0.017 it is notably significant yet only 43.1% of the fishers reported having knowledge of it; more male fishers were knowledgeable on climate change than the females implicit of cultural bias of educating males over females thus empowering them to more knowledge access than women.

Chart 1 ÷ Statistical correlation of knowledge level of the fishers on climate change

Knowledge on C.C.	Male(%Yes)	Female (% Yes)	p-value
	46.3	37.1	0.017****

These findings are consistent with reports of Nzeadike *et al*, (2011) that found that the level of scientific knowledge of the local communities of climate change was still low in the Niger Delta region of Nigeria but is in contrast to the findings of Musnguzi (2013) and of Aphunu and Nwabeze, (2012) who found in their studies that there was an increasingly high knowledge and perception of climate change among the fishers.

4.2.9 Co-relating meteorological climate trends and perceived climate trends in Mbita

Understanding perceptions of communities on climate change and relating it to meteorological evidence is important in planning adaptation strategies with rural communities. Comparing perceptions of fishers on rainfall change with meteorological rainfall trend shows that perception on annual rainfall trend does not agree with meteorological rainfall trend for the study area.

Most fishers correctly listed the years 2015 and 2017 as the hottest they have experienced in the last 10 years and 2010 and 2012 as the coldest years they have ever experience in the region . The scientific data from ICIPE corroborated this as true with the 3 years having maximum temperatures ranging from 29-320c annual averages-. The fishers also correctly reported that the months of February, March, and November as the hottest months in every year, while July,August and September as the coldest months.

Accordingly, the fishers also reported, the wettest year ever experience in this region in the 10 years as 2004, 2006 and 2008 which all had over 2000 mm and the driest as 2010 2012 and 2013.These were all correct except for 2010 which had over average rains of 616mm but looked dry as the previous year had enhanced rains of over 2369 mm as corroborated by the scientific data.

When asked about the changes they have observed during focus group discussions the fishers highlighted that temperature is increasing there is a high frequency of dry periods, the rainfall amount are decreasing, there is an increase in mid- season dry spells, rainfall is becoming intense and patchy, and the onset of rainy/growing season is increasingly unpredictable and in most cases starts later than normal. This was consistent with the climatic data as indicated by temperature trend analysis. The fishers perceived that temperature has been increasing in Mbita County in the last 30years. This shows that the impact of global warming is already being felt by people living in the rural areas.

4.2.10 Causes of Climate Change

From the FGDs the fishers perceived climate change to be caused by a range of factors which were broadly categorized into three clusters: in agreement with scientific understanding; in contradiction and those who didn't know the cause Most respondents were in the 1st cluster which included human activities, destruction of vegetation/trees, poor farming practices while category; 2nd cluster of responses believers of super natural forces/God,_seasonal changes and change in wind systems .the broader picture shows that these findings were consistent with those from household surveys. The finding was further consistent with IPCC (2013) and Niang *et al.* (2014).

Characterizing perception by age, the older fishers viewed CC from traditional lenses attributing the causes to their ancestors emotions who would be angry due to ignoring cultural norms and beliefs by current generation hence, they believed that the spirit of ancestors controlled the cosmos and brought in adverse changes in weather overtime leading to changes in climate as punishment to the modern society.

Contributing to observable human activities which brought CC, respondents explained that cutting of trees (deforestation) for agriculture or habitation and industrialization was repeatedly

cited as cause of climate change; also burning of firewood and charcoal as sole sources of cooking energy; pollution of water bodies due to low latrine coverage in the area as well as sand mining along beaches and inside the lake.

4.2.11 Sources of information

Responding to sources of CC information in interactive sessions the respondents stated they mainly relied on their personal experience and traditional systems to monitor and forecast the local weather and climatic conditions as they believed this was the most precise and accurate means .The change indicators included animals (frog, ant, crow, cowbird, and fish); atmospheric and celestial and astrological bodies (the moon, sun, stars rainbow, clouds, and the wind, and lake conditions). Several indicators signal the start or end of a rainy or dry season. For instance as one participant indicated, '*the things around us shows us what will happen for example before the beginning of a season or end the sound of frogs in June indicates rain. Hot sun indicates rain, Ants carrying food shows heavy rains and a dark moon will show dry season is coming*'

Other than their interpretation of natural phenomena the fishers also stated that they sourced and received most climate related information mainly from the radio, because of its easy access, as it is even on the phone an item just about anybody owns; they mainly tuned into (Ekialo Kiona Suba Youth Radio, Sunset FM, Ramogi FM; and Rusinga FM) all which informed them of when not to go fishing if the weather could be dangerous. Word of mouth came up strongly as channel of information among relatives and friends, besides some said they got information through workshops and public meetings/baraazas, convened organized by the local administration authorities. The finding was consistent with that of Tologbonse *et al* (2010) who found that the most important information source on climate change was through personal experience followed by radio and television. Responding to the distinction between ''climate change'' from ''weather'' patterns or events the respondents were able to share that ''climate change'' was associated with long-term changes while weather patterns were short term observed day to day.

4.2.12 Relevance/use of information

Most of the fishers did not think that the information they received was beneficial as it did not explain to them the conditions to look for to know what changes to expect and they felt that the information is not tailored for them. The broadcast were in expert language was not relevant to

their fishing activities. Asked what kind of information they would like to receive, the fishermen were interested in short-term forecast of wind direction and movement of water currents. Most fishers interviewed reported that the weather and climate information they received was not relevant to their operational decisions instead relying mostly on traditional methods and experiential understanding A few who thought it was relevant reported they used the information to organize and make decisions on when to go fish and when not to depending on the forecast. One respondent stated; "*The information on weather and climate is not directed to fishers but more for farmers and we only use it as a guide. To make it worse most times even the predicted weather does not come to pass or happen so we rely on ourselves to understand the changes and plan how to deal with them.*"

4.2.13 Perceptions of the future climate

Responding to the projected perception of CC, the older fishers were pessimistic because they held the view that CC is a natural phenomenon beyond human control and therefore they have to be accepted as normal for they believed strongly that there is very little people can do about it. Some women fishers also expressed a fatalistic view of the world coming to an end and extreme weather being one of its many progressive indications. The majority of fisher respondents were in consensus that the weather patterns will only continue to worsen; meteorological prediction is more and more erratic about rainfall resulting into less stable seasons with a marked decrease in rainfall amounts and increase in temperatures. The fishers attributed the decrease of forest cover to new land-use for settlement and for agriculture and infrastructure which would make the climatic changes become evenworse. Few fishers however were optimistic that the trends could be reversed and even restored if the government became more aggressive in enforcing policies of no cutting of trees and ensuring afforestation and re-afforestation programmes.

4.3 Findings on objective 2 which sought to establish the adaptation strategies– of the fisher community in Mbita. The study found completely gendered adaptive activities which were consistent with roles men and women played in fishing as part of their livelihoods.

4.3.1 Shifting Fishing Time

The majority 172 (56.2%) of the respondents out of whom 168 were males and 4 were females. During the rainy weather they went fishing early in order to reduce risks associated with

afternoon storms; this finding was consistent with Nagy *et al.* (2006) who found that fishermen adapted by using cautious behavior to avoid weather related risks.

4.3.2 Fishing for Longer Time Periods of Time

Just 142 (46.4 %) of the respondents comprising of 139 males and 3 females stated that they fished for longer time going into deeper waters during dry seasons compared to earlier times when fishers were fewer. On using wrong fishing nets 122 (39.9 %) of the respondents said that they changed fishing nets and boats to catch undersize fish of these; changing of boats was necessitated to cope particularly with strong winds. Boat owners invested on bigger engines and more fuel to go further into the lake and enabled them better catches; 95(31%) of the respondents comprising 92 males and 3 females said that they resorted to catching any fish species.

4.3.3 Marketing Adaptation

The majority 86 (28.1%) of the respondents comprising of 46 males and 40 females selling big fish to only big buyers while in effort to support marketing of fish 101 (33.1%) of the respondents composed of 34 males and 67 females processed fish before selling it to small buyers for a higher prices.

4.3.4. On use of savings to sustain household.

The majority 167 (54.8%) used their saving to sustain their household when fish catches dropped. On having received help from family members to help sustain their livelihood 165 (53.9 %) of the respondents comprising 127 of males and 38 females received help from family members.

4.3.5 On selling of assets to sustain their livelihoods

Only 104 (33. 9%) made of 78 males and 26 females resorted to selling their assets to sustain their livelihoods during the times of acute fish shortage. From FGDs across the beaches sampled, the female fishers reported that they obtained permission from men to sell / it the men who actually sold the property as *bonafide* owners of what families owned culturally.

4.3.6 Migratory fishing

Only 124 (40.5 %) respondents comprising of 103 males and 21 females said that they had migration to places/beaches with more fish intermittently. From FGDs across beaches, the study found that males temporarily migrated to other beaches or even to other lakes to cope with climate variability which reduced fish catches; they also migrated to calmer and better fishing waters like Lake Turkana and Uganda waters. These findings supported earlier findings by Fauzi and Anna (2010) who reported that fishers employ a variety of techniques like temporal and seasonal migration and diversified income to cope with uncertainty. The few females who migrate between fishing sites did it to buy fish for resale and particularly when there was not enough fish at the beaches where they were and had to meet tender orders from their regular customers.

4.3.7 Other Adaptive Strategies

From FGDs the study found that most of the fishers had adopted multiple occupations/alternative livelihoods to deal with reduced fish catches and subsequent lower incomes. These included small businesses like running bars/hotels/selling second hand clothes, betting/selling harvesting sand, firewood and seeking formal employment in hotels (Plates a-d)_linked over many generations in the overall objective of achieving household nutritional security reducing their vulnerability.

a) Clothes vending as alternative/supplementary activity- - Women mainly

b) Plate Double engine boats fitted with Refrigeration system by men exclusively

c) Firewood for processing fish (technically

d) Sand harvesting by women (culturally male role) mal-adaptation; forest destruction) mainly men

Further, some male fishers shared that in extreme cases of CC, they sold their livestock (particularly small livestock such as goats, sheep and poultry) during times of low fish catches and incomes and food shortage. This finding was consistent with (Eakin, 2005; Weeratunge *et al*. 2014) who established that during food shortage farmers coped with food shortages by selling small livestock in order to acquire sufficient funds to purchase maize. Some male fishers also operated *bodaboda,* motorbike riders, charcoal burning, firewood and sand, hiring themselves out at construction sites, becoming watchmen, home guards and casual workers however the younger males resorted to *sport pesa* gambling as an alternative livelihood.

Allison and Ellis (2001) in their study in South Java Indonesia reported similar findings that coastal artisanal fisheries for small pelagic species often switched between rice-farming, tree-crop farming and fishing in response to seasonal and inter annual variations in fish availability. The fishers shared that for Lake Victoria, fishing and farming (and livestock herding) have

become inextricably linked over many generations in the overall objective of achieving household nutritional security reducing their vulnerability. They explained that responsive adaptation strategies were short term responding strategies which are often less structural and more often seen as individual household response strategies. The studies found that majority of the strategies used by the fishers were responsive adaptation strategy as they are not coordinated by any other stakeholders but the fishers themselves. Some of the strategies used by Mbita fishers could be considered mal-adaptation as some of them triggered environmental degradation through destruction of forest, using unauthorized fishing net to catch underweight fish among others. Shifting fishing sites and using twin engine boats were found to be climate smart options of adaptive fishing but had cost implications. This finding supported earlier findings by Chali *et al*. (2014) whose study focused on Lake Kariba which reported that the new fishing boats in Siavonga district reduced fuel cost as climate-smart since mitigated the release of greenhouse gases from use of fossil fuels.

On the whole the fishers observed at all beaches that there was need to reduce fishing frequency, they had limited alternative economic activities that are environmental friendly; male fishers pointed out that; there fishing activity for it to remain viable livelihood venture. They even suggested fishing policies that would close lake fishing for at least three months to allow fish breeding and growth. They suggested the encouragement of alternative economic activities like farming, shop-keeping, but this could only work for fishers who owned land; migratory fishers would still have no alternatives. Moreover the fishers decried inadequate institutional support and inappropriate policies and inaccessibility to natural resources by majority of the fishers

Table 4 Determination of statistical significance of the fishers communities coping/ adaptation strategies to CC in Mbita.

Climate change adaptation	Male(Yes%)	Female(Yes%)	p-value
Shifted fishing time	83.5	3.8	0.000***
Fish for longer time period	69.2	2.8	0.000***
Fish further away than before	67.7	3.8	0.000***
Changed fishing nets/boats	56.7	7.6	0.000***
Catch any fish species	45.8	2.9	0.000***
Sell to big buyers	22.9	38	0.676
Process and sell to small buyers	17	63.8	0.000***

Received help from family members	20.12	48.98	0.000***
Used savings to sustain household	44.2	74.3	0.074
Sold assets to sustain livelihood	45.3	35.2	0.000***
Migrated places to places	51.2	20	0.001***

As represented in the table the adaptive and coping strategies used by fishers were gendered and roles stereotyped on cultural approval of the local community. Shifting of fishing time was practiced by 83.5% of male respondents and only 3.8% female respondents with a statistical significance of p-value of 0.000; confirmed that only the males did the actual fishing the 3.8 % females who were in the shifting fishing were boat owners and could influence decision of where to go fishing. Again fishing for a longer time as a coping/adaptation to CC strategy was adapted by 69.2% male respondents while only 2.8% female counterparts were into longer time fishing adaptation with a statistical significance of p-value of 0.000. On fishing further away than before was practiced by 67.7% of the male respondents while only 3.8% of their female counterparts who were boat owners practiced it giving a statistical significance of p-value of 0.000. On changing their fishing nets/boats; 56.7% male respondents practiced with only 7.6% of their female counterparts who hired male fishers had taken this up because most of the fishing equipment is owned by the male fishers with women owning more processing equipment ,this was statistically significant with a p-value of 0.000.When asked if they had resorted into catching any fish species as a coping and adaptation strategy;45.8% of the male fishers respondents agreed with this while only 2.9% of their female counterparts agreed with this, this was statistically significant with a p-value of 0.000.

Processing and selling to small buyers as a coping and adaptation strategy was practiced by 63.8% of the female respondents while only 17% males practiced this with a statistical significance of p-value of 0.000. Receiving support from family members as a coping/adaptation strategy was reported by 20.12% of the male respondents 48.98% of their female counterparts explained that they survived from family members support with a statistical significance of p-value of 0.000; asset sale as CC adaptation strategy practiced by 45.3% male respondents while 35.2% of female headed households said in extreme situations they sold assets with a statistical significance of a p-value of 0.000 and migratory fishing was used by 51.2% of the male

respondents and 20% female respondents with a statistical significance of p-value of 0.001. Selling of big fish to big buyers and using of savings to sustain households by the fishers as ways of coping and adaptation strategies were not statistically significant at p-values > 0.05.

5 Conclusions and Recommendations

5.1 Conclusions

The fishers in Mbita Division were fully aware of weather and climate variability which they were already experiencing with negative impacts on their fish dependent livelihoods and erratic predictions and abrupt seasonal variability made impossible to predict seasonal changes. But they lacked the knowledge of Climate change and its causes. Whereas the Mbita fishers' community received scientific weather information from local radio stations that relied on meteorological forecasts, they considered it irrelevance and relied on indigenous and personal interactive experiences with wind patterns position of stars in the sky which supported traditional systems to monitor and forecast using flora and fauna changes .It was concluded that climate scientists are not doing enough to educate fishers' communities about CC and CV and how best they could use it scientific information to better adapt to associated changes.

The study found that adaptation/coping strategies and activities in Mbita were gendered and culturally stereotyped in fishing activities and responsibilities giving men more adaptive options than women. Adaptation required investment on bigger refrigerated boats with bigger engines and more fuel to go further into the lake and enabled those better catches which were only accessible to few men as the income level of most of the fishers was too low to support this. It was found that fishers' households adapted during extremes through us of savings, sale of family assets to sustain HH, dependence on well-wishers and relatives or engagement in multiple occupations/alternative livelihoods including bodaboda riding for men, running small businesses eg bars/hotels/selling second hand clothes mainly women) and betting/selling harvesting sand, firewood for men and women.

The fishers had limited applicable adaptive alternatives as shifting fishing sites and using twin engine boats would have been climate smart options of adaptive fishing but had cost implications the majority of fishers could not afford the county government must mainstream fisher livelihood as part of sustainable development agenda.

5.2 Recommendations

While overfishing and pollution are considered threats to fisheries, the greatest threats to fisheries remain the use of undersized nets, human overpopulation, the water hyacinth and the fishers' health and an understanding of how these factors that have influenced the fisheries in the Lake Victoria Kenyan fisheries is therefore important and critical in sustaining the fisheries and must be addressed as a matter of urgency.

Mbita fishers community require a well institutionalized gender inclusive, trans-disciplinary multi-sectoral community based livelihood inclusive network to support the fishers and other local livelihoods through workshops and training on adaptive responses which are community owned in collaboration with local research organizations and universities

On the whole the fishers for institutionalized CC adaptation pathways which will formulate and mainstream at all beaches sustainable fishing there is need to reduce fishing frequency, –and numbers of fishermen and boats sustainable livelihood activities in the entire County of Mbita

5.3 Recommendations for ~~Further~~ further research

Future studies should address comparative analysis of several other beaches from different counties to establish if Lake Victoria has its own micro climate which affect the fishers' adaptive strategies to CC and incorporate indigenous knowledge of CCA.This study was limited to Mbita Division in Homa Bay County. It could also be replicated on other regions where fishing is one of the economic activities of the communities to compare the findings.

The study recommends that the County government of Mbita should to take initiative to establish an institutionalized community based, transdisciplinary, multi-sectoral policy driven consultative network that is gender and livelihoods inclusive and interactive research organizations like universities in the region to ensure continuous monitoring and adaptation to the emerging weather patterns.

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