CLIMATE CHANGE, FOOD SECURITY, NATIONAL SECURITY and ENVIRONMENTAL RESOURCES

GLOBAL ISSUES & LOCAL PERSPECTIVES

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous climate change, food security, national security and environmental resources issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate change, food security, national security and environmental resources issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate change, food security, national security and environmental resources necessary in policy making process that will stimulate increase in food production and environmental sustainability.

Climate Change, Food Security, National Security and Environmental resources: Global issues and Local Perspectives is organized in four parts. Part One deals with Climate Change with Six Chapters, Part Two is concerned with Food Security with Nine chapters, Part Three deals with National Security with Five Chapters, while Part Four pertains Environmental Resources, has Five Chapters.

Ahmed Makarfi / Eteyen Nyong

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Chapter 4

Effect of Climate Change on Income and Constraints of Periwinkle Harvesters In Nigeria

Eteyen Nyong

Abstract

This study examines the effect of climate change on Output of Periwinkle Harvesters in Oron Local Government Area Akwa Ibom State. The objectives were to assess the socioeconomic characteristics of the periwinkle harvesters, determine the income level of harvesters, determine the effect of climate change on periwinkle harvesters, examine the awareness of effect of climate change on periwinkle harvesting and to identify the constraints faced by periwinkle harvesters. Purposive sampling technique was used to sample two fishing communities in Oron local government area. Snowballing technique was used to select 40 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.

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). 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 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.

Over the years they have been an increasing Change in the climatic condition of the Niger Delta region where the production of this molluscs thrive. Since periwinkles are shellfish that inhabits mangrove swamps of West Africa (Jamabo & Chinda, 2020) were the substratum is muddy and rich in detritus. Increase in sea level caused by heavy rainfall, and reduction in salinity affect their ecosystem. It is generally held that Periwinkle is the most dominant Molluscs in the brackish Waters of West Africa. It is a source of animal protein, vitamins and minerals (Jambo & Chinda, 2010). This gastropod is sources of income for artisanal farmers in the coastal region but is gradually getting scares due to negative effect of Climate change, which is generally referred to as alteration in average weather condition of a place cause by natural variability or human activities. Climate change has detrimental impact on the longevity, abundance, composition, Distribution and output of Periwinkle.

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 (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 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.

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).

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 (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 poikilothetmic in nature and the body temperature changes with environmental temperature, so they are very much sensitive 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.

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.

Objective of the Study: 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

Justification of the study: This study will be very useful in academics as it will serve as a framework for research, also this study will provide the society with the necessary information of how to measure climate change and suggest possible ways to mitigate the effect of climate change on periwinkle harvesters in order to enhance increase catch, increase sales. Increase income, and improve standard of living. Moreso findings from this research will advance harvesters/sellers knowledge on the effect of climate change and how to cope with the reoccurring changes in climate. Finally, this study will serve as a guide to policy makers to formulate good and effective climatic policies in favour of periwinkle harvesting.

Climate Change

Climate change is one of the most remarkable challenges confronting the global community today and such has been given different definitions by different people based on their perception and the way it affects them (Ifeanyi-Obi *et al.*, 2012). However, the most universal definition was the one by intergovernmental panel on climate change, who defined climate change, as a change in the state of climatic conditions which can be measured and identified through changes in the mean of its properties that persists for a period of time. It also refers to any change in climate over a period of time as a result of anthropogenic or human activity (IPCC, 2007). The subject of climate and predicted impacts on the environment and socio-economic system now constitute one of the most devastating environmental problems facing humanity.

For the Last few decades, climate change, food security and their complex interaction have become a global issue (Plaganyi, 2019). Changes in the climatic conditions may be limited to a specific region or may occur across the whole earth, but, it is affecting all the ecosystems including the aquatic organisms. Climate change is the global phenomenon of climate transformation characterized by the changes in the usual climate of the planet (regarding temperature, precipitation, and wind) that are especially caused by human activities. As a result of unbalancing the weather of Earth, the sustainability of the planet's ecosystems is under threat, as well as the future of humankind and the stability of the global economy.

According to NASA (2021). Climate change is a broad range of global phenomena created predominantly by burning fossil fuels, which add heat-trapping gases to Earth's atmosphere. These phenomena include the increased temperature trends described by global warming, but also encompass changes such as sea-level rise; shifts in flower/plant blooming; and extreme weather events climate change can be said to be a systematic Change in the long term state of the atmosphere over multiple decades or longer (Uejio, 2015). Izzat feddi in his article opine that climate change is a compounding factor that regional fisheries managers cannot ignore because there are vulnerable to it. The concept and perception of climate change varies significantly among fish farmers in the brackish water zone. This has generated a lot of concern over the last decade. This has been defined and interpreted in so many ways, with the reality accepted by many and refuted by few people among the populace dwelling in these areas

Causes of Climate Change: At its most basic, climate change is caused by a change in the earth's energy balance how much of the energy from the sun that enters the earth (and its atmosphere) is released back into space. The earth is gaining energy as we reduce the amount of solar energy that is reflected out to space (center for climate change, 2016)**.** The climate varies naturally from year to year and decade to decade. This is caused by natural processes linking the atmosphere, ocean and land, as well as variations in heat output from the sun. In addition to changes in climate that are caused by natural climate variability, climate change can be caused by human activity. The kind of climate change we are experiencing now is being caused primarily by these human factors. The sun's energy warms the Earth and the warmed Earth releases heat to the atmosphere. Certain gases in the atmosphere trap this heat and act like the glass of a greenhouse. Such gases are called

greenhouse gases. The main greenhouse gases are water vapour, carbon dioxide and methane. Greenhouse gases absorb heat and radiate some of it back to the Earth, raising surface temperatures. This process is often called the greenhouse effect (Georgia, 2021).

The greenhouse effect is a natural process, but it is being intensified by human activities that increase greenhouse gas levels in the atmosphere, especially carbon dioxide. Increasing greenhouse gas levels in the atmosphere makes it more effective at trapping heat, resulting in overall warming of the earth. Burning fossil fuels (coal, oil, gas) and some industrial processes are the main sources of carbon dioxide. Climate change caused by human activity is referred to as anthropogenic climate change.

Therefore, there are four major causes of climate change namely: astronomical causes, volcanic eruptions, variations in solar output and human activity. Among these, human activity has been recognized as the most prominent factor responsible for climate change (IPCC, 2007). This normally happens through the emissions of greenhouse gases as earlier mentioned, (mainly carbon dioxide, methane, halocarbon and nitrous oxide). In Niger Delta region, human activity changes the amount of greenhouse gases in the atmosphere in three important ways.

Burning of fossil fuels: When fossil fuels such as coal, wood and petroleum products burn, they release greenhouse gases, also human activities such as driving automobiles, cooking food, bush burning, gas flaring and industrial operations equally releases these obnoxious, gases into atmosphere (Anyadike, 2009). In Niger Delta, oil explorative activities are very common and predominant. One major way this industry is impacting on the climate of the region is through gas flaring. Niger Delta is reported to have over 123 gas flaring sites scattered all over the region, consequent of oil exploration, making the Niger Delta one of the highest emitters of greenhouse gases in Africa (Akinro *et al.*, 2008).

Also according to IPPC, concentration of Carbondioxide, methane and nitrous oxides have increase to level unprecedented in at least the last 800,000 years. Thus the atmospheric share of Carbondioxide to climate change has risen by 40% since pre-industrial times.

Removal of mangrove forest: Mangrove forest is an important segment of the ecosystem in the coastal areas of Niger Delta; it serves many purposes, which ranges from stabilization of coastal environment to nursery for some shell fish and filtration of nutrient and sediments (James, 2008). The area covered by mangroves is influenced by a number of factors such as land position, rainfall pattern, sea level, sedimentation, storms and tidal regime. Removal of mangrove forests, where forests are cut down faster than they are replaced is a major contributor to climate change. Aggressive utilization for fire wood, clearing of new site for building or road construction and procurement of oyster spat (attached to mangrove root) has been majorly responsible for its exploitation. Depletion of mangroves has reduced the stabilization of ecosystem and further made the coastal areas prone to the effects of climate change (Akinrotimi, 2012).

*Increasing population***:** There is population explosion in most of the Niger Delta states, as a result of the assumed lucrative opportunities in oil and gas industry. This phenomenon has led to increase in human activity, which invariably has led to more emissions.

Measurement of Climate Change

According to Joan, (2014), climate change is measured by changes in temperature, precipitation, wind, storms, sea level rise, etc. Measurements of climate change is important in order to understand the impacts it has on our society. Climate system is a complex, interactive system and as such there is no single instrument used in measuring climate change rather there are thousands of measuring devices spread across the globe on land, under the sea and in the air (Shako, 2015). A different literature has shown diverse ways of measuring climate change as discussed below.

Novel methodology approach: This approach was adopted to estimate climate impact and adoption and provide an application using high frequency data in the context of the impact of climate change on ground level. A key element of this approach is the decomposition of methodological variables into two components namely long-run trend and shocks. The long run trend involves a 30 years moving average purposely lagged to capture all the information available to individuals and firms up to the year prior to the measurement as provided by the national oceanic and atmospheric administration (NASA), and the shocks which is referred to a deviation from the lagged 30 years average is measured by simultaneous estimation of the responses to weather shocks (Bento, 2017).

Measurements through climate variable: Climate system is usually described I'm terms of the mean and variabilities of temperature, precipitation and wind etc. Thus there are a number of factors used to observe and measure climate which includes temperature, precipitation, biomass, sea level whose measurements reflect changes in shoreline, chemical decomposition measured by tracking greenhouse gases. (Shako, 2015)**.**

Experimental simulation and cross-sectional approach: The literature has relied on two set of methods to conduct climate impact assessment .Which is experimental-simulation and cross sectional analysis. Experimental simulation begins with unfold experiment in laboratory and other controlled setting while the Cross sectional approach in contrast is a direct measurement of climate sensitivity that is made across all locations. Critical system is observed in different climate zones and measurements are taken to see how the system responds to bring in different climate settings cross sectional approach does an excellent job of capturing efficient adaptation because it measures precisely people's decision, Cross sectional approach is also quite good at representing large landscape. (Mendelssohn, 2005) for the purpose of this research, cross sectional approach will be adopted.

Periwinkle

Periwinkle botanically known as *Tympanotonus fuscatus* or the African mud creeper, is a specie of snail living in brackish water. A gastropod molluscs in the family potomidea (van Damme *et al*, 2020) *Tympanotonus Fuscatus* is the only extant specie in the genus Tympanotonus (Reud *et al*, 2018). Shells of Tympanotonus fuscatus can reach a size of about 35-100millimetres Egonmwan, (2018) says that the specie is amphibious.it is active in the rainy season and in dry season it congregate under objects or burrow into the soil in the habitat. periwinkle is found only at the edges of the lagoon and not in the main body.Specifically, *Tympanotonus fuscatus* concentrate under the roots and decaying red mangrove trees and small collection of water during low tide. Hence, their population depends on their quest for food and shelter.

Important of Periwinkle: The flesh of *Tympanotonus fuscatu*s is used in the preparation of delicacies in the Niger Delta region. While the shell is used for construction works especially in coastal communities close to the mangroves. Periwinkle (*tympanotonus fuscatus var radula*) is a

relatively cheap source of animal protein and is mostly consumed in the Southeast of Nigeria and some riverine areas of West Africa. Molluscs are generally soft-bodied animals that contain external skeleton called shell. Some mollusks are found mostly in shallow waters and sometimes in inter-tidal zone where they burrow into beds of the river thereby serves as their habitat and they feed majorly on algae and diatoms. Periwinkle is commercially valuable in the Niger Delta area of Nigeria. The value compares favourably with those of domestic livestock and fish. A lot of publications are available on the nutritional qualities of Nigerian snails which are in the same class with the Nigerian periwinkle. However, scanty information can only be found on the nutritional qualities of Nigerian periwinkles. Considering the enormous commercial, nutritional and industrial importance of periwinkle, the fish industry cannot continue to remain neglected. Also, with the current rate of population increase, there would be a need for snail meat substitution so as to prevent their extinction due to consumption. Hence, it is expedient to create awareness to the people about high proportion of nutritional indices of periwinkle consumed in Nigeria. Periwinkle meat is domestically used as human food, livestock feed and the shell can be painted with various colours and used as ornament for decoration.

*Dynamics of Climate Change and Periwinkle***:** When in their habitat, they migrate to the coastal edge and usually aggregate under the breathing roots of mangrove plant species such as Avicenianitida, Rhizophora mangle and palm, for protection from the direct heat of sun (Cariton & Cohen, 2002). They have the ability to survive without water or wetting for a long period of time especially during dry season but rely on their food reserve. Related to this, increase in temperature causes destruction of this plant species exposing Periwinkle to adverse weather effect, this might cause their mortality and hinders proper metabolic functioning, another reason for quantity reduction. Also, the impact of climate change in periwinkle shall fish is that it's modifies specie distribution and the productivity of specie as well, it has negative impact on productivity and on the livelihood of artisanal farmers in the communities that depends on the collection and selling of periwinkle, (Feidi, nd)

Moreover change in climate causes a rise in the ocean acidity which is mainly due to rise in carbon dioxide levels in the atmosphere leading to a decrease in the PH level (a measure of acidity or basicity of an aqueous solution) which makes it more difficult for periwinkles to form their shell,

(Johnson *et al;* 2018) a process known as calcification, leading to a decline in distribution of this specie. To add to that, change in climate like excessive rainfall causes reduction in salinity level (Manuel, 2012) as earlier mentioned and this decrease in salinity has effect in the production of the young ones into the population, which is one of the reasons the few collected periwinkles is going out on a high price. At the same time mass shell fish kills has been observed in coral coast due to increase in water temperature for over 30°C (Bulch & Johnson, 2017). The influence of high water temperature and oxygen concentrations are thought to be responsible for mass shellfish mortality.

More so, ocean warming, one of the attribute of climate change, increasingly jeopardize the sustainability of ongoing harvest of periwinkles especially at low latitude (Pratcheut *et al.*, 2017). There's been a range of climate induce effect on the biology and behavior of periwinkles, including shift in dietary composition (Wen *et al.*, 2016) and decline in abundance (Williams *et al*., 2014) and catch rates (Tobin *et al.*, 2010). Ocean warming and acidification also has direct effect on periwinkles fish physiological performance and fitness(Mundy *et al.*, 2012). A significant increase in temperature will constrain metabolic performance with effect on movement, individual behavior which affects recruitment, and individual survival. In a broad sense, the combined effect of ocean warming, and acidification certainly leads to greater inter-annual variability in reproduction and replenishment and overall decline in productivity.

Importantly, climate induce degradation of marine habitat possess the most immediate and greatest effect to the biodiversity and functioning of periwinkles (Parachette *et al.*, 2008) because highly degraded marine habitat support less than 1/3rd of the biodiversity of periwinkles. Furthermore, According to Przeslawski *et al.*, (2008) changes in the quantity and quality of coastal habitat projected under climate change has deleterious effect on periwinkle population, there will be fewer places within the coral reefs for species to forage and shelter from potential predator, resulting in reduction in the diversity and abundance of periwinkle (Pratchett *et al.*, 2011) The effect of climate change on the recruitment, distribution, availability and harvest of this important molluscs also directly has socio economic impact on the collectors, sellers 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). Simultaneously climate change also affect the biodiversity of periwinkle production. Increases in water temperature, because of climate change will alter fundamental ecological processes and the geographic distribution of aquatic species. Such impacts may be ameliorated if species attempt to adapt by migrating to suitable habitat. However, human alteration of potential migratory corridors may limit the ability of species to relocate, increasing the likelihood of species extinction and loss of biodiversity.

Changes in seasonal patterns of precipitation and runoff will alter hydrologic characteristics of aquatic systems, affecting species composition and ecosystem productivity. Populations of aquatic organisms are sensitive to changes in the frequency, duration, and timing of extreme precipitation events, such as floods or droughts. Changes in the seasonal timing of snowmelt will alter stream flows, potentially interfering with the reproduction of many aquatic species. Therefore people in the Pacific island region who harvest and market periwinkle and derive their second or first income in this way (Princa *et al.*, 2010) are implicated since this projected changes in production of periwinkle shell fish has limited cash flow and reduced the people's purchasing power for vital services and commodities (Viera *et al.*, 2017)**.**

Effect of Climate Change

It has been established that the climate change is affecting the phenology of periwinkle organisms (Walther *et al;* 2002; Paramesan *et al* 2002). Aquatic organisms like periwinkle 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.

It directly acts upon the physiological behavior and growth pattern of organisms, subsequently decrease reproductive capacity and finally cause mortality. Indirectly it may alter the productivity, structure, function and composition of aquatic ecosystems. Relatedly impact of climate changes I'd linked to changes in water temperatures and PH Level, rising sea level , shifts in ocean

circulation and altered rainfall & storm patterns causes specie to change their distributions and productivity. (FAO, 2018)**.** The earths ocean absorb between one -quarter to one-third of our fossil fuel emission and are now 30% more acidic .This acidification poses a serious threat to underwater life particularly creatures with calcified shells like periwinkle. This has a devastating effect on periwinkle shellfish as well as the people that depend on it for sustenance.

Periwinkle, from research has a definite breeding season which co-incised with the high salinity period (Ajao & Fagade, 1990). It has been observed in recent times that due to climate changes, the high salinity period which co-insides with the dry season in the brackish water area (estuaries and lagoons) is drastically reduced, since it rains in most part of the year in the Niger Delta. This is a major factor that may have affected the production and recruitment of young ones into the population. All these effects finally result in decreased fish production. It disturbs the economic condition of fish farmers and hamper their normal livelihood by huge economic losses. In this chapter, we will discuss how climate change affects the production of fish and the lives of fish farmers and how it could be mitigated through proper actions. (Saturupa *et al.*, 2020).

Theory of Production: Production is the most basic Economic activity and involves the creation of utility. According to Olayide and Heady (1982), production is the process whereby some goods and services called inputs are transformed into other goods and services called output. Powell (1978), considered production as the process of transforming raw materials into something consumed by someone else and further outlined its characteristics as the transformation of resource(raw material) into sellable product whose value is higher than that of the raw material alone. Ojo (2004) defined production process as one whereby some goods and services called inputs are transformed into other goods and services called output. Koutsoyiannis (1979) refer to this technical relationship as the Production function and involves the use of inputs. In Agriculture, major input include land, capital labour and measurement of resources (Abang *et al,* 2008).

Production Function: In production function, the productivity of labour, capital and other inputs as well as the contributions to Total output caused by technical progress is measured. This enables one to attribute the growth of output to the proximate causes such as; the growth in the labour force, the increase in the stock if capital, Economics of scale and the catch of all technical progress.

This function describes the technical relationship between input and output in any Production process. Halcrow (1980) defines it as the technical relationship between input and output, indicating the maximum amount of output that can be produced with each and every set or combination of specific inputs. Byrns and Stone (1989) supported this perspective adding that Production function summarizes the current state of technology and specified the amount of various contributions of inputs.

According to Walter (1970), the ingredients of the Production function are the technical condition, the knowledge and availability of techniques and any limitation imposed on the supply of factors of production to the firm. The production function is purely technical relationship which connects factors inputs and outputs. It's describe the law of proportion, that or the transformation if factors inputs into output, at any particular period. Abang *et al*. (2008) defined production as purely technical relationship between quantities of various inputs used and the optimum output of the commodity that is produced. Production function exhibits the law of diminishing returns. The law states that if additional units of an input are held constant, output increase at increasing rate reaches maximum and finally declines. Therefore, it is best to produce where additional use of input increase output at increasing rate considered to be the rational stage of production and cease further addition of input where output begin to decline.

Mathematically, the production function was assumed to be continuous and differentiable function of the firm;

$Y= f(X^1, X^2, X^3 /X^4)$ --------- input-output equation

Where;

Y= Output (kg)

X^1-X^3 = variable factors of production, measured in physical units

X^4= Fixed factors of production

Review of Relevant Empirical Framework

Akinrotimi *et al*., (2009) carried out a research on Economic viability and marketing strategy of periwinke Tympanotonus fuscatus in river state, Nigeria. Structured questioner was used in investigation, data was analyzed using descriptive statistic. The results of the socio economic characteristics of the periwinkle collectors/harvesters proved that there were more female's collectors (70%) than male collectors (30%), highest percentage of collectors were found within the age bracket (20-30) while just 1% was 60 years and above. Most of the collectors were found to be primary school certificate holders. This means that greater percentage of periwinkle sellers are females (retailers) while youth of age 20 – 30 are the harvesters with a few aged men and bulk of periwinkle sellers /harvesters are primarily school holders.

Johnson *et al.,* in his research discovered that many people in the Pacific island region catch and sell fish and that average of 47% of households derive their first or second income from catching and selling fish (Princa *et al*, 2010), that the main implications of climate change on fish and shellfish population is decline in income of fishermen, thus limiting cash revenue flowing into the community in a related study on, "Modeling the effect of climate change on shellfish production in marine artisanal fisheries", it was discovered that the decline in number of fish and shellfish are attributable to overfishing, climate variability and unstainable fishing methods. Key informant interview was employed in soliciting data on changes in climate and trend in marine artisanal shell fish catch, the primary objective was to develop a simple linear regression model for predicting shellfish catch. The results showed that the predictor variable that significantly explained shellfish production was temperature .That increase in sea surface temperature will adversely affect shellfish production. Therefore it is recommended that ministry of fisheries and acquaculture development should ensure the formulation of climate smart policies and management strategies for sustainable use of the resources.

Morse, Shanmugarajah carried out a research on "Impact of climate change on the fishermen livelihood development". The data for the study were collected through informant case study from villages, the findings in the study explores correlation between the unpredictable climate changes on fishermen development activities. Result showed that climate change is one of the most significant challenges to global economic development as well as village dwellers development. It stated that fishing, being a human activity and work as an interface between humanity and the sea,

and is as a result prone to be the most affected by changes in climate, because it's important determining variable like, temperature and wind are climate related. And as such productivity is affected. The study therefore elucidates the problems faced by the fishermen community due to climate change, based on empirical data to be: a) occupational uncertainty b) income disorganization c) income damage and losses and d) psyco-social problems. The study suggests that government should provide necessary support to fishing labourers families, because they are suffering to manage their day to day life due to impact of climate change.

In related article written by Assan *et al.,* (2020), on the effect of climate change on Marine organisms, it was discovered that the impact of climate change is effective at several stages and that aquatic organisms in response to climate change redistribute themselves by shifting their latitudinal range, to find a more favourable habitation. Also the review showed fishes suffer growth reduction, sub optimal behaviors and reduced immune competence due to thermal stress exerted on them by climate change, also that increased in temperature have a detrimental effect on the reproductive system of Fishes. It was therefore recommended that more research should be carried to determine the effect of climate Change on Marine ecosystem in order to help policy makers formulate quick solutions to curves the effect of climate change.

Also, according to journal published by Nature conservation bureau, ministry of environment on "Basic concept of climate change, adaptation of Biodiversity," discovered that change in Climate can cause impact such as species extinction and the displacement decrease or loss of habitat which subsequently leads to deterioration of biodiversity and ecosystem services. As changes in ecosystem and ecosystem services affects fisheries, water environment and water resources. Additionally, a study by NOAA (2013), suggests that in the phase of distinct variability in environmental conditions, African fisheries are at risk because semi-arid countries with significant coastal and inland fisheries have high exposure to future increases in temperature. Seasonal changes, reproduction and other physiological changes have influences on shellfish abundance. Unfavourable conditions such as low salinity and ocean acidification leads to massive mortality among oysters and scallops (Laakkonen, 2014). Prior studies show that relative humidity has no direct influence on shellfish abundance, but rather has indirect influences on some environmental stressors (Levinton *et al.,* 2011; Wright *et al.,* 2011). They further reported that shellfish

distribution and abundance are strongly influenced by intrinsic population characteristics such as growth rates, population densities, and interactions with other organisms through competition, predation and environmental changes, which can occur simultaneously.

In a similar studies conducted by Dr. Soheila & Dr. Braham (2010) , in the "effect of climate change on Aquaculture", it was discovered that the impact of climate change have immediate effect on the context of anthropogenic pressure, the studies estimate that increased global mean temperature of 3 - 4°C will increase the adverse impact of climate change, thus it is recommended that adaptation measures be taken to build resilience to the effect of climate change and ensure sustainable benefit of fisheries and Aquaculture.

Food and agricultural organization (FAO), in its research on adaptive management of fisheries in response to climate change, discovered that the most recent Intergovernmental Panel on Climate Change (IPCC) Assessment Report (IPCC-AR5 2013) and the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC, 2019) provide strong evidence that the global ocean surface and subsurface environments are changing, particularly ocean temperatures and acidification (IPCC, 2019; Rhein *et al.*, 2013).Global models indicate that there is likely to be a net decline in the productive potential of the world's oceans due to climate change, although regional and local effects are less clear. Such changes to the physical and chemical characteristics of marine ecosystems are driving major shifts in the productivity and distributions of fish and invertebrate populations (Barange *et al.*, 2018). In addition, coastal habitat degradation, marine heat waves (Hobday *et al.*, 2016) and other extreme events are accelerating the impacts of climate change on ecosystems (Smale *et al.*, 2019) and having large effects on fisheries around the world it was added that these impacts are occurring cumulatively and as such existing pressures of fishing on stocks. It is recommended that a good practice for developing climate adaptive fisheries management under a variety of species, environmental and governance context which are central to coping with climate change should be adopted.

The study of impact of climate change on fisheries by food and agriculture organization proved that ocean warming reduces the solubility of oxygen in water, and it's accounts for 15 percent of current total global oxygen loss, and oxygen influences biological and biochemical processes at

their most fundamental level. The impacts are very dependent on widely varying oxygen tolerances of different species and taxonomic groups. Global warming is likely an ultimate cause of ongoing deoxygenation in many parts of the open ocean (Breitburg *et al.,* 2018). Ocean warming, which reduces the solubility of oxygen in water, is estimated to account for approximately 15 percent of current total global oxygen loss and more than 50 percent of the oxygen loss in the upper 1 000 m of the ocean. Intensified stratification is estimated to account for the remaining 85 percent of global ocean oxygen loss by reducing ventilation

Methodology

This chapter discuss the study area, design of the study, population sample and sampling technique, analytical techniques, method of data collection, validation of research methods and data analysis techniques.

Description of the study area: This study was carried out in Oron Local Government of Akwa Ibom State, Nigeria. It is home to the Maritime Academy of Nigeria and the Oron museum. (Maritime Academy of Nigeria, 2015) Oron was created in 1970; it is located in the south eastern fringe of Akwa Ibom State, boarded in the south-eastern by Ibeno and Uruan and in the east by cross River estuary. Covering a geographical area of approximately 45,135 square kilometers, it is located approximately on latitude 4° 42'N and longitude 8° 10°N. According to the 2006 population of 87,461 people with polar co-ordinate of 351.756305694580079°W and 8. 24364305419921E. It has an area of 70km2 and a population of 156,461 at the end of 2006 census. The postal code of the area is 5232 (postal office, 2009). Oron is a tropical region and has a uniform high temperature all year round. The two main seasons are the dry season and the wet season. The dry season spans between the months of October and April while the wet season spans between the months of May and September. There are also two prevailing, the south-west onshore wind which brings heavy rain and the Northeast trade winds blowing across the Sahara Desert which brings in the dry season. Oron has an area of tropical monsoon climate (occasionally known as a tropical wet climate) Tropical monsoon climate is a type of climate that corresponds to the Koppen climate classification category AM. It has a monthly mean temperature above 18°C(64°F) in every month of the year and in dry season.(Wikipedia, Nd) tropical monsoon climate intermediate

climate between the wet tropical rainforest climate (AF) and the drier topical savannah climate (AW) The main occupation of Oron people are fishing, farming, trading, crafts creation etc.

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.

Sampling Technique and Sampling Size: Purposive sampling technique was use to select Oron Local Government Area. Also, purposive sampling technique was used to select two riverine villages (Esuk Oro and Esuk Iquita). Snow ball sampling technique was used to select 40 respondents (Periwinkle harvesters) from each village. Giving a total of 80 respondents. Snow ball sampling technique is a non-probability sampling technique in which an existing subject draw referrals to recruit samples required for the research study.

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.

Objective 1: the socio-economic characteristics of the respondent was analyzed using descriptive statistics, such as mean, tables percentage, frequency count.

Objective 2: To determine income level of the harvesters was analyzed using descriptive statistics, like frequency tables, percentage.

Objective 3: Determine the effect of climate change on periwinkle population

This objective was analyzed using the multiple regression model.

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

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

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 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

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

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

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) 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), and Adegbite & Oluwalana (2004) 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 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) 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 area.

Table 4.1a Social Characteristics of Respondents

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

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)

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.

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). 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). 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 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) 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 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
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 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 Abunjuwah & Acquah who discovered that lack of storage facilities and access to credit is the major constraints faced by fishermen.

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 bon 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.Government at all level should support the harvesters by providing fishing equipment like canoe, engine, for harvesters to help stabilize commercial harvesting process. 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. An awareness should be created on the nature of effect climate change has an output of periwinkle harvesters.

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