

FISHERS' PERCEPTIONS OF CLIMATE CHANGE ON FRESHWATER FISHERIES AND THE ROLE OF THESE SYSTEMS IN THEIR ADAPTATION STRATEGY IN CENTRAL RIVER REGION OF THE GAMBIA.

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ABSTRACT

Government departments, nongovernmental organizations and generally the local people in the Gambia have little access to climate projections and therefore little understanding of the uncertainties surrounding freshwater climate change impacts and adaptations. This study examines the fisher's perceptions of climate change on freshwater fisheries and the role of these systems in their adaptation strategy in Central River Region of The Gambia. This was achieved through the application of mixed method qualitative and quantitative research. A sample of 70 fishermen were selected through multiphase sampling in six villages of five districts in Central River Region. Face-to-face interviews were conducted using structured questionnaires. The data was analyzed using descriptive statistics including frequency counts and percentages. The research showed that unpredictable rainfall, increased winds, increased temperature, drought and flood were the main climate effects experienced by the respondents. Some of the challenges faced by these fishermen includes increasing risk and uncertainties in fishing, reduction in fish catch, bad fishing methods by some foreign fishermen, lack of storage facilities for their fish stock and high mortality of fish. This leads to low income and productivity and food insecurity for the rural poor. Fishermen have therefore as an adaptive measures resulted to changing fishing methods, increasing fishing zones, shifting to other resources and livelihoods diversification as responses to climate change effects. Lack of proper and regular information, poor marketing facilities, poverty and limited research were the common constraints faced by the fishermen to response to climate change effects. Therefore more government supports in terms of fishing

boats and machines and reliable information are necessary measures of adaptation recommended to improve information and knowledge through community reach programme by government to ensure sustainable fishing behavior among fishermen.

Keywords: Central River Region, Freshwater fisheries, Climate change, Adaptation, Socio-economic characteristics, The Gambia.

1. INTRODUCTION

Fisheries play an important roles in providing food, income and employment in many developing countries including The Gambia, either as a stand-alone activity or in association with crop agriculture and livestock rearing (1). The wealth generated from both aquaculture and fisheries in marine and freshwater environments is overwhelming (2). The sector's economic output provides important contributions to alleviate poverty and food insecurity especially for the rural people through three main interlinked pathways: nutritional benefits from the consumption of fish; income to those employed in the sector and through generation of revenues from exports, taxation, license fees and from payment for access to resources by foreign fleets (1).

Climate change is one of the most important environmental issues facing the world today. This is evidenced by the spate of conferences, campaigns, reports and researches on climate change in the last 20 years (3, 4) to mention a few. Currently, there is widespread consensus in the scientific community and even among politicians that climate change is happening and that the impacts are already with us (5). Climate change is often used to describe any kind of change in climate that may be natural or human- induced (6). Climate change according to Pnue (7) is any long-term change in the patterns of average weather of a specific region or the earth as a whole. It is an abnormal variation in the earth's climate that usually occurs over durations ranging from decades to millions of years. Evidence shows that global mean temperature increased by 0.6°C during the 20th century, with the 6 hottest years occurring between 1997 and 2007 (7). This warming of the world's climate has been linked to higher concentrations of carbon dioxide and other greenhouse gases (GHGs) in the atmosphere, which are dominantly of anthropogenic origin such as fossil fuel combustion, land use and deforestation. Climate change phenomenon has serious deleterious consequences for the earth in the form of significant variations in regional climates, recurrent droughts, excessive heat waves, windstorms, killer floods, and so on. Fisheries resources are threatened by over-exploitation, habitat degradation, pollution, invasive species, parasites and diseases and more recently, the increasing variability and change in climate (8, 9). Future climate change may cause further damage to river ecosystems, though the response of organisms varies depending on their sensitivity, vulnerability, and adaptive capacity to the environmental changes (10). While the other threats have received considerable attention,

climate variability and change, which intensified since the last three decades of the 20th century has received less attention (8).

There are noticeable consequences of climate change in The Gambia such as widespread floods (personal communication, Department of Water resources) and droughts especially in the northern part (11). The IPCC (3) has pointed out that climate change impacts pose great dangers with consequences such as desertification, sea level rise, flooding, water salination, among others. These impacts could manifest in food security challenges, damage to infrastructure and social dislocation. Additional impacts include threat to health as rising temperature could bring about diseases such as chronic heat rashes, Cerebra-Spinal Meningitis (CSM), stroke, malaria and other related diseases (12). Climate change will affect every citizen, every part of our environment and our natural resources, and thus practically every aspect of our lives, our economy, and our urban and sub-urban development patterns (12). Global concern regarding the devastating impact of climate change has emphasized the need for creating awareness and building community capacity for adaptation strategies to mitigate the effects of climate change. As pointed out by Naclimuthu and Vijayakumari (13), the need of the hour is to make people sensitive towards nature through a strong programme of climate change awareness. This is imperative in the sense that, there are some misconception and misunderstanding of climate change issues. Many researches have been conducted concerning the understanding of climate change and global environmental problems.

Climate change awareness involves creating knowledge, understanding and values, attitude, skills and abilities among individuals and social groups towards the issues of climate change for attaining a better quality environment. Climate change specialists have repeatedly pointed out that a solution to climate change problem will require climate change awareness and its proper understanding. The role of researchers and extension workers will go a long way in achieving this purpose.

Freshwater ecosystems are hot spots of biodiversity with disproportionate percentages of species based on surface area. Recently, freshwater biodiversity has declined faster than that of either terrestrial or marine habitats, a situation likely to continue (14, 15). These losses are a consequence of degradation due to diversion and regulation of river flows, fragmentation, eutrophication, contamination, over-harvesting, invasions of exotics, filling and draining, and alterations to disturbance regimes (15). Aquatic ecosystems are particularly sensitive to climate change due to the high heat capacity of water and due to indirect effects through changes to catchment processes (15). Climate change will alter their hydrology and thermal regimes and given that many freshwater organisms have precise thermal and hydrological tolerances place them under increasing threat (15). In simple terms, climate change will increase global temperatures and, through regional changes in precipitation, evaporation and runoff, make some

areas wetter and others drier. This will redistribute freshwater systems but dispersal capacity and geographical and human barriers will limit colonization of new locations. Humans already withdraw about 50% of available freshwater resources with global requirements increasing almost 10-fold during the 20th century (15). Although the detrimental effects of climate change are unlikely to be more severe than other anthropogenic impacts, changes in land use and climate and biotic additions and losses in ecosystems interact to result in biodiversity loss (15). For example, it is predicted that rivers with reduced discharge as a result of climate change and increased human water consumption may lose up to 75% of their fish species by 2070 (16, 15). Fish are likely to be more affected by climate change than most other animals due to the influence of temperature on their metabolic rate and physiology. Climate change may affect fish and their habitat due to global increase in surface air and water temperature, groundwater temperature, and changes in precipitation patterns, wind direction and intensity, stratification of water bodies, freeze-thaw cycles, runoff, dissolved oxygen concentrations and UV-B radiation penetration (15).

The Gambia is faced with lot of challenges in sustainably managing both marine and freshwater resources including the continuous decline of fish stocks and destruction of the ecosystem. The knowledge and know-how to utilize this ecosystem from degradation is insufficient. This paper therefore assesses the perception of fisher folks on climate variability, the challenges and extent to which fishermen of Central River Region are coping with perceived changes in climate variables and their impacts on the livelihoods of the fishermen. The paper is organized as follows: the first section briefly discusses introduction as well as empirical evidences on the impact of climate change on fisheries. Data and methodological procedures are discussed in section two. Section three presents empirical results as well as discussions. The last section consists of conclusion.

2. MATERIALS AND METHODS

2.1 Description of the area of study

The Gambia is a small Sahelian country, bordered by Senegal and extending to the Western Coast of Africa between 13° and 14° N. It covers a total land area of approximately 10,689 sq. km with a length of about 400 km and a width varying between 24-50 Km. According to the 2013 National Population and Housing Census, The Gambia's population is estimated at 1.8 million people with a population growth rate of 2.8 % per annum. The climate of The Gambia is a Sudano-sahelian type of climate, with a short rainy season from June to October and a long dry season lasting from November to May. The average annual rainfall is 900 mm (17). There has been an average reduction of 27% in the annual average rainfall since 1951(17). The mean temperature is 25°C. The study area (Fig.1) is located in the Central River Region (CRR) of The

Gambia. It is one of the six Regions in the country. The CRR consists of ten local administrative districts headed by a District Chief called Seyfo. According to the 2013 census, 226,018 inhabitants are living in the Central River Region (18) of The Gambia. The area is characterized by good soil structure and fertility and has some vegetative cover compared to the rest of the country especially the Northern part (11).

Virtually all residents in the CRR depend directly or indirectly on the agricultural sector and poor or failed harvests seriously threaten the food security in the area. Because of its vulnerability (high dependence on agriculture), the Central River Region was chosen as the focus of this case study.

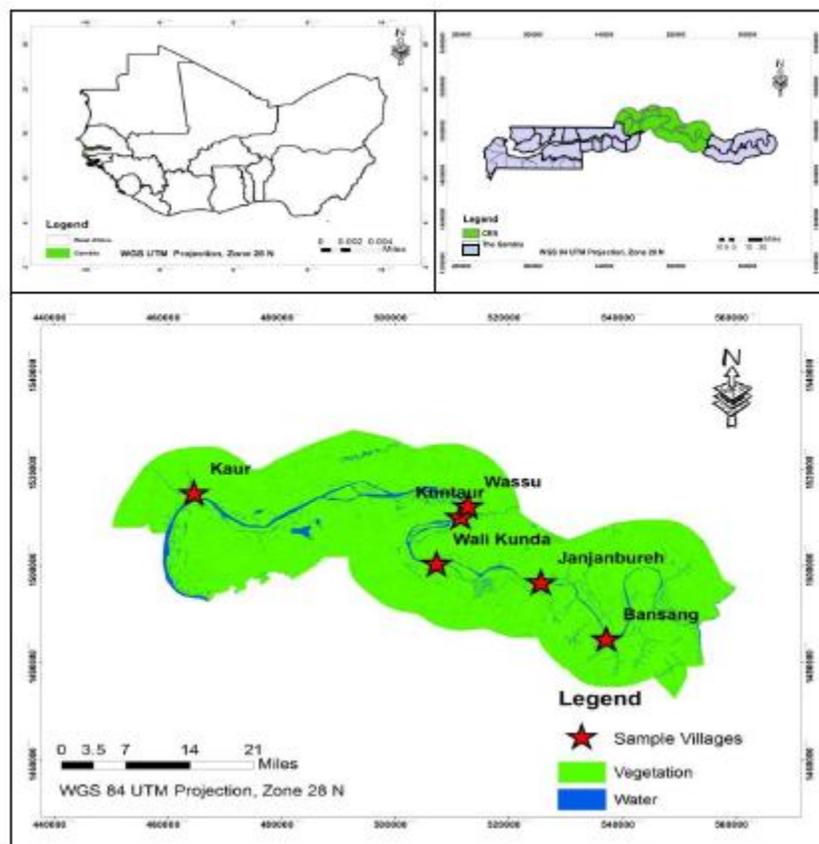


Figure 1: Location of Central River Region in The Gambia, with the six study sites marked (red star)

2.2 Research design and data source

Primary and secondary data were used for the study. Primary data was collected using a semi structured questionnaires, Focus Group Discussions (FGDs) and key informant interviews in 2017. The semi-structured questionnaire was administered to a total of 77 heads of fishing households selected through random sampling but only 70 were useful for this survey due to some inconsistencies detected during data editing and cleaning. The households were from six fishing sites in Central River Region around the river Gambia. The questionnaires covered fishers' perceptions of climate variability and change, demographic characteristics, livelihood activities, impacts of perceived climate variability and change on livelihoods, adaptation and mitigation measures, constraints to adaptation and mitigation and required interventions.

The primary source consists of the cross-sectional household survey data of 70 fishermen with a mixed method approach of qualitative and quantitative data. Cross-sectional design is deemed appropriate as data was collected from a section of fishermen's to explain the research problem. An advantage of the mixed method is that the respondents have the chance to individually justify their selection in the quantitative data with open ended questions during the 2017 fishing year in CRR of The Gambia. The study administered questionnaire and held Focus Group Discussions to elicit information and this was administered in the fishermen local languages. Both structured questionnaires and interviews were held with indigenes and local government officials and all other stakeholders on climate change knowledge. The study decomposes various measures of climate change adaptation. In addition, the study used Focus Group Discussions (FGDs) to find out the level of understanding of climate change from the fishermen, also communities perception of the vagaries in weather conditions as well as coping strategies adopted. Multi stage sampling was used in this study. Firstly, random sampling was used to select five districts out of ten district in the CRR, while communities that are prone to climate change were purposively selected (19). The villages selected were, Wally Kunda (N 13.57 W 014.9), Bansang (N 13.57330 W 014.92294), Janjanbureh (N 13.54368 W 014.76309) in the South bank and Kuntaur (N 13.68670 W 014.87980), Wassu-Darka (N 13.69576 W 014.89130) and Kaur (13.69271 W 015.32516) in the North bank. These villages were selected based on their classification as freshwater fishing centres and rural areas. The number of fishermen interviewed was determined proportionally to their respective total number of fishermen. At least seven fishermen were randomly selected from each community identified above, making a total of 77 fishermen households interviewed, but only 70 data were useful for further analysis due to some inconsistencies detected during the data cleaning and editing.

The secondary data included data on climate variables (mean maximum temperature, mean minimum temperatures and total rainfall). The data on the climate variables from 1982 to 2016 (Figures 2 and 3) were obtained from Gambia National Meteorological Department for Sapu which is the nearest weather station in Central River Region.

2.3 Sample Size and sampling procedure

A sample size of 30 individuals from the six study sites were selected randomly in a preliminary investigation to determine the proportion of respondents who have observed both changes in rainfall and temperature. Rainfall and temperature have been selected for the current study because their variation can easily be detected by fishers. Fifty percent of the respondents who have observed both changes in rainfall and temperature were used to calculate the sample size (N) following Dagnelie (20) formula:

$$N = [(U_{1-\alpha/2})^2 \times p(1-p)]/d^2$$

Where:

N=sample size

$U_{1-\alpha/2}$ = 1.96: value of the Normal random distribution at probability of $1-\alpha/2$ (0.975).

P=proportion of a given characteristic of a population

d=margin error of a parameter estimated from the sample $1\% \leq d \leq 15\%$

From this formula, the sample size (N) was estimated at 70 for all the six study sites.

2.4 Statistical analysis

The data obtained were analyzed using Statistical Package for Social Scientists (SPSS version 23). Both descriptive statistics and linear regression analysis were used in analyzing the data. The descriptive analyses consist of tables and figures used specifically to describe the socio-economic characteristics of the respondents. The processed data were presented mostly in tabular forms to give vivid comparative analysis needed to show observable trends.

3. RESULTS

3.1 Trend of climate variables

The rainfall pattern for the period (1982-2016) was not stable with wide variations (Figure 2).

The highest total annual rainfall recorded was 1782 mm in 1999 while the lowest was 645 mm in 1981. From 1999 the total rainfall has decreased from 1782 mm to 953 mm in 2011 and it increases in 2012 to 1557 mm.

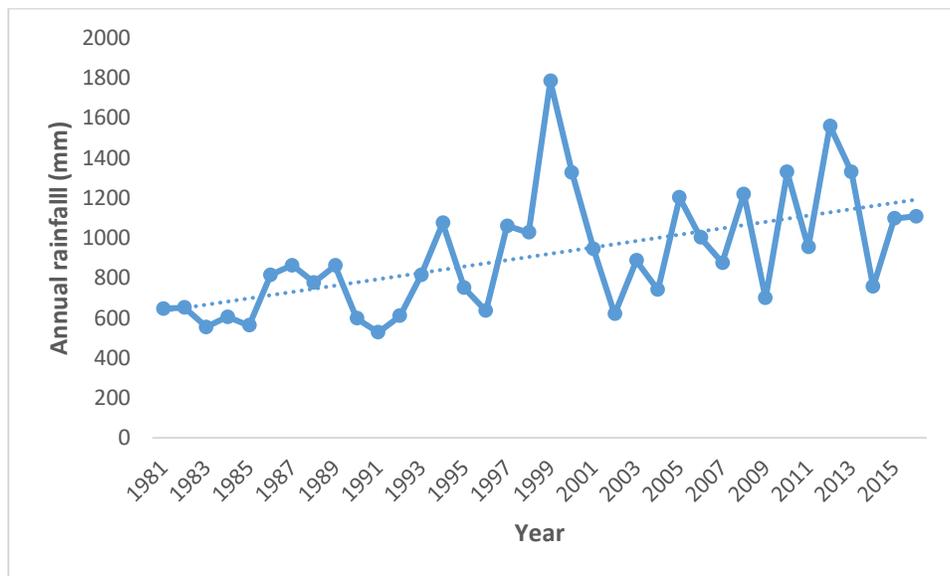


Fig. 2: Long-term rainfall pattern for Sapu, 1982– 2016 (Data source: The Gambia Meteorological Bureau (21))

The temperature distribution over the thirty-four (34) year period also shows patterns of unstable temperature. The highest total annual temperature was in the year 2004 which was 37.06°C (Figure 3a) while the lowest total annual temperature was 19.84°C (Figure 3b) in 1996. From 1996 to date the temperature has been increasing drastically and meandering from a minimum temperatures of 20°C to maximum temperatures of 37°C.

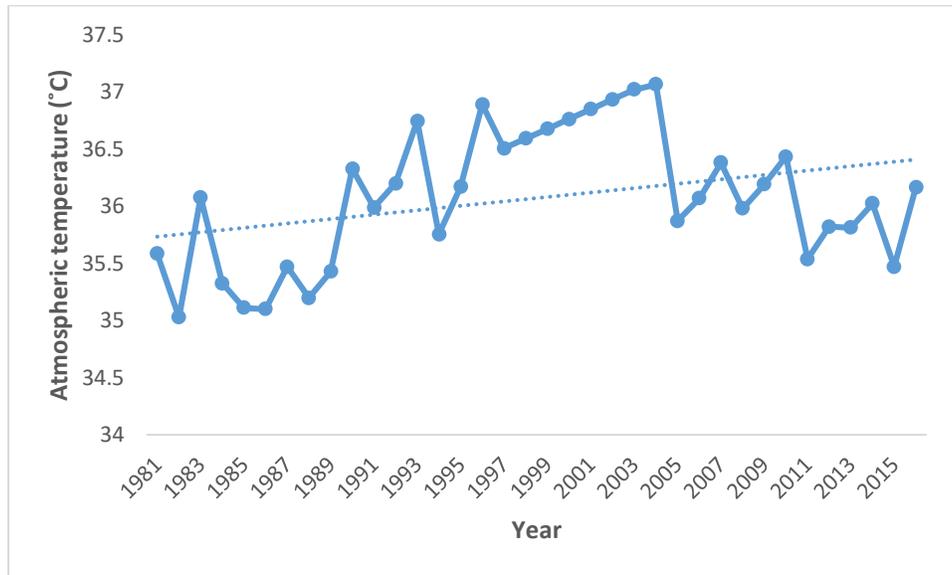


Fig. 3a: Long-term maximum atmospheric temperature pattern for Sapu, 1982– 2016 (Data source: The Gambia Meteorological Bureau (21))

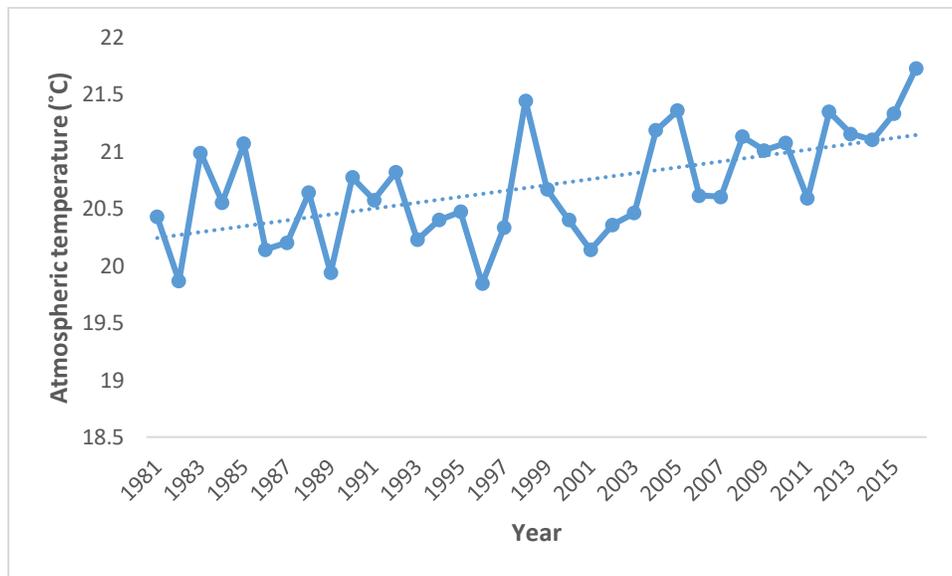


Fig. 3b: Long-term minimum atmospheric temperature pattern for Sapu, 1982– 2016 (Data source: The Gambia Meteorological Bureau (21))

3.2 Socio economic characteristics of the respondents

Approximately 99 percent of the sampled fishers are men ranging between the ages of 25 years to 78 years. The modal age of the fishers range between 36-45 years; however the average age was recorded as 30 years indicating that young people are involved in fishing activities in the area.

As shown in table 1, very few graduates (1 %) were among the respondents; one-third of them had exposure to primary or secondary school education (34.3%) while about 14.3% percent had no exposure to formal education. Informal education in the area includes Qur'anic education which is the most common among the fishermen (50%). Fishing is considered to be a primary activity by constituting almost 95.7 percent of the respondents; alternative income sources include, crop farming, trading, etc. Most of the fishermen (31.4%) have been fishing for more than twenty-one to thirty years. Additionally (20%) have been in the business for more than ten years to twenty years whereas (15.7%) have two to ten years' experience in fishing. Very few (4.2%) of the respondents are into crop farming, petty trading and civil service.

Table 1: Background characteristics of the respondents

Background	Frequency (n=70)	Percent
Age distribution		
less than 25 years	7	10
26-35	12	17.1
36-45	19	27.1
46-55	13	18.6
56-65	11	15.7
above 65	8	11.4
Total	70	100
Education levels		
Primary	10	14.3
Secondary	14	20
Tertiary/University	1	1.4
Informal/Madarasa	35	50
None	10	14.3
Total	70	100
Main economic activity		
Fishing	67	95.7
Crop farming	1	1.4

Petty Trading	1	1.4
Civil servant	1	1.4
Total	70	100
Fishing experience		
1-10 years	11	15.7
11-20 years	14	20
21-30 years	22	31.4
31-40 years	9	12.9
41-50 years	9	12.9
above 50 years	5	7.1
Total	70	100

Source Authors field work, 2017

3.3 Perception of climate change by fishermen

Nearly all the respondents (95.7%) showed that they are aware or heard about climate change (Figure 4).

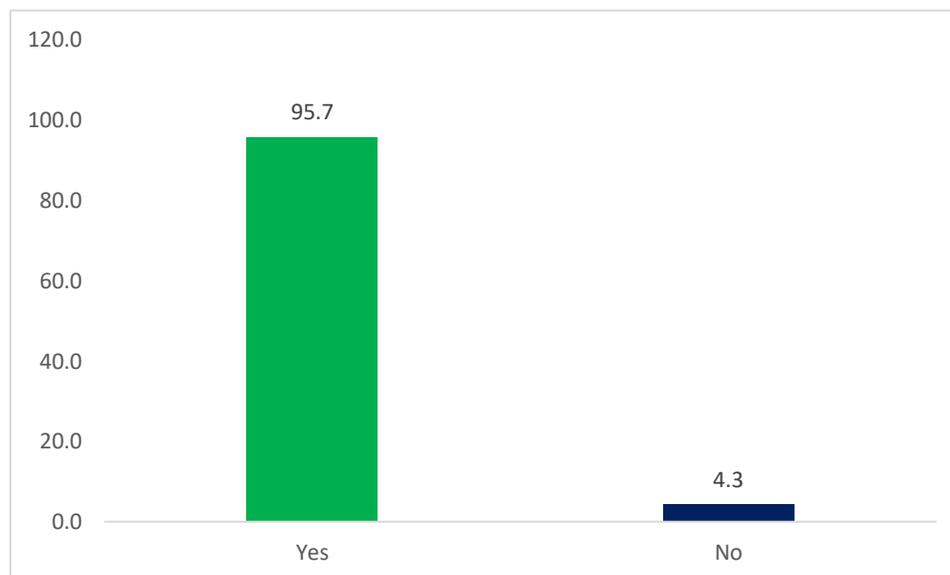


Figure 4: Respondents climate change awareness in the six villages of Central River Region

Source Authors field work, 2017

They associated climate change with increase temperatures, floods, drought, and decreased in rainfall (Table 2).

Table 2: Respondents understanding of climate change

Climate change understanding	Frequency (n=70)	Percent
Increase in temperature	63	94.00
Droughts	44	26.50
Decrease in rainfall	44	26.50
Flood	15	22.40

Source Authors field work, 2017

3.4 Sources of information on climate change

Table 3 shows that the main source of information on climate change was through radio/mass media (70 %), followed by fisher folk to fisher folk (44.3%), extension services (17.1%), personal experience (14.3%), Neighbour farmers (7.1%) and Farmer associations (4.3%). Results in Table 3 also showed that sources from market places, rumours, workshops, researchers and project/NGO/Program respectively (1.4%) were the least source of information on climate change in the area.

Table 3: Sources of information on climate change to fishermen

Sources	Frequency (n=70)	Percent
Radio/mass media	49	70
Fisher folk to fisher folk	31	44.3
Extension services	12	17.1
Personal experience	10	14.3
Neighbour farmers	5	7.1
Farmer association	3	4.3
Market place	1	1.4

Rumours	1	1.4
Workshops	1	1.4
Researchers	1	1.4
Project/NGO/Program	1	1.4

Source Authors field work, 2017

3.5 Main effects of climate change experienced by respondents

Table 4 illustrate the fishermen's perception about the impact of climate change

on the fishing and their livelihoods. As can be seen in Table 4, majority of the respondents (90%) sighted that increased in temperature as a main effects of climate change. Forty-four of the respondents (62.9%) said drought is also one of the effect of climate change. Increased winds (60%) sighted as the third effects of climate change on fishing. Decreased rainfall and flood respectively are the other effects of climate change experienced by these fishermen.

Table 4: Main Effect of climate change experienced by fishermen

Effects	Frequency (n=70)	Percent
Increased temperature	63	90.0
Drought	44	62.9
Increased winds	42	60.0
Decreased rainfall	25	35.7
Flood	15	21.4

Source Authors field work, 2017

3.6 Fishers' adaptation strategies of climate change

To overcome some of the challenges associated with climate change, the respondents have adopted a number of adaptations measures as outlined in Fig. 5.

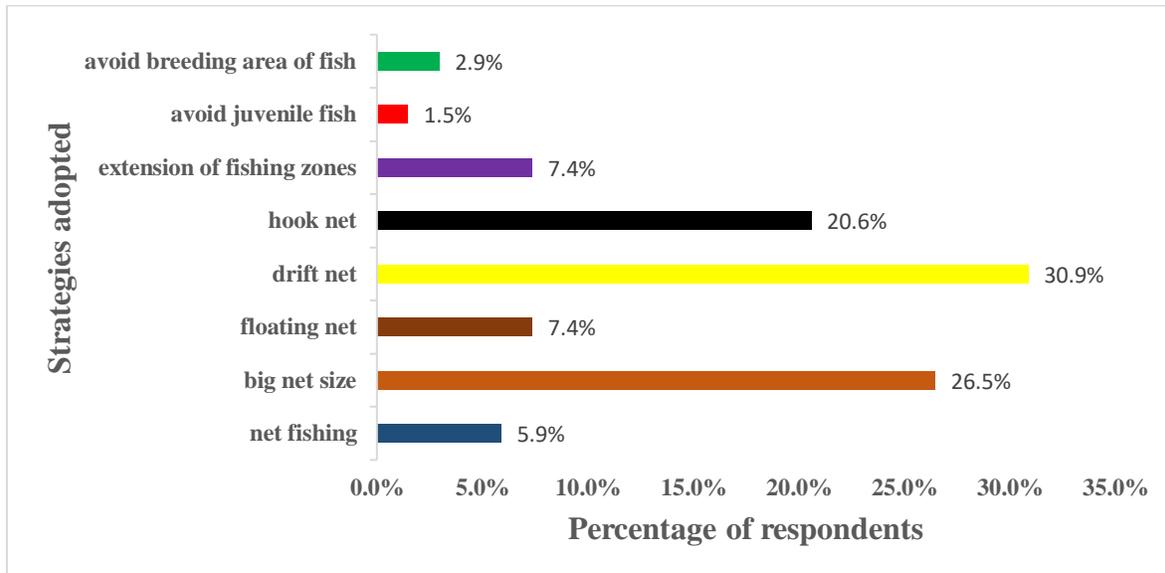


Fig. 5: Adaptation strategies adopted by the fishermen in the six villages of Central River Region

Source Authors field work, 2017

As shown in Fig. 5, 30.9 percent of the fishermen in the six communities uses drift net as a mean of adaptation. Some (26.5 percent) used big net size for fishing, others (20.6 percent) uses hook net fishing system. Other adaptation strategies includes extension of fishing zones, use of floating net, net fishing, avoidance of breeding area of fish and avoiding of juvenile fishing.

3.7 Challenges faced by fishermen in adapting to climate change

Challenges encountered by the fishermen are presented in Table 5. In Table 5, 81.4 % of the respondents said that poverty that is inadequate funds are the main obstacle for them to tackle the menace of climate change. Other challenges includes lack of enough fishing materials and lack of enough support from the government. Other minor but important challenges are lack of fishing gears and machines by some fishermen, lack of government official enforcing the fisheries laws and regulations, foreign fishermen engaging in illegal fishing, deforestation and feeds for fish.

Table 5: Challenges faced by respondents in adapting to climate change effects

Challenges	Frequency (n=70)	Percent
Poverty	57	81.4
Lack of fishing materials	5	7.1
Support from government	2	2.9
Fishing gears and machines	1	1.4
Government to enforce fisheries laws and regulations	1	1.4
Foreign fishermen	1	1.4
Deforestation	1	1.4
Protection from bad fishing net	1	1.4
Feed for fish	1	1.4

Source Authors field work, 2017

4. DISCUSSION

4.1 Socio economic characteristics of the respondents

The socio economic characteristics shown in this study are in conformation of the positions that the male gender primarily constituted the major fish labour in The Gambia .The modal age of the fishers range between 36-45 years indicating that young people are involved in fishing activities in the area. This may also be due to the demanding nature of fishing which requires physical strength like carrying of heavy tools and equipment including fishing gears and nets and paddling of boats as used by most fishermen.

The low level of education may have influence awareness and adaptation strategies to climate change. Informal education in the area includes Qur'anic education which is the most common among the fishermen. Fishing is considered to be a primary activity by constituting almost ninety-six percent of the respondents. This is justified by the fact that fishing is the main economic activity of the respondents. The fishing occupation requires more time, energy and resources to meet ones needs and for this reason the respondents said it is their main economic activity.

4.2 Perception of climate change by fishermen

The way the indigenous people think and behave in relation to the environment in which they live have a very important role in addressing climate change (22). Nearly all the respondents showed that they are aware or heard about climate change. They associated climate change with increase temperatures, floods, drought, and decreased in rainfall. This research is also in conformity with Taderera (23) which states that most Africans are aware that weather patterns are changing drastically during last decades. Similarly a research conducted by (24) states that 95.5% of respondents around Tanbi Wetland are aware that weather patterns are changing drastically during last decades. Moreover, (25) and (26) reported 100 percent of climate change awareness among fishermen and farmers respectively during a survey conducted in Ghana and Nigeria.

4.3 Sources of information on climate change

The study revealed that the main source of information on climate change was through radio/mass media, followed by fisher folk to fisher folk, extension services, personal experience, Neighbour farmers and Farmer associations. The finding is in line with that of (27) where personal contacts, family and friends were the main sources of information on climate change. Similarly, (28) found out that the most important information source on climate change was personal experience followed by radio and television. Fishers' knowledge on climate change through personal experience was probably due to the fact that their livelihood seems to be seriously threatened. The study also showed that sources from market places, rumours, workshops, researchers and project/NGO/Program respectively were the least source of information on climate change in the area. This has implication for extension administration and policy making since knowledge of climate change impacts is related to the availability of information on the phenomenon.

4.4 Main effects of climate change experienced by respondents

This research seeks to know from the respondents the effects of climate change on fishing and the fishermen. The respondents confirmed that climate change has increased the risks and uncertainties in the fishing business in their villages. As most of them pointed out that due to changes in weather and climate, their forecast of when to go and the amount and type of fish to catch can no longer be guaranteed. They normally catch less fish than they used to in the past. This is due to fluctuations in fish and wild stock distribution. Majority of the respondents sighted that increased in temperature as a main effects of climate change.

4.5 Fishers' adaptation strategies of climate change

Cochrane (29), asserted that sea level rise, glacier melting, ocean acidification and changes in rainfall patterns, groundwater and river flows will significantly affect coral reefs, wetlands, rivers, lakes and estuaries; requiring adaptive measures to exploit opportunities and minimize impacts associated with climate change on the fishing business and the fishermen. To overcome some of the challenges associated with climate change, the respondents have adopted a number of adaptations measures including drift net, big net size, and hook net.

Other adaptation strategies includes extension of fishing zones, use of floating net, net fishing, avoidance of breeding area of fish and avoiding of juvenile fishing. All these are strategies geared towards the sustainable use of the freshwater fish to meet the demand of the present generation without compromising the future generations.

4.6 Challenges faced by fishermen in adapting to climate change

Challenges encountered by the fishermen are mainly poverty that is inadequate funds as the main obstacle for them to tackle the menace of climate change. This result is similar to the one obtained by (30) who reported 86.67% financial constraints faced by farmers to cope with climate change during a study in Borno State of Nigeria. Other challenges includes lack of enough fishing materials and lack of enough support from the government. Other minor but important challenges are lack of fishing gears and machines by some fishermen, lack of government official enforcing the fisheries laws and regulations, foreign fishermen engaging in illegal fishing , deforestation and feeds for fish.

CONCLUSION

Climate change is a truly global challenge and there is no doubt that it will influence the fisheries sector. This fisheries sector is a blessing in disguise for many communities for it act as a source of food, income, and foreign exchange earnings. Therefore, understanding the fish response of climate change is important for formulating adaptation measures.

Arising from the findings of this investigation, the conclusion drawn is that fishermen were relatively active youthful population with lot of experience. With the necessary support from government as proclaimed by lot of them, these fishermen are capable of improving livelihoods, build resilience and use sustainable practices. Climate change is a new reality that will have deleterious effects on the society. It is a phenomena that will affect every aspect of our lives, our economy, our urban and sub-urban development patterns, natural areas and our life style. Not much is known about climate change by non-experts. For this reason awareness creation is a key measure to address the impact of climate change.

The intensive media coverage and public awareness campaigns prevalent in much of the industrialized world and the urban areas have been largely absent in the rural part of the country

including central river region. However, there is a definite awareness that the climate is changing; this stems from observable changes/personal experiences from local people, like the timing and amount of rainfall. Such anecdotal knowledge needs to be explored in order to understand how people comprehend climate change and, thereby, to communicate information more effectively. Equipped with knowledge, people will be able to debate the issues and to prepare more effectively for the future uncertainties.

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