Climate Change and Fisheries: Perspectives from Small-Scale Fishing Community in Badagry, Lagos, Nigeria

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ABSTRACT  
The present study focused on impact of climate change on livelihood of Ganyingbo fishing community in Badagry, from June to September, 2020. Data were collected through administration of 58 structured questionnaires to artisanal fishermen while test of significance of research hypotheses was conducted using chi-square and t-test at 95% confidence interval. The results showed that the fisher folks composed of 83% male and 17% female. The most common age group among fishermen was 30-39 years (27.58%) and 57% do not have other job apart from fishing. Majority (37.93%) of the fishermen did not attain beyond secondary school education while only 3.45% had tertiary education. Calculated coefficient of marketing efficiency indicated that 54.8% and 72.26% of their sales revenue were taken up by costs before and after the effect of climate change respectively. Total expenditure of fishermen increased by 24.9% while income decreased by 5.26%. The t-test analysis indicated significant (p<0.05) difference between the total cost associated with fishing in Ganyingbo before (N17850.0± 2015.22) and after (N22300.0 ± 2380.0 ±
6297.40) effect of the climate change. Fishermen (87.93%) believed that adopting coping strategies to mitigate the climate change is germane for artisanal fisheries systems. A significant (p<0.05) difference was observed ($X^2 = 30.56: 9.49$) between expected and observed perspective of fishermen based on viability of artisanal fisheries in Ganyingbo community. As noted in this study, fishing business in Ganyingbo is still viable however more effective mitigation measures are required to ensure its sustainability.

**Keywords:** Perception; fisherfolks; fishing community; mitigation and adaptation; climate change.

1. **INTRODUCTION**

Whether natural or human driven, climate change affects every areas of human lives and wellbeing. Apart from global increase in temperature, some of the current and projected manifestations of climate change include; sea level rise, shifting in global climate zones, melting of polar ice, increased incidence and severity of extreme weather events, increased drought, desertification, and flooding. It can also result in a significant loss in food security, natural disasters, vanishing coastlines, human displacement, natural resource depletion, scarcity of safe drinking water, fauna migration, pests management challenge, diseases and other health problems, loss of cultural practices and traditional ways of life, economic losses and energy crises, among others [1].

Climate change will exacerbate existing physical, ecological, and socioeconomic stresses on the African coastal zone [1]. It also poses significant and long-term risks to artisanal fisheries in many tropical developing countries in general and Sub-Saharan African (SSA) countries in particular. Globally, some 43.5 million people work directly in fisheries sector, with the great majority in developing countries. Adding those who work in associated processing, marketing, distribution and supply industries, and fisheries sector supports nearly 200 million livelihoods [2].

According to Nelson [3], agriculture’s vulnerability (fisheries and aquaculture inclusive) to climate change will put millions of people in developing countries at greater risk of poverty, hunger, and malnutrition thus impacting on their food security's status. The impacts of climate change on food web arrangement will affect fish distribution in the water ecosystem and thus alter the spread of pelagic fishes. Omitoyin and Tosan [4] divulged that artisanal fishery provides employment for about 5.8% of the Nigerian population and supplied 81.9% of the total domestic fish production. Artisanal fisheries have been seen to be a vital section of the remote trade in numerous Nigeria areas. Over 90% of fish consumed in Nigeria were offered by artisanal fisheries [5].

Several empirical studies were conducted to investigate the different impacts of climate change on Nigeria fisheries and aquaculture which includes the work of Idowu et al. [6] and Ipinjolu et al. [7] on the impact of climate change in Nigeria; the potential impacts of climate change on fisheries and aquaculture in Nigeria [8]; climate change, effects and mitigation strategies on aquaculture: a review [9]; impacts of climate change on fisheries: implications for food security in Sub-Saharan Africa [10], and fish farmers’ perception of climate change impact on fish production in Delta State, Nigeria (Leon and Antonio, 2015). According to these authors, climate change scenario especially through temperature and carbon dioxide increase will continuously warm the earth with resultant effects on fisheries and aquaculture, and that Nigeria vulnerability is high.

Therefore, the present study focused at investigating the perception of fishermen (in Ganyingbo fishing community of Badagry) on impact of climate change on artisanal fisheries and their livelihood.

2. **MATERIALS AND METHODS**

2.1 **Study Area**

The study was conducted in Ganyingbo fishing community in Badagry, Lagos State, Nigeria. The study area (Fig.1) was selected based on its significant contribution to fish supply in Badagry Local Government Area. Badagry lies between Latitude: 6° 24’ 54.07” N and Longitude: 2° 52’ 52.75” E.

2.2 **Determination of Sample Size**

The sample size of the population of the study was determined by using the following equation:

$$n = \frac{N}{1+N X (e)^2}[11].$$
Where n = sample size, N = population size = 68, e = 95% confidence level = 0.05.

Therefore, from the total population (N) of the community estimated as 68, n = 58.

2.3 Collection of Data

Data were collected through administration of structured questionnaires. A total of 58 questionnaires were randomly administered to artisanal fishermen in the study area. The questionnaire was sub-divided into five sections. The survey method used in this study also involves interviews and direct observation.

2.4 Validity of the Instrument

The instrument (questionnaires) was validated by: (1) Supervisor for this study. (2) Other experts in the faculty of science, Lagos State University.

2.5 Method of Data Analysis

The data collected were analyzed using statistical package for social sciences (SPSS) version 20. The categorical variables were analyzed using descriptive statistics (frequency and percentage) and inferential statistics. The results obtained from demographic variables were presented in the form of tables, and percentage (%). The test of significance of research hypotheses was conducted using t-tests and chi-square at 95% confidence interval, with p-value of 0.05 or less considered statistically significant.

3. RESULTS

Table- 1 represent the socio characteristics of the Ganyingbo fishing community that included the fisherfolk’s gender, age, marital status, education level, training undergone and years of experience. About eighty three percent (82.76%) of the fisherfolks were males while 17.24% of them were females. The most common age group found among fishermen in Ganyingbo was 30-39 years (27.58%), while the least age group were 20-29 years and 61 years and above age group which were 3.45% and 3.45% respectively. Over 65% of the fisher folks did not undergo any training before starting their fish business while 57% of them do not have other job apart from fishing. Majority of the fisher folks (34.48%) were engaged in vulcanizing while the least works as processors (12.08%). It was found that 41.38% of the fisherfolks were mostly experienced in fishing more than 16 years and above. In case of school education, 37.93% of the fishermen in Ganyingbo fishing community did not attain beyond secondary school education while only 3.45% had tertiary education.

The summary of the total expenditure incurred after the effect of climate change by fisherfolks at Ganyingbo fishing community was significantly (p < .05) higher than expenditure recorded before the effect of climate change (Table- 2). On the contrary, significant higher income was obtained before the effect of climate change as compared to income obtained after the effect of climate change. The expenditures for fishing increased by 24.93% while the income (revenue) declined by 5.26%. The marketing efficiency was calculated using Shepherd Futrel method (Arene, 2008) which is stated as: ME = TC/TR X100. Where ME = coefficient of marketing efficiency, TC = total cost incurred and TR = total value of product sold as shown in Table -2. The total cost associated with fishing in Ganyingbo before and after effect of the climate change were #17850.0± 2015.22 and 22300.0 ± 6297.40 respectively.

On the other hand, the revenues from the fishers were #32571.43± 6757.88 and # 27857.14 ±3325.92 respectively. The coefficient of marketing efficiency for fisherfolks were 54.8% and 72.26% before and after the effect of climate change respectively.

3.1 Impact of Climate Change on Livelihood of Ganyingbo’s Fisherfolks

The most frequent climatic disaster experienced by the fishermen was flood (50%) as presented in Table- 3 while drought (17.24%) was the least experienced. Sixty nine percent (69%) of the respondents had their livelihood being affected by climate change while the livelihoods of 31.03% of them were not affected by climate change. Catch output of 91.38% of respondents have decreased due to climate change. Eighty six (86%) of the fishermen responded that effects of climate change resulted in catch of less adult fishes, changes in fish distribution and physiological, morphological, reproductive, migratory and behavioural responses of fish. Similarly, 89.66% of fisherfolks believed that climate change could lead to extinction of certain species of fish.
**Fig. 1.** Map of Badagry showing the location of Ganyingbo fishing community

**Table 1.** Socio characteristics of Fisherfolks in Ganyingbo community

| Variables                        | Frequency | Percentage (%) | Cumulative Percent |
|----------------------------------|-----------|----------------|--------------------|
| Sex                              |           |                |                    |
| Male                             | 48        | 82.76          | 82.76              |
| Female                           | 10        | 17.24          | 100                |
| Age                              |           |                |                    |
| 20-29                            | 2         | 3.45           | 3.45               |
| 30-39                            | 16        | 27.58          | 31.03              |
| 40-49                            | 14        | 24.14          | 55.17              |
| 50 and above                     | 9         | 15.52          | 70.69              |
| 51-60                            | 15        | 25.86          | 96.55              |
| 61 and above                     | 2         | 3.45           | 100                |
| Marital Status                   |           |                |                    |
| Single                           | 17        | 29.31          | 29.31              |
| Married                          | 41        | 70.69          | 100                |
| Education Level                  |           |                |                    |
| Unschool                         | 14        | 24.14          | 24.14              |
| Primary                          | 22        | 37.93          | 62.07              |
| Secondary                        | 20        | 34.48          | 96.55              |
| Tertiary                         | 2         | 3.45           | 100                |
| Undergo training before starting fish business | | | |
| Yes                              | 20        | 34.48          | 34.48              |
| No                               | 38        | 65.52          | 100                |
| Other Job Outside Fishing        |           |                |                    |
| Yes                              | 25        | 43.10          | 43.10              |
| No                               | 33        | 56.90          | 56.90              |
| Activities apart from Fishing    |           |                |                    |
| Net making                       | 10        | 17.24          | 17.24              |
| Welding                          | 13        | 22.41          | 39.65              |
| Mechanic                         | 8         | 13.79          | 53.44              |
| Vulcanizing                      | 20        | 34.48          | 87.92              |
| Processing                       | 7         | 12.08          | 100                |
| Number of Years spent in Fishing |           |                |                    |
| 6-10                             | 18        | 31.03          | 31.03              |
| 11-15                            | 16        | 27.59          | 58.62              |
| 16 and above                     | 24        | 41.38          | 100                |
Table 2. Average weekly fishing expenditure and income of Fishermen at Ganyingbo

| Parameter       | Before Effect of Climate Change | After Effect of Climate Change | Percentage Increase/Decrease (%) |
|-----------------|---------------------------------|--------------------------------|----------------------------------|
| Expenditure(#)  | 17850.0± 2015.22a               | 22300.0± 6297.40b              | 24.93                            |
| Income(#)       | 32571.43± 6757.88a               | 30857.14 ± 3325.92b             | 5.26                             |
| ME(TC/TR)X100   | 54.8                            | 72.26                          |                                   |

Mean with different superscripts = significant difference at p<0.05

Table 3. Effects of climate change on livelihood of fishermen

| Parameters                                                                 | Frequency | Percentage (%) |
|---------------------------------------------------------------------------|-----------|----------------|
| Climate disaster you have experienced                                     |           |                |
| Flood                                                                     | 29        | 50.00          |
| Drought                                                                   | 10        | 17.24          |
| Storms                                                                    | 19        | 32.76          |
| How intense was the disaster                                             |           |                |
| Fair                                                                      | 20        | 34.48          |
| Severe                                                                    | 18        | 31.04          |
| Very Severe                                                               | 20        | 34.48          |
| Did it affect your livelihood                                            |           |                |
| Yes                                                                       | 40        | 68.97          |
| No                                                                        | 18        | 31.03          |
| Any decrease in catch output                                              |           |                |
| Yes                                                                       | 53        | 91.38          |
| No                                                                        | 5         | 8.62           |
| There were less Adult fishes and changes in fishes distribution           |           |                |
| Yes                                                                       | 50        | 86.20          |
| No                                                                        | 8         | 13.80          |
| Physiological, morphological, reproductive, migratory and behavioural responses of fish is affected |           |                |
| Yes                                                                       | 50        | 86.20          |
| No                                                                        | 8         | 13.80          |
| Climate change influence price of fish                                   |           |                |
| Yes                                                                       | 45        | 77.59          |
| No                                                                        | 13        | 22.41          |
| Climate change influence some fish to go to extinction                    |           |                |
| Yes                                                                       | 52        | 89.66          |
| No                                                                        | 6         | 10.34          |

3.1.1 Climate change and adaptive strategies adopted by fisherfolks in Ganyingbo

Ganyingbo fishing community agreed that 84.48% fishermen had modified fishing activities over the last 5 years due to climate change (Table - 4). However, 74.14% of fishermen disclosed that there was positive change in artisanal fisheries of Ganyingbo over the last 10 years. Furthermore, 79% of them agreed that when habitat destruction and pollution of water bodies were prevented, stress in fresh water and brackish water would decline. A total of 87.93% of fishermen believed that adopting coping strategies to impacts of climate change is a must for artisanal fisheries systems. On the other hand, 100% of fishermen agreed that establishment of community stakeholders to identify and give immediate response against impacts of climate change is necessary.

3.1.2 Effectiveness of mitigation measures on impacts of climate change at Ganyingbo fishing community

It was found that 83% of fishermen responded that mitigation avoid significant human interference with climate change, while 86% of them connoted that development of sophisticated monitoring programmes and models will be crucial in combating climate change (Table-5). However, 89.66% of them disclosed that mitigation measures were limited in Ganyingbo fishing community and there was no enough effective approach in combating climate change. While 77.59% of respondents in Ganyingbo fishing...
community believed that reduction in flow of heat-trapping green house gases into atmosphere would have positive impact on climate change, 22.41% of them had contrary view.

### 3.1.3 Fishermen’s opinion on the viability of artisanal fisheries in Gayingbo community

Table 6 showed the results on Fishermen’s opinion on the viability of artisanal fisheries in Gayingbo. Fifty nine (59%) percent of the respondents agreed that fishing business is a profitable trade, while 19.19% agreed that fishing business is more profitable than sand mining. However, 24.66% agreed that price of fish is beyond the reach of most people. Sixty six (66%) of respondents agreed that reduced fish prices will automatically lead to improved sales. On the other hand, 38.35% of the respondents agreed that they will still make a marginal profit if selling price of fish is reduced regardless of fishing cost due to effect of climate change. In term of gender dominance in the fishing business, 80% of fishermen agreed that fishing is totally dominated by men. The test of significant for these variables using chi-square showed that there is a significant difference between expected and observed perspective of fishermen on the viability of artisanal fisheries in Gayingbo community at 0.05 significant alpha level ($X^2 = 30.56: 9.49$).

### 4. DISCUSSION

In this study, majority of the fishermen (consisting of more than 80% male) in Ganyingbo fishing community falls within the youthful age of 30-39 years. Similar active age groups and gender dominance have been reported in Ondo State by Omitoyin and Tosan [4] and Akinwunmi et al. [12]. Over 55% of the fisherfolks that do not have other job apart from fishing could suggest that the fishermen output is still reasonable regardless of impact of climate change.

The dominant number of fishing experience in Gayingbo fishing community are 16 and above and this imply that fishermen in Ganyingbo community are well experienced in the fishing business. The fishing experience recorded in this study was similar to the findings of Olusola et al. (2017). However, majority of the fishermen in Ganyingbo fishing community did not attain beyond secondary school education. The literacy level of respondents in this study was very low in comparison to the findings of Akinwunmi et al. [12] and Adeosun and Adesukola [13].

#### Table 4. Impact of climate change on adaptive strategies of artisanal fisheries in Gayingbo fishing community, Badagry

| Variables                                                                 | Frequency | Percentage (%) |
|---------------------------------------------------------------------------|-----------|----------------|
| Changes or adjustment in fishing activities has been done over the last 5 years due to climate change | Yes       | 49             | 84.48          |
|                                                                            | No        | 9              | 15.52          |
| Any Positive change in artisanal fisheries over the last 10 years         | Yes       | 43             | 74.14          |
|                                                                            | No        | 15             | 25.86          |
| To reduce stress in fresh water and coastal waters, habitat destruction and pollution should be avoided | Yes       | 46             | 79.31          |
|                                                                            | No        | 12             | 20.69          |
| Adopting coping strategies to impacts of climate change is a must for artisanal fisheries systems as it affects livelihood | Yes       | 51             | 87.93          |
|                                                                            | No        | 7              | 12.07          |
| Establishment of community stakeholders to identify and give immediate response against impacts of climate change is necessary | Yes       | 58             | 100            |
|                                                                            | No        | 0              | 0              |
### Table 5. Effectiveness of mitigation measures on reduction of effect of climate change on Gayingbo fishing community

| Questions                                                                 | Frequency | Percentage (%) |
|---------------------------------------------------------------------------|-----------|----------------|
| Mitigation avoid significant human interference with climate change      | 48        | 82.76          |
| Yes                                                                       | 48        | 82.76          |
| No                                                                        | 10        | 17.24          |
| Development of sophisticated monitoring programmes and models will be importance in combating climate change | 50        | 86.21          |
| Yes                                                                       | 50        | 86.21          |
| No                                                                        | 8         | 13.79          |
| Restoration of mangrove forest can protect shorelines from erosion and provide breeding ground for fish | 52        | 89.66          |
| Yes                                                                       | 52        | 89.66          |
| No                                                                        | 6         | 10.34          |
| Mitigation measures are limited and no enough effective approach in combating climate change | 52        | 89.66          |
| Yes                                                                       | 52        | 89.66          |
| No                                                                        | 6         | 10.34          |
| Reduction in flow of heat-trapping green house gases into atmosphere would have positive influence on climate change | 45        | 77.59          |
| Yes                                                                       | 45        | 77.59          |
| No                                                                        | 13        | 22.41          |

### Table 6. Assessment of fishermen’s perspective on the viability of artisanal fisheries in Gayingbo community

| Statements                                                                 | SA(%) | A(%) | U(%) | D(%) | SD(%) |
|----------------------------------------------------------------------------|-------|------|------|------|-------|
| Presently, fishing in Badagry is a highly profitable trade                  | 26.02 | 32.88| 5.48 | 16.44| 19.18 |
| Fishing is more profitable than sand mining                                | 9.59 | 9.60 | 6.84 | 41.09| 32.88 |
| Due to effects of climate change, the price of fish recently is beyond the reach of most people | 9.59 | 15.07| 24.66| 30.14| 20.55 |
| Reduced fish prices will automatically lead to improved sales             | 28.77 | 36.99| 9.59 | 9.59 | 15.07 |
| If I reduce selling price of fish irrespective of impact of climate on the cost of catching, I will still make a marginal profit | 12.33 | 26.02| 5.48 | 41.10| 15.07 |
| Fishing business is totally dominated by men                               | 50.0  | 30.0 | 8.0  | 2.0  | 10.0  |
| Chi-Square Test                                                            | $X^2_{cal} (30.56)^a$ | $X^2_{tab} (9.49)^b$ |

$SA = strongly agree, A = agree, U = undecided, D = disagree, SD = strongly disagree; ^a,b = significantly different at 5% level of probability (p<0.05)$
The summary of the total expenditure and income of fishermen before and after the effect of climate change which revealed a 25% increase in expenditures and 5% decrease in income generation, could suggest that climate change have notable effect on Ganyingbo fishing community. This suggestion was buttressed by the calculated coefficient of marketing efficiency which indicated that 54.8% and 72.26% of their sales revenue are taken up by costs before and after the effect of climate change respectively. Since the lower the coefficient of marketing efficiency the higher the level of efficiency, it implies that gain in fishing business at Ganyingbo is more efficient before the effect of climate change.

The test of significant for variables using chi-square which showed that there is a significant difference between expected and observed perspective of fishermen on the viability of artisanal fisheries in Ganyingbo community indicated that artisanal fishing business in Ganyingbo fishing community is viable and lucrative and similar observation was reported by Anyanwu et al.[8] in Onitsha River Niger.

The most frequent climatic disaster experienced by the fishermen was flood. In line with the finding of this study, Ikot Ibom Itam community, in Akwa Ibom had experienced heavy flood that led to the disappearance of four local streams [14]. The present finding also corroborates the report of Chidi and Ominigbo [15] that climate change causes exacerbating problems of too much water (flood) to little water (droughts) and reduced water quality, salt water intrusion, sea level rise, and drying.

Catch output of 91.38% of respondents have decreased due to climate change. Most of the fishermen responded that effects of climate change resulted in catch of less adult fishes, changes in fish distribution and physiological, morphological, reproductive, migratory and behavioural responses of fish. Similarly, 89.66% of fisherfolks believed that climate change could lead to extinction of certain species of fish.

As presented in Table- 5, Eighty three (83%) of fishermen responded that mitigation avoid significant human interference with climate change, while 86% of them connoted that development of sophisticated monitoring programmes and models will be crucial in combating climate change. However, 89.66% of them disclosed that mitigation measures are limited in Ganyingbo fishing community and there was no enough effective approach in combating climate change. While 77.59% of respondents in Ganyingbo fishing community believed that reduction in flow of heat- trapping green house gases into atmosphere would have positive impact on climate change, 22.41% of them had contrary view.

Iioni and Oyaide [16] carried out a study on the assessment of artisanal fish in the Delta State. The result of their study revealed that a Net Margin/fisher/year is ₦111,677.62. Anyanwu et al. [8] in their study of Economics of fish Artisanal within Niger River in native North authority place of Anambra State obtained a Gross Margin of ₦96,002.29 per fisherman per month. Most fisheries exploitation in freshwaters and coastal waters are carried out by artisanal (small scale) fishermen, employing simple fishing gear and equipments.

However, with changing conditions in the water bodies such as temperature rise, increased salinity and invasion of aggressive water species, the fish dominated region seems to be affected causing the fishes to move to different part of the water body thus forcing the fishermen to travel longer distance in search of abundant supply of fishes for a good catch [17].

The number of people directly employed in fisheries and aquaculture is conservatively estimated at 43.5 million, of which over 90% are small-scale fishers [18]. In addition to those directly employed in fishing, there are “forward linkages” to other economic activities generated by the supply of fish (trade, processing, transport, retail, etc.) and “backward linkages” to supporting activities (boat building, net making, engine manufacture and repair, supply of services to fishermen and fuel to fishing boats, etc.). Taking into account these other activities, over 200 million people are thought to be dependent on small-scale fishing in developing countries, in addition to millions for whom fisheries provide a supplemental income [18]. Fisheries are often available in remote and rural areas where other economic activities are limited and can thus be important engines for economic growth and livelihoods in rural areas with few other economic activities [18]. Some fishers are specialized and rely entirely on fisheries for their livelihood, while for many others, especially in inland fisheries and developing countries, fisheries form part of a diversified livelihood strategy [19,20]. Fisheries may serve as a “safety
net” to landless poor or in the event of other livelihoods failing [18]. Many small-scale fisher folk live in poverty, often understood as resulting from degradation of resources and/or from the safety net function of fisheries’ for the poorest in society. This generalized understanding of the economic poverty of fishers in the developing world captures some of the situation of small scale fishers, but misses both the fact that they may earn more than peers in their communities and that their poverty is multidimensional and related to their vulnerability to a variety of stressors including HIV/AIDS, political marginalization and poor access to central services and healthcare [21].

While poverty in fishing communities or other forms of marginalization reduces their ability to adapt and respond to change, increasingly globalized fish markets are creating new vulnerabilities to market disruptions which may result from climate change. A key feature of the socio-economics of inland fisheries, which may influence how they interact with climate change, is the intense seasonality of many highly productive floodplain fisheries, for example those in Southeast Asia (SEA) and Bangladesh [22]. Somewhat related to this trend is the tendency for inland fisheries to be conducted by people who do not define themselves as fishers, but rather engage with seasonal fisheries alongside other livelihood options [20].

Several empirical studies have been conducted to investigate the different impacts of climate change on Nigeria fisheries and aquaculture which includes the work of Idowu et al. [6] and Ipinjolu et al.[7] on the impact of climate change in Nigeria; the potential impacts of climate change on fisheries and aquaculture in Nigeria [8]; climate change, effects and mitigation strategies on aquaculture: a review [9]; impacts of climate change on fisheries: implications for food security in Sub-Saharan Africa [10], and fish farmers’ perception of climate change impact on fish production in Delta State, Nigeria (Leon and Antonio, 2015). According to these authors, climate change scenario especially through temperature and carbon dioxide increase will continuously warm the earth with resultant effects on fisheries and aquaculture, and that Nigeria vulnerability is high. Leon and Antonio (2015) asserted that warming has increased thermal stratification, reduction in surface water cold and warm mix thereby preventing upwelling effects of nutrients, and consequently affect primary productivity, the distribution and fecundity of marine fishes. Surprisingly, it was also observed that changing climate through reduced temperature will temporarily increase dissolved oxygen in water which will deplete afterwards due to increase in biochemical Oxygen demand; a natural phenomenon in water noted to regulate water quality. The effect would increase nutrient content of water bodies causing algal bloom, thus eutrophication of waters [23].

Increase in temperature can adversely increase food consumption by fish, especially small sized fishes, and resultantly increase the cost of inland aquaculture. Consequently, increase biological oxygen demand (BOD), deplete available dissolved oxygen (DO) and thus, pollution of water bodies and death in some cases. The quality of water body is a key to the survival of fish life, which is an important consideration for both marine and inland aquaculture assessment. Changes or poor water quality has been reported to result to large scale fish death in ponds or marine ecosystems, especially as fish and shellfishes known to have suitable environmental conditions to thrive in some of these aquatic systems. Climate change through increased temperature reduces oxygen level in water. Thus increased biochemical oxygen demand (BOD) will deplete the available oxygen causing an anoxia in water bodies. Increase in dissolved oxygen has been observed to regulate water quality by reducing carbon dioxide concentration in waters [23].

Studies have shown that non-climate factors such as poverty, inequality, food insecurity, conflict, disease and globalization can increase vulnerability by affecting the exposure, sensitivity and adaptive capacity of systems, communities and individuals [24]. Vulnerability depends upon three factors: exposure to a hazard, in this case to the effects of climate change; sensitivity to the hazard and the degree to which the community, the region or the country depends on fisheries, and; the ability to adapt to, absorb or recover from the hazards [25].

Fishing communities that depend on just a few species are more vulnerable to fluctuations in stocks than communities that spread their dependency over an extensive range of marine resources. This vulnerability is aggravated in communities that have historically fished intensively or overfished [26].

A livelihood can be defined as the capabilities, assets and activities required for means of living
The concept of sustainable livelihood seeks to bring together the critical factors, assets and activities that affect the vulnerability or strength of household strategies [19]. People can access, build and draw upon five types of capital assets: human, natural, financial, social and physical.

In addition to negative impacts, climate change is likely to create opportunities and positive impacts in some fisheries, although these are not well understood or described in the literature. In inland waters, fisheries created by increases in flooded areas may partially offset the loss of land for agriculture or other economic activities [28].

Fisher folk and their communities around the world are already constantly adapting to various forms of change [29]. Examples of adaptation in fisheries are dominated by diversification or flexible livelihoods [19], and migration in response to climate-mediated fluctuations in yield. Responses to direct impacts of extreme events on fisheries infrastructure and communities are believed to be more effective if they are anticipatory as part of long term integrated coastal and disaster risk management planning [30]. Adaptations to sea level rise and increased storm and surge damage include hard (e.g., sea walls) and soft (e.g., wetland rehabilitation or managed retreat) defenses, as well as improved information systems to integrate knowledge from different coastal sectors and predict and plan for appropriate strategies.

In the present study, the livelihood and catch output of most of the respondents was affected by climate change. The implication is that most of the fishermen may eventually become bankrupt. Artisanal fisheries are an important food source, and therefore, changes in the total amount or geographic distribution of fish available for catch could potentially affect food security [31]. From the results obtained in this study, the fishermen had various mitigating measure in place however, those mitigation measures are limited in combating climate change. Similar suggestion had been opined by Taucher and Oschlies [32] Sumeila et al. [17].

5. CONCLUSION

The findings of this study indicated that climate change had an impact on the artisanal fisheries of Ganyingbo fishing community in Badagry. Climate change impacts their livelihood, output and input, and as well as on the mitigation and adaptive measures. The results coefficient of marketing efficiency indicated that gain in fishing business is more efficient before the effect of climate change at Ganyingbo fishing community.

CONSENT

As per international standard or university standard, respondents’ written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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