

Analysis of Technical Efficiency and Effect of Climate Change on Periwinkle Production in South-South, Nigeria

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ABSTRACT

This study examines the analysis of technical efficiency and effect of climate change on Periwinkle Harvesters in Akwa Ibom State. The objectives were to assess the socioeconomic characteristics of the periwinkle harvesters, determine technical efficiency of periwinkle harvesters, determine the effect of climate change on periwinkle harvesters. Purposive sampling technique was used to sample 8 fishing communities from four local government areas of Oron, Mbo, Udung Uko and Urue Offong/Oruko. Snowballing technique was used to select 10 respondents from each community, giving a total sampling size of 80. Analytical methods used included, descriptive statistics, four - point likert scale and multiple regression. The results showed that majority of periwinkle harvesters were female (63%), 46.30% of the respondents were married, 42.59% were single and 11.30 % were divorced. A total of 55% had secondary education, 28.8% had primary education and 16.3 % had no formal education. Majority of the respondents engaged in periwinkle harvesting as their major occupation, 47.4% earned above the mean income level of 36,962.50. From the results, handpicking was the most commonly used method of harvesting. The respondents were all aware of the existence of climate change but only a few of them had knowledge about the nature of effect, climate change has on harvesting. From the findings the major constraints faced by the harvesters was sea rise and presence of predators, like snake. The results of the perceived effect of climate change on periwinkle output showed that the salt content of the sea has no effect on the quantity of periwinkle harvested. Furthermore, the result showed that an increase in rainfall leads to decrease in the catch rate of periwinkle. For sea rise, the result of the yes category compared to the base category, showed that from the harvesting experience of the respondents, the quantity of periwinkle harvested increases as the sea rises. While the "No" category, compared to the base category showed that rise in sea level has no effect on the quantity of periwinkle harvested. The study recommends, amongst others; that policy makers and NGOS should create an awareness on the nature of the effect of climate change on periwinkle harvesting.

Key Words: Periwinkle, Harvesters, Technical Efficiency, Climate Change,

INTRODUCTION: Agriculture is at the center of the economy, providing the main source of livelihood for the majority of Nigerians. Agriculture in Nigeria is the foundation of the economy as it keeps the people stable in what they do (Megan, 2018). According to CIA (2012) Agriculture contribute 40% of the Gross domestic product (GDP) and employs about 70% of the working population in Nigeria. Agriculture is also the largest economic activity in the rural area where almost 50% of the population lives. Fisheries is an important sector of agriculture that contributes about 3.00-5.00% to the agriculture share of the Gross domestic product. Nigeria is a Maritime nation with a vast population of over 160 million people and a coastline measuring approximately 853 kilometers. Fish production as

an enterprise in this country possesses the capacity to contribute significantly to the agricultural sector (Osagie, 2012). Therefore, the maintenance and sustainability of the life process of these aquatic organisms is undoubtedly important due to their economic role in the society of all fisheries products, shellfish has been noted to have a highest biological value in terms of high protein in the body, low cholesterol content and higher protein assimilation (Amieghene, 2005), (Nyong,et. Al., 2021,2022). Periwinkle, botanically called *Tympanotonus fuscatus* is one of the fisheries products common to the coastal areas of Nigeria, most especially Rivers State. They are found at the inter-tidal zone of brackish water, creeks, estuaries and lagoons in the Niger Delta area (Adebayo-Tayo, *et. al.*, 2006). It is of

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economic importance as it serves as a source of protein to many Nigerians. It also serves as a source of income to the collectors and marketers, thus forming an important industry in the entire Niger Delta region of the country (Egonmwan, 2007). Furthermore, the shells of these periwinkles are used in place of gravels in the building industry, as decorative arts and in the production of animal feed (Akinrotimi, 2009). The genus *Tympanotonus* commonly known as periwinkle is a single specie of the phylum mollusca, family potomidea and class gastropoda, in this paper periwinkle will be commonly referred to as molluscs or gastropod. It has two varieties namely *Tympanotonus fuscatus var fuscatus* and *Tympanotonus fuscatus var radula*. The output of this specie has been greatly impeded by factors of climate change (Bob, 2012), because of a decline in the harvest, also periwinkle population is sensitive to changes in climate condition of their habitat (Nyong,et. Al., 2021,2022).

Periwinkle harvesting is regarded as the Domestic fish production which is a form of artisanal fishery. Artisanal fishery refers to the harvesting or capturing of fishes from natural bodies such as rivers streams, and oceans by small scale Fisher folks using both traditional and modern fishing years. According to Bob, (2012) there's been an alarming reduction in Periwinkle population. This decrease in periwinkle quantity is caused by climate change. Generally Aquatic organisms are very vulnerable to climate change because the average temperature of both air and water are changing simultaneously. Climate change in the aquatic system mainly occurs through sea level and temperature rise, change in monsoon patterns, extreme weather events and water stress having both direct and indirect impacts on aquatic animals including fish stocks. Its direct effect on the physiological behavior and growth pattern of organisms, subsequently, decreases reproductive capacity and finally causes mortality. Indirectly it may alter the productivity, structure, function and composition of aquatic ecosystems. All these effects finally result in decreased fish production (Nyong,et. al., 2021,2022) (Satarupa *et al.*, 2020).

Rising ocean temperatures, and ocean acidification are radically altering brackish water, as well as changes in water temperature, water flow, and fish habitat loss. Climate change is modifying fish distribution and the productivity of periwinkle shell fish.(Cheung *et al.*, 2009).The impacts of climate change on ocean systems has impacts on the sustainability of periwinkle shell fish, on the livelihoods of the communities that depend on fisheries, and on the ability of the oceans to capture and store carbon (biological pump). The effect of sea level rise means that coastal fishing communities and the harvesters are significantly impacted by climate change. The rising ocean acidity makes it more difficult for periwinkle shell fish or corals to form their shells a process known as calcification. Many important animals, such as zooplankton, that forms the base of the marine food chain have calcium shells. Thus the entire marine food web is being altered there are cracks in the food chain. As a result, the distribution, productivity, and species composition of local fish production is changing. (Brender, 2010).

Periwinkle shell fish contribute significantly to food security and livelihoods. It's provides essential nutrition for people and some percentage of animal protein and minerals to people from the poorest countries (World Fish Center, 2008). This food security is threatened (Nyong,et. al., 2021,2022)by climate change and the increasing world population. Climate change changes several parameters of the fishing population: availability, stability, access, and utilization. According to Garcia (2010), the specific effects of climate change on these parameters will vary widely depending on the characteristics of the area, with some areas benefiting from the shift in trends and some areas being harmed based on the factors of exposure, sensitivity, and ability to respond to said changes. The lack of oxygen in warmer waters will possibly lead to the extinction of aquatic animals (Nyong,et. al., 2021,2022)

The effect of climate change on the output of periwinkle, directly has socio economic impact on the harvesters and buyers of Periwinkle shell fish and on the community at large. Having known the important role played by the abundance of this gastropod in terms of nutrient availability (protein) source of income and purchase power, to mention but a few, it is without doubt that the gradual decline in the abundance and functionality of this specie induced by changes in climate has detrimental effect on the artisanal farmers and the coastal communities (Kawarazuku & Bene, 2012) (Nyong,et. al., 2021,2022). Periwinkle production is the process of harvesting Periwinkle from their natural habitat by periwinkle Farmers, and selling same to marketers and then to the final consumers. Over the years, there has been an extensive research on the beneficial effect of periwinkle shell fish to the Society, and it's been discovered that periwinkle is a good source of protein, vitamins and minerals (Jamabo & Chinda, 2010). Periwinkles have a very high protein content of 102mg/ml. according to (Akwuri & Archibong, 2011; Bob, 2012) it is revealed that the organism is very medicinal for cases like endormic goiter due to its iodine calcium phosphate and iron content. Their shell is used as powder for pimples, vim for cleansing, fertilizers and calcium source of animal feed. Also periwinkle shell competes favourably in construction industry, ornamentals and cosmetics (Nyong,et. al., 2019,2021,2022) (Jamabo & Chinda, 2010) and majorly, it is a source of revenue generation for the farmers and marketers of periwinkle.

Thus, with the progressive decrease in population and quantity of this specie (Jamabo & Chinda, 2010) it's relevant role is lacking attention and has caused all round production decrease in sectors concerned like animal feed producing enterprise, cement industry, cosmetics industry etc. There's no longer enough periwinkle shell for production of calcium nutrient in animal feed and the available ones are going out on a high price, causing increase in overall animal products cost. Simultaneously the construction industry, ornamentals and cosmetics industry are losing out on their raw materials for production. For emphasis periwinkle are poikilothermic in nature and the body temperature changes with environmental temperature, so they are very much sensitive

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to changes in temperature in their external environment. When the external environment temperature goes beyond the tolerance limit of these organisms, they will go for migration and this proves is called behavioural thermoregulation, this phenomenon reduces minimal catch by 40% and this causes decrease in available market quantity (Nyong,et. al., 2021,2022).

Subsequently decrease in quantity leads to increase in price associated with decrease in availability (scarcity). This is a problem not only to periwinkle Farmers and final consumers but to the Society at large because it has a direct effect on the gross margin of the community. Thus, there's a growing concern among the farmers, marketers and final consumers of this organism on how to control the alarming quantity decrease induced by climate change, maintain profitable market for periwinkle as well as sustainable nutrient supply and income stability. It is against this backdrop, the researcher sought to analyze the effect of climate change on output of periwinkle harvesters (Nyong,et. al., 2021,2022). The general objective of this research is to determine the effect of climate change on output of periwinkle harvesters. The specific objectives are to: determine the socio-economic characteristics of periwinkle harvesters; determine the income level of periwinkle harvesters; determine the Effect of climate change on periwinkle harvesting ;examine the awareness of the effect of climate change on periwinkle harvesting; and identify the constraints faced by periwinkle harvesters (Nyong,et. al., 2021,2022).

Data Collection: Primary data was used for this study. Data for this study was collected using structured questionnaire administered by enumerators that know the terrain and is familiar with the language and the people as well. The questionnaire was pretested for construction and validity. The areas covered in the questionnaire was socio economics data of the respondent such as age, gender, household size, level of education, marital status, source of capital, method of harvesting periwinkle, climatic variables like rainfall, temperature e.t c, income level of harvesters, effect of climate change on output of periwinkle harvesters, constraints faced by harvesters.

Data analysis: This section deals with the mathematical expression of the relationship between variables used in estimation of economic phenomena. Method of data analysis used will be based on the objectives.

Multiple regression is a statistical technique that can be used to analyse the relationship between a single dependent variable and several independent variables. The objective of multiple regression analysis is to use the independent variables whose value set are known to predict the value of the single dependent variable. The advantage of this approach is that it leads to a more accurate and precise understanding of the association of each individual factor with the outcomed , it also consider the effect of more than one explanatory variable on some outcome of interest. It evaluate the relative effect of this explanatory variable on the

dependent variable when holding all other variables constant. This reasons makes multiple regression most suitable approach for analysing this objective.

Mathematical $Q=F(X^1, X^2, X^3, X^4...X_n)$

$$Q=b^0 + X^1b^1+X^2b^2+X^3b^3+ X^4b^4 +X^5b^5 +X^6b^6....+U.....(Eqn 1)$$

Where

Q =Periwinkle quantity harvested in kg/farmer(dependent variable)

$X^1_X^6$ =Independent variables

X^1 = Rise in sea level

X^2 =salinity

X^3 =rainfall

X^4 =Temperature

X^5 =Age measured in Years

X^6 =years of harvesting experience

U=Error term

b^1 to b^6 = parameters

Use the questionnaire in the Appendix section for more details on how this research captured the climatic variables. Rise in sea level, salinity, rainfall and temperature.

Objective 4

Identify harvesters awareness of climate change issues on periwinkle harvesting.

This objective will be analyzed using a Four point likert scale of, Extremely aware, moderately aware, slightly aware, and not all aware (Wade, 2006) likert scale is a psychometric scale commonly involved in research used to represent people's opinion and attitude to a topic or subject matter. It is a contnumm from highest to lowest points and has an intermediate points in between these two extremeties that is why it is the most suitable analytical technique for this objective (Form plus blog)

Explicitly

Using EA= Extremely aware, MA= Moderately aware, SA =Slightly aware and NA= Not all aware.

EA= 4, MA =3, SA =2 , NA=1

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Likert Scale = $\sum W/NLS = \text{Sum of Weights (W1+W2+----Wn)}/N$ Where; W = Weights assigned to each of statement by the respondents and it ranges from 1 to 4 where '1' is less important and '4' is extremely important N = Total number of respondents (i.e. 80)

$$\text{Weighted score} = \frac{\text{No of EA} \times 4 + \text{No of MA} \times 3 + \text{No of SA} \times 2 + \text{No of NA} \times 1}{N}$$

The mean will be obtained by adding all respondents weight and dividing by 4.

$$= 4 + 3 + 2 + 1 / 4 = 10 / 4 = 2.5$$

Hence awareness with mean score of 2.5 will be considered as the major awareness level and awareness with mean score of 2.0 will be considered as a minor awareness level.

Objective 5: identify the constraints faced by periwinkle harvesters.

This objective was analyzed using descriptive statistics such as mean, percentages and frequency counts.

RESULT AND DISCUSSION

Socioeconomics characteristics of the respondents: Table 4.1a shows the economic characteristics of the respondent. The distribution of respondents according to Gender reveals that 62.50% of periwinkle harvesters are female, while about 37.50% are males. This implies that both males and females were involved in periwinkle harvesting, but majority of the harvesters were females. This result is in consonance with the findings of Akinrotimi *et al.*, (2009) who reported that periwinkle harvesters are majorly females (70%) and (30%) are males. Also analysing the Age variable it shows that 31% of the periwinkle harvesters were within the age bracket of 16-25, also 31% were within the age bracket of (26-35%) and (8%) were within the age bracket of 36-45%. The mean age of harvesters was 32 which implies that the harvesters are mainly in their economically active age, this also indicate the dominance of young age in harvesting business. This corroborate with findings from Akinrotimi *et al.*, (2009), Ajanle & Aregbor (2015), Zacharia *et al.*, (2013) and Omeje *et al.*, (2022) (Nyong, *et al.*, 2021,2022), who reported that 70%, 74%, 72%, 51.6%, and 61.67%, respectively, of fisher folks are within the age bracket of 20-40 years.

Frequency distribution of respondent on marital status in Table 4.1a shows that 46.25% of the respondents are married, 42.50% are single and 11.30 are divorce. This implies that an average percentage of the respondent in the study area were married and that they have a lot of family responsibility. This result agrees with findings of Aminu *et al.*, (2017) who reported that (66%) of the respondent are married and 20% are single. It is slightly different from the findings of Sakib and Ifiekhar (2019) who reported that 85% of fisher folks are married and 15% percent are single. Furthermore frequency distribution of household size shows

that 25.1% of the respondent has a household size of 0-4 persons, 45% has 5-9 persons and 30% has 10-14 persons. The mean household size is 6 persons. This implies that majority of respondent in the study area had a large household size, therefore a large household size reduces labour cost has family labour will be employed. Invariably large household size has a high dependency ratio and increases expenditure. This study aligns with the finding of Aminu *et al.*, (2017), Adegbite & Oluwalana (2004) and (Nyong, *et al.*, 2021,2022) who reported that the higher the household size, the more likelihood got labour sufficiency. Looking at the result of the distribution of respondent in the study area based on their years of experience. The results in Table 4.1b reveal that 25.1% of the respondent 0-4 years of experience, 45.1% had had 5-9 years experience and 30% had 10-14 years of experience. The mean harvesting experience is 7 years; this means that an appreciable amount of the respondents had good harvesting experience. This is in consonance with the findings of Olaye, (2010) who observed that fishing experience is important in determining the profit level of fisher folks. The more the experience the wider their level of understanding of the system. The frequency of respondent according to educational level shows that majority of the respondent 55% in the study area had secondary education, 28.8% had primary education and 16.3% of the respondents had no formal education. This implies that respondent in the study area is relatively educated. This agrees with the findings of Fawole and Fashina (2005) who reported that fisher folks have average educational level. On the contrary, this study disagrees with the findings of (Nyong, *et al.*, 2021,2022) Olaye *et al.*, (2012) who reported that 60% of fisher folks are uneducated.

The distribution of the respondent according to type of fishing engaged in Table 4.1b shows that 31.3% of the respondent engaged in harvesting periwinkle for commercial purposes while 68.8 percent of the respondent Practice subsistence form of periwinkle harvesting. This implies that majority respondent in the study operates with low capital which limits them to subsistence type of harvesting. Moreso the distribution of respondents according to source of farm capital reveals that 76.3% of the respondent used saving as their source of Capital. 3.8% raised their Capitals from loans and 20% had a combination of both savings and loans. From this results majority of the harvesters in the study do not embrace loan taking which is a limiting factor to business expansion and has implications on their credit mobility. The results of frequency distribution of respondents according to major occupation reveals that majority 62.5% of the respondent in the study area practice periwinkle harvesting as their major, source of livelihood while a percentage of 37.5 had alternative source of livelihood. This implies that the household in the study area had periwinkle harvesting as their major occupation and that it was enough to meet their family financial obligation. This disagrees with the findings of Olodmole *et al.*, (2010) (Nyong, *et al.*, 2021,2022), and Aminu *et al.*, (2017) who reported that Fisheries activities alone was not enough to meet the financial obligation of the respondent. The distribution of respondents according to method of fishing in Table 4.1b shows that majority of the respondent with a percentage of 92.5% used handpicking method of harvesting, 20% of the respondents used netting and 5% used bottom fishing. This implies

that handpicking is the most widely used method of harvesting periwinkle in the study are

Table 4.1a Social Characteristics of Respondents

Variable	Frequency	Percentage
Gender		
Female	50	62.50
Male	30	37.50
Total	80	100.00
Age		
16-25	25	31.25
26-35	25	31.25
36-45	23	28.7
Above 45	7	8.75
Total	80	100.00
Marital status		
Single	34	42.50
Married	37	46.30
Divorce	9	11.30
Total	80	100.00
Household size		
0-4	20	25.10
5-9	36	45.10
10-14	24	30.00
Total	80	100.00
Harvesting experience		
0-4	20	25.10
5-9	36	45.10
10-14	24	30
Total	80	100.00

Source: Field survey, (2022)

Table 4.1b Economic Characteristics of Respondents

Variable	Frequency	Percentage
Educational level		
No formal education	13	16.3
Primary level	23	28.8
Secondary level	44	55.0
Total	80	100.00
Type of fishing engaged		
Commercial	25	31.30
Subsistence	55	68.70
Total	80	100.00
Source of farm capital		
Savings	61	76.25
Loan	3	3.75
Both	16	20.00
Total	80	100.00
Major occupation		
Fishing	50	62.50
Non fishing	30	37.50
Total	80	100.00
Method of fishing		
Handpicking	74	2.50
Bottom fishing	4	92.50
Netting	2	5.00
Total	80	100.00

Source: Field Survey, (2022)

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Income Level of Harvesters: Table 4.2 shows result of income level of harvesters as collected and analyzed in the field. In general employment and income level are dual decisive factors mostly used for determining the living standard of any community (Kumar *et al.*, 2020) According to the analyzed results, it is discovered that 5% of the respondent had income level of 15,000-16,000 , another 5% had income level within a range of ₦16000-20000, 6.30% had a range of 21,000-25,000, 22.60% had a range class of 26,000-30,000, 13.80% had a range of 31,000 – 35000, 12.6% had a range of 36,000- 40000, 14.70% had an income

level within the range of 41,000 to 45,000 and 20.10% had income level of 45,000 and above. Using the calculated mean of ₦36,962.50, it is discovered that 47.4% of the respondent earned from 36,000 to 45,000 and above, which is not below the mean, therefore the income level of the respondents in the study area is on an average level and is sufficient to handle their basic needs. This research disagrees with the study of Kumar *et al.*, (2020) who discovered that income level of fish farmers is relatively low and not sufficient to take care of their livelihood (Nyong, *et. al.*, 2021,2022).

Table 4.2 Result of the income level of harvesters.

Monthly income level	Frequency	Percentage (%)
15,000 only	4	5.00
16,000 - 20,000	4	5.00
21,000 - 25,000	5	6.30
26,000 - 30,000	18	22.60
31,000 - 35,000	11	13.80
36,000 - 40,000	10	12.60
41,000 - 45,000	12	14.70
Above 45,000	16	20.10
Total	80	100.00
MEAN INCOME	₦36,962.50	

Sourced: Field Survey (2022)

The Perceived Effect of Climate Change on Periwinkle Harvesting: Assessing the perceived effect of climate change on periwinkle harvesting, multiple regression model was used, with quantity of periwinkle output as the dependent variable, while salinity, Temperature, Rainfall, sea level, age and harvesting experience has the independent variable. From the results of Table 4.3 below, the estimated R-square of 52% implies that 52% of the variability of the dependent variable is attributable to the explanatory variable. F statistic is significant at 1% which shows that the model used is significant. The result for salinity was significant at 10% and this implies that in the past five years compared to the base category, the salt content has no effect on output of periwinkle harvested. This is because periwinkle concentrate under the roots and decaying red mangrove trees and small collection of water during low tide. (Egonwam., 2018) and (Nyong, *et. al.*, 2021,2022). Explicitly periwinkle are found at the edges of the lagoon were they are being handpicked and not inside the main water body.

Rainfall was significant at 5% probability level. This means that, compared to the base category, the "Yes" and "No" category is negatively significant and has an inverse relationship with output of periwinkle harvested. This implies that an increase in rainfall leads to a decrease in the catch rate of periwinkles. Notably, in dry season with no or little amount of rainfall, quantity of harvested periwinkle increases than in the rainy season because the mangrove swamp Will be dry and easily access than in rainy season were the swamp and dry lands will be covered with flowing

water this results agrees with the findings of Meyenede *et al.* (2006) and (Nyong, *et. al.*, 2021,2022). Also the results in the Table 4.3 shows that for the variable 'sea rises" the 'yes' category compared to the base category was positively significant at 5% probability level. This implies that "sea rise" is directly proportional to the "quantity of output harvested" meaning that from periwinkle harvesters experience, the quantity of periwinkle harvested increases as the sea rises. This disagrees with the aprioro expectation which state that when there is a Rise in sea level the quantity of periwinkle harvested reduces because the natural habitat of the periwinkle will be denatured with outflow of water, thus making handpicking difficult. Since periwinkle inhabit mangrove swamps were the substratum is muddy and rich in detritus (Jamabo & Chinda, 2010) and not in the main water body, increase in sea level affect their ecosystem.

Still on the results of "Sea rise" the "No" category compared to the base category, was also positively significant at 5% probability level. This implies that 54.09 % of the respondent in the study area selected "No". Meaning that rise in sea level had no effect on quantity of periwinkle harvested. From the structured questionnaire those who selected "yes" has had from 5 years of harvesting experience and above , but those who selected "No" had less than 5 years experience and as such cannot vividly understand the effect of Sea Rise on quantity of output harvested. The results also shows that age is positively related with the quantity of periwinkle harvested at 1% probability level which implies that the older an harvester, the more his/her output. Harvesting experience had a

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positive significant at 1% probability level, which explains that as years of experience increases, the amount of periwinkle harvested increases. This research agrees with the findings of Olaye (2010) and (Nyong,et. al., 2021,2022)

who observed that harvesting experience is important in determining the profit level of fisher folks. The more the experience, the wider their level of understanding.

Table 4.3: Multiple regression result of the effect of climate change on quantity of periwinkle harvested.

Variables		Coefficient	Robust Standard
Salinity	Yes	21.08	17.44
	No	28.56*	16.51
Temperature	Yes	27.69	24.98
	No	26.00	19.56
Rainfall	Yes	-53.83**	25.13
	No	-100.90**	50.96
Sea Level	Yes	59.67***	24.41
	No	54.09**	29.24
Age		2.629***	1.238
Harvesting Experience		9.48***	3.152
Constant		94.73***	31.0204
R-Square = 0.52		F-Stat = 7.44***	

Source: Data Analysis (2022)

Awareness of the effect of climate change on periwinkle harvesting: Table 4.4 shows the level of awareness of respondents on the effects of climate change on periwinkle harvesting. The result was analysed using a four point likert scale in order to capture respondents opinion towards the subject matter. The mean was obtained by adding all respondents weight and dividing by 4 giving a total of 2.25 as the bench mark. The variable "Are you aware that climate change has an effect on harvesting" ranked 1st with a weighted mean of 2.86. This implies that it is a major awareness and that majority of the respondents in the study area were aware that climate change does have an effect on periwinkle harvesting. Also the second variable "Are you aware of climate change existence" ranked 2nd with a weighted mean of 2.54. This implies that it is a major

awareness as well since it's weighted mean is above the bench mark, thus an appreciable population of the respondents in the study area had knowledge about the existence of climate change. However, the variable, "Do you know the nature of effect climate change has on harvesting" ranked 3rd with a weighted mean of 2.55 and this also implies that it is a major awareness. In General, the respondent were mostly aware of the fact that climate change does have an effect on harvesting but they barely knew the nature of effect climate change has on harvesting. This concise with findings of Mustapha et al., who discovered that majority of farmers are aware of climate change especially rainfall pattern and prevailing temperature, and also (Nyong,et. al., 2021,2022) and Sofuluwe, Tijani & Bauwa (2011).

Table 4.4: Awareness of the Effect of Climate Change on Periwinkle Harvesting

Variables	Weighted mean	Mean Square	Std dev.	Decision	Rank
Are you aware of climate change existence	2.54	8.69	2.48	Major Awareness	2nd
Are you aware that climate change has an effect on harvesting	2.86	8.96	2.47	Major Awareness	1st
Do you know the nature of effect climate change has on harvesting	2.55	8.03	2.34	Major Awareness	3rd

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Do you think climate change affect habitat of periwinkle	1.54	8.51	1.44	Minor awareness	4th
Does climate change affect the profitability of periwinkle harvesting	1.55	8.03	1.34	Minor awareness	5th

Source: Data Analysis (2022)

Constraints Faced by Periwinkle Harvesters: Table 4.5 is a multi-response table that shows the major constraints faced by periwinkle harvesters. The constraint includes, predators, lack of good fishing equipment, rise in sea level and formalin application in the sea. The result shows that 26.31% of the respondents selected predators has their major challenge, 20.00 percent selected rise in sea level has their major constraint and 4.91 % selected Formalin application has their constraint. This implies that majority of the respondents

Table 4.5: Major Constraints Faced by Periwinkle Harvesters

Constraints	Frequency	Percentages(%)
Predators	75	26.31
Fishing Equipment	39	13.68
Rise in Sea Level	57	20.00
Formalin	14	4.91
Irregularity in water movement	20	7.00
Storage facility	45	15.89
Market system	35	12.28
Total	285	100

Source: Data Analysis (2022)

Conclusion: The study analyzed the effect of climate change on output of periwinkle harvesters climate change is a major threat to fishing/ harvesting of periwinkle, it has been revealed that climate change constitute effective deterrent to the sustainable development of periwinkle harvesters, therefore an understanding of the effect of climate change is a vital ingredient to reducing the depletion of output of harvesters and consequently reduce the threat to livelihood of those involved in periwinkle harvesting. Hence, this study shows that not all climatic variables has an effect on periwinkle harvesting, amongst all the significance variable include, Rainfall, Salinity and sea Rise. Thus these variables have tremendous effect on output of harvesters.

Recommendation: Protective measures should be provided for the respondents in the study area in order to check and balance the negative occurrence of predators like snakes, and other dangerous animals found in the habitat that may deter harvesting process and to ensure security of lives and as well encourage easy and productive harvesting. Moreso, government at all level should support the harvesters by

were affected by predators followed by rise in sea level. This is in consonance with the findings of Akpabio & Iyang (2007), who discovered that predators is the main constraints faced by fishermen/harvesters amongst all the listed sociocultural constraints, on the contrary, this opposes the studies of (Nyong, et. al., 2021,2022) who discovered that lack of storage facilities and access to credit is the major constraints faced by fishermen.

providing fishing equipment like canoe, engine, for harvesters to help stabilize commercial harvesting process. Again the Fisher communities should be given specialized education opportunities to widen their understanding of climate change and open their minds to accept innovation that will help mitigate the effect of climate change. Also an awareness should be created on the nature of effect climate change has an output of periwinkle harvesters.

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