**Biophysical and Socio-Economic Impacts of Climate Change on Livelihood of Coastal Communities in Rivers State, Nigeria**

**Abstract**

This study investigated the biophysical and socio-economic impacts of climate change on the livelihoods of coastal communities in Rivers State, Nigeria. Using a descriptive survey design, data were collected from 100 households randomly selected from three purposively chosen coastal communities in Okrika Local Government Area. These communities were selected due to their reliance on fishing and agriculture and their vulnerability to climate change. A structured questionnaire was administered to assess climate change impacted on the biophysical, environment, the socio-economic livelihoods and adaptation strategies adopted by coastal communities. Data analysis was conducted using response frequencies and means. Findings reveal that climate change has significantly affected the biophysical environment, contributing to rising sea levels, flooding, erosion, irregular rainfall patterns, and pollution, all of which have disrupted ecosystems. The socio-economic impact includes displacement of livelihoods due to flooding, depletion of aquatic resources, destruction of farmlands, adverse health effects from pollution, and declining household incomes. To cope with biophysical adaptation strategies, community members employed mangrove restoration and afforestation as strategies. And to cope with socio-economic impacts, many coastal dwellers have diversified their sources of livelihood. The study thus recommended capacity building training on community-based climate adaptation strategies, investment in long-lasting flood defence infrastructure and also government and non-governmental organizations (NGOs) should encourage alternative revenue-generating endeavours to lessen economic vulnerability in coastal communities in Rivers State.

***Keywords:*** *Biophysical Environment, Climate Change Impact Livelihoods, Coastal Communities, Socio-Economic Environment*

**1. Introduction**

The globe has been fighting climate change for a few decades due to rising sea levels, more frequent catastrophic weather events, and changes in natural systems. Climate change has emerged as one of the most pressing environmental concerns of the twenty-first century, with substantial biophysical and social implications for coastal communities worldwide. Climate change has several impacts on coastal areas, including rising sea levels, frequent extreme weather events, coastal erosion, saltwater intrusion, and declining fishery resources (IPCC, 2019). Because of their geographic location, socioeconomic circumstances, and significant reliance on marine and coastal resources for their livelihoods, coastal populations in Rivers State, Nigeria, are susceptible to these issues. Creating sustainable adaptation and mitigation plans for these communities requires understanding the biophysical and socioeconomic effects of climate change. The socioeconomic and biophysical landscapes of many countries, including Nigeria, have been severely damaged by climate change. The Stern Review and IPCC 4th Assessment Report indicate that climate change will have adverse effects on people's health, safety, and livelihoods, with the "poorest people in the poorest countries expected to suffer first and foremost. Akeem (2010) revealed that Nigeria is one of the nations most exposed to and vulnerable to the effects of climate change. West Africa's densely populated coastal region is one of the region most at risk from climate change worldwide, according to the IPCC (2007). About 20 million Nigerians, or 22.6% of the country's total population, already reside in the coastal area where economic activity is concentrated (Badjeck, Bohn, and Sommerville, 2014).

In West Africa, farming and fishing are the primary sources of income for people who live along the shore. According to WWF (2013), the West African Marine Eco-Region's fisheries are the region's most significant source of foreign exchange and primary funding source for social and economic advancement, bringing in $400 million a year. The upwelling of nutrients into the warm, shallow seas that indicate the Sahara's embrace of Atlantic swells is essential to the natural ecosystem of West Africa, including Nigeria. According to research, around 1,000 fish species inhabit mudflats, sandy beaches, mangroves, estuaries, and seagrass beds (Badjeck, Bohn, and Sommerville, 2014). Along with crocodiles, whales, dolphins, sharks, rays, and various birds, other species in this area include the vulnerable West African manatee and the highly endangered monk seal. The effects of climate change on society and the economy worldwide are already apparent. Several new detrimental effects on civilization and its future growth will arise from the anticipated climate change. The increase in temperature, which impacts human health and life, agriculture and energy production and causes forest fires, is one of the most detrimental and immediate effects of climate change. On the other hand, the quantity and availability of food, water, and energy are directly threatened by excessive rainfall, which causes floods, landslides, and rockslides. However, it is evident from the direct effects of climate change on life and labour that they can slow down economic development, limit access to social and health care, and raise poverty. More than 100 million people may fall below the poverty line by 2030 as a result of climate change, according to World Bank estimates. This is mainly due to home loss, increased health issues, and decreased agricultural production.

The impact of climate change on the environment and the livelihoods of residents in coastal towns is posing an equal threat to their biophysical environment. The atmosphere (air), hydrosphere (water), lithosphere (soil), and biosphere (organisms) comprise the biophysical environment, which is the natural and constructed surroundings of humans. Each of these spheres supports life on Earth. However, ecosystems, particularly the aquatic ecology, have been affected by human (anthropogenic) actions in an attempt to meet their demands by consuming the natural resources found in the environment. Eheazu (2016) asserts that while climate change is a natural cause of environmental deterioration, human activity contributes to some of it. Nigeria's Federal Ministry of Environment lists some of these improper agricultural practices (Eheazu 2011). These include fuel wood extraction and bush burning, watershed degradation that causes rivers to silt up, soil erosion, and the loss of water courses, among others.

Rivers State's coastal towns are experiencing various biophysical effects from climate change, including changes to land, water, biodiversity, and the general health of the ecosystem. Rising sea levels and more excellent wave action cause coastal erosion, one of the most essential biophysical effects. According to s Nwilo and Badejo (2004), the Niger Delta, which includes Rivers State, has one of Nigeria's worst rates of coastline erosion; in some places, the estimated yearly land loss is between 25 and 30 meters. Communities are uprooted, livable land is lost, and vital infrastructure like roads, schools, and medical facilities is destroyed due to this erosion. Another significant biophysical effect is saltwater intrusion, which endangers freshwater resources in coastal regions. Drinking water supplies and agricultural productivity are impacted by the intrusion of saltwater into freshwater bodies, which is caused by rising sea levels and decreased river discharge due to climate variability. Because soil salinization lowers soil fertility and crop viability, farmers in Rivers State who depend on rain-fed and irrigated agriculture see declining yields. Similarly, shifting ocean temperatures and acidification hurt fisheries, a significant source of income for many coastal residents, causing fish species to migrate and fish stocks to decline.

Along the coast, extreme weather phenomena like storms and torrential rains also seriously threaten communities. Rivers State's floods have become more frequent and intense, causing property damage, fatalities, and family displacement (Eke et al., 2021). Flooding poses serious hazards to public health because it accelerates the spread of waterborne illnesses like cholera and typhoid. Additionally, anthropogenic activities and climate change are degrading mangrove habitats, vital breeding grounds for marine species and acting as natural buffers against storm surges. The livelihoods of coastal people in Rivers State are significantly impacted by climate change on a socioeconomic level in addition to its biophysical repercussions. The loss of agriculture and fisheries productivity is one of the main economic effects, as it directly impacts food security and income generation. In these communities, farming and fishing are the primary sources of income for many households. However, poverty and economic instability have increased due to climate change-related disruptions in agricultural and marine production. By increasing the displacement of coastal people, climate change also makes socioeconomic vulnerabilities worse. Due to flooding and sea level rise, many residents are forced to relocate to metropolitan areas, where they encounter issues with housing inadequacy, unemployment, and restricted access to social services (Onwuka, 2021). Increased socioeconomic challenges are also a result of the disruption of conventional lifestyles and the disintegration of social cohesiveness.

Another critical component of climate change's socioeconomic effects is its health effects. Many coastal populations affected by flooding have reported higher rates of respiratory illnesses, malaria, and malnutrition. These issues are worsened by inadequate sanitation and restricted access to medical care, taxing already poor groups. Additionally, local infrastructure and businesses are at risk due to climate change. The region's economic stability is further impacted when roads, bridges, and marketplaces are destroyed by erosion and flooding, interrupting trade and commerce (Ugochukwu & Onyekachi, 2020). Additionally, the deterioration of beaches, mangroves, and other natural assets harms the tourism industry, which could benefit coastal communities economically. Increased public awareness and education on climate change adaptation, especially among vulnerable people, is necessary to address the serious environmental issue of climate change's biophysical and socioeconomic implications on the livelihood of coastal communities in Rivers State.

**Statement of Problem**

Coastal communities in Rivers State are becoming increasingly susceptible to the negative consequences of climate change, including altered rainfall patterns, extreme weather events, coastal erosion, and rising sea levels. The loss of arable land, the depletion of fisheries supplies, and the salinization of freshwater sources are all consequences of these biophysical changes that endanger the environment. As a result, these communities' socioeconomic stability is in jeopardy since climate-related disruptions impact fishing, agriculture, and other sources of income, resulting in decreased income, food poverty, and population displacement. This study investigated the biophysical and socioeconomic impacts of climate change on the livelihoods of coastal communities in River State, with an emphasis on identifying critical vulnerabilities, adaptation strategies, and policy implications for enhancing community resilience because of the ongoing impact that climate change is having on these communities.

**Purpose and Objectives of the Study**

This study investigated the biophysical and socio-economic impacts of climate change on the livelihoods of coastal communities, providing insights into the challenges faced and potential adaptation measures.

Specifically, the objectives of this study were to:

1. Assess the biophysical impacts of climate change on coastal communities in Rivers State.
2. Evaluate the socio-economic impacts of climate change on livelihoods in coastal communities of Rivers State.
3. To examine adaptation strategies adopted by coastal communities in response to climate change-induced challenges.

**Research Questions**

Specifically, the research questions that guided the study were:

1. To what extent has climate change impacted on the biophysical environment of coastal communities in Rivers State?
2. In what ways has climate change affected the socio-economic livelihoods of members in coastal communities of Rivers State?
3. What are the adaptation strategies adopted by coastal communities in response to climate change-induced challenges?

**2. Literature Review**

**Concept of Biophysical Environment**

The biophysical environment is the living and non-living elements of the natural world that interact to support life. In addition to physical characteristics like landforms, climate, water bodies, and atmospheric conditions, they also contain biological elements like flora and fauna (Odum & Barrett, 2005). Because it offers resources necessary for life, such as food, shelter, water, and air, this environment serves as the basis for ecological equilibrium and human survival. The atmosphere (air), lithosphere (land), hydrosphere (water), and biosphere (living things) are the four divisions of the biophysical environment. These elements combine to create intricate systems that sustain ecological processes and biodiversity. For instance, the biosphere depends on the lithosphere for habitat and nutrients, but the hydrosphere works with the atmosphere to control weather and climate. Because temperature, precipitation, and seasonal fluctuations affect vegetation patterns and species distributions, climate significantly impacts ecosystem structuring (IPCC, 2021). Also, soil composition affects water retention, agricultural production, and species subsistence. Matson, Parton, Power, and Swift (1997) stated that urbanisation, pollution, industrialisation, and deforestation are just a few ways human activity has drastically changed the biophysical environment. Anthropogenic activities upset ecological equilibrium, resulting in environmental deterioration, biodiversity loss, and climate change. These changes seriously threaten ecosystem services, which are essential for sustaining life-supporting systems. According to Chapin et al. (2009), addressing environmental issues and advancing sustainable development requires an awareness of biophysical relationships. Conservation tactics, such as climate adaption and ecosystem restoration, aim to protect the biophysical environment's integrity for coming generations.

**Sustainable Livelihood**

The ability of people, households, and communities to sustain a standard of life without endangering future generations is known as sustainable livelihood (SL). Chambers and Conway (1992) pointed out that sustainable livelihood incorporates social, environmental, and economic aspects to guarantee resource sustainability and long-term resilience. The idea is fundamental in rural and emerging areas, where socioeconomic weaknesses, poverty, and environmental degradation are major issues. DFID (1999) stated that sustainable livelihood approach (SLA) is concerned with the notion that for people to maintain their standard of living, they need a variety of assets, including financial, social, human, physical, and environmental capital (DFID, 1999). According to Scoones (1998), a livelihood is deemed sustainable if it can withstand and bounce back from shocks, preserve or improve assets and capacities, and create possibilities for future generations without depleting natural resources. Sustainable livelihood is about establishing avenues for financial success while maintaining social cohesion and ecological integrity. Environmental sustainability is directly related to sustainable livelihood. The long-term sustainability of many rural lifestyles is threatened by deforestation, climate change, and overexploitation of natural resources (Bebbington, 1999). Intergenerational sustainability depends on ensuring economic activity does not harm the environment.

Since sustainable livelihoods rely on ecological balance, natural resource availability, and community resilience to environmental shocks, they are inextricably related to the biophysical environment and climate change. Chambers and Conway (1992) noted that it is said to be sustainable when a lifestyle can withstand and bounce back from shocks and strains while preserving or improving its resources and capacities. Land, water, air, and biodiversity comprise the biophysical environment, the basis for livelihood pursuits, including forestry, fishing, and agriculture. However, the sustainability of these operations has been impacted by additional issues brought about by climate change. The biophysical environment that supports livelihoods is in danger due to changes in rainfall patterns, increased extreme weather events, and land degradation brought on by climate change (IPCC, 2021). For example, agricultural output is adversely affected by rising temperatures and unpredictable rainfall, which causes food insecurity and economic instability in rural populations (FAO, 2020). Additionally, livelihoods that depend on freshwater and arable land are directly impacted by climate-induced environmental deterioration, such as coastal erosion and desertification, which limits access to these resources (UNEP, 2019).

**Biophysical Impacts of Climate Change on Coastal Communities Livelihood**

Coastal communities in Rivers State, Nigeria, is experiencing significant biophysical effects from climate change, especially given its location in the Niger Delta. Climate-related risks, such as rising sea levels, coastal erosion, more frequent extreme weather events, saltwater intrusion, and biodiversity loss, pose a serious threat to the area. According to Okorie and Ijah (2020), excessive rainfall in in Rivers state led to increase in sea level and thus contributed to flooding in many parts of the rivers state, thereby displacing both the aquatic lives, the forest wildlife such as different large snakes crawling seen around the living areas and also the displacement of people from their living homes and destructions of their properties by the flood These issues significantly impact the state's ecological stability, livelihoods, and environment. Sea level rise is one of the most essential biophysical consequences of climate change in Rivers State. According to the Intergovernmental Panel on Climate Change, low-lying coastal areas like Rivers State will be disproportionately impacted by the ongoing rise in global sea levels caused by thermal expansion and ice cap melting (IPCC, 2021). Sea level rise has caused coastal lands to be submerged, communities uprooted, and essential infrastructure lost. Rising sea levels and frequent tidal surges have worsened coastal erosion, causing shorelines to erode and arable land to be lost gradually.

In Rivers State, extreme weather occurrences like storms, flooding, and heavy rainfall have become more intense due to climate change, leading to devastating impacts on communities. Homes, highways, and farmlands have all been destroyed by the increased frequency and severity of flooding disasters. Increased rainfall intensity and inadequate drainage systems in cities like Port Harcourt worsen the effects of floods, displacing populations and causing economic disruptions, according to Ebele and Emodi (2016). Furthermore, local economies have been disrupted and infrastructure damaged by tropical storms and strong winds, especially in populations dependent on farming and fishing (Adeagbo et al., 2021). Saltwater intrusion into freshwater systems, caused by increasing sea levels and frequent storm surges, impacts water quality and agricultural productivity. In Rivers State, saltwater intrusion into rivers and groundwater sources has decreased soil fertility and crop yields, impacting food security and rural livelihoods

Another significant biophysical effect of climate change in Rivers State is biodiversity loss. Numerous plant and animal species have been displaced due to habitat modification brought on by coastal erosion, flooding, and saltwater intrusion. According to Okorie and Ijah (2020), saltwater intrusion is causing trees used for traditional crafts, food, medicine, and home construction to go extinct in many rural areas in Rivers State. This is because the seawater slowly seeps into the earth due to the yearly floods. Since ocean acidification brought on by climate change makes it harder for marine organisms like shrimp, oysters, corals, and so on to form their shells (calcification), members of the riverine community who only rely on collecting periwinkle, shrimp, oysters, crayfish, and so forth find it challenging to make ends meet. Fishermen are also keeping track of their daily losses due to shifting rainfall patterns that alter fish habitats, which alter fish production's distribution, productivity, and species composition. Nearby farmers are also feeling the effects of climate change. Every year, crop yields decline due to climate change's effects on crop and vegetable growth, including altered soil moisture, transpiration, excessive rainfall, and other factors.

Human activities like deforestation, oil pollution, and increasing sea levels are destroying mangrove forests, vital breeding sites for marine life. For instance, ornamental fish species are at risk of extinction due to the destruction of these ecosystems. Numerous fish species are in danger of going extinct due to the destruction of these ecosystems, which impacts the local fishing communities' means of subsistence. Furthermore, habitat fragmentation brought on by the loss of forest cover has decreased wildlife populations and upset ecological balance.

**Socio-Economic Impact of Climate Change on Coastal Communities** **Livelihood**

Coastal communities are in the midst of a pressing crisis, grappling with severe challenges brought on by climate change. This is particularly acute in areas where natural resources underpin economic activity and livelihoods. The socioeconomic effects of climate change are not a distant threat but a current reality, impacting these communities' livelihoods, infrastructure, health, and general economic stability. The loss of arable land, damage to infrastructure, relocation, problems with disease outbreaks, and other socioeconomic effects of climate change on the livelihood of coastal populations are immediate and urgent.Despite the significant consequences of climate change, coastal populations are demonstrating remarkable resilience. Many people who live along the shore depend on farming, fishing, and tourism all of which are quite susceptible to changes in the climate. Fish populations are disrupted by rising sea levels and warming oceans, which lowers fish catches and fishermen's earnings. Similarly, saltwater intrusion into farmlands brought on by coastal erosion and flooding has a detrimental effect on agricultural output. It makes it harder for farmers to make a living. The primary sources of income for many people living in the coastal areas of Rivers State are farming and fishing. However, climate variability directly impacts household incomes due to its effects on declining fish stocks, unpredictable weather patterns, and the loss of arable land (Bene et al., 2016). As a result of their financial losses, many farmers and fishermen are moving to cities or seeking new means of income.

Another significant effect of climate change is the intricate web of damage it causes to infrastructure. Homes, roads, and public infrastructure are being destroyed due to rising sea levels and extreme weather events like hurricanes and storm surges. Land loss is accelerated by coastal erosion, which puts further demand on already scarce resources for adaptation and reconstruction and forces communities to relocate. The cost of fixing destroyed infrastructure further weakens local economies, trapping populations in a cycle of poverty and uprooting. This interconnectedness of issues underscores the complexity of the problem.Health issues in coastal areas are also made worse by climate change. Cholera and typhoid epidemics have been reported as a result of flooding and water contamination caused by climate change. Inadequate sanitation exacerbates these health problems, particularly in low-income coastal communities, making children and the elderly more susceptible. The spread of illnesses like cholera and malaria is facilitated by rising temperatures and shifting weather patterns. Flooding-related contaminated water sources raise the risk of waterborne diseases, and food insecurity brought on by diminishing fish supplies and agricultural losses causes malnutrition, especially in vulnerable groups like the elderly and children.

**Adaptation Strategies to Address Biophysical and Socio-economic Impacts of Climate Change on the Livelihood of Coastal Communities**

Coastal communities face significant biophysical and socio-economic challenges due to climate change, including sea-level rise, coastal erosion, saltwater intrusion, flooding, loss of biodiversity, declining fishery resources, and disruptions to agricultural activities. These communities adopt biophysical and socio-economic adaptation strategies to mitigate the adverse effects and enhance their resilience. These include:

**Biophysical Adaptation Strategies**: One of the key biophysical adaptation strategies employed is mangrove restoration and afforestation. Given the critical role of mangroves in stabilizing coastlines, protecting against storm surges, and serving as breeding grounds for marine life, local communities and environmental organizations have embarked on replanting mangroves along eroded coastal areas. This effort helps to reduce coastal erosion and improve fishery habitats, thereby supporting livelihoods dependent on fishing. Another notable strategy is the construction of embankments and sea walls. Communities vulnerable to flooding and erosion have built sandbag barriers and reinforced shorelines with concrete embankments to minimize damage from rising sea levels and tidal surges. Though often requiring external support and funding, these structural interventions have effectively safeguarded settlements and farmlands. Communities have also adopted climate-smart agricultural practices, such as using salt-tolerant crop varieties and implementing improved irrigation techniques to counteract the effects of saltwater intrusion. These practices help farmers maintain productivity despite changing environmental conditions.

**Socio-Economic Adaptation Strategies:** To cope with socio-economic impacts, many coastal dwellers have diversified their sources of livelihood. Rather than relying solely on fishing or farming, households have ventured into alternative income-generating activities such as petty trading, aquaculture, and artisanal crafts (Ibama et al., 2020). This strategy reduces dependency on climate-sensitive occupations and enhances economic resilience.Another critical strategy is community-based resource management and cooperative societies. Local cooperatives have been established to provide financial support, capacity-building, and resource-sharing among members, ensuring better access to credit and markets for climate-affected individuals (Okon et al., 2021). These cooperatives facilitate adopting sustainable fishing and farming practices, promoting long-term community resilience.Early warning systems and disaster preparedness programs have also been introduced in collaboration with governmental and non-governmental organizations. These systems include weather monitoring, flood alerts, and community sensitization on emergency response measures. By enhancing awareness and preparedness, these initiatives reduce vulnerability to extreme weather events and improve community responses to climate hazards. Furthermore, relocation and resettlement plans have been implemented in severely affected areas. Some communities have begun voluntary relocation to less vulnerable inland areas, supported by government policies to reduce exposure to high-risk coastal zones. While relocation presents economic and social challenges, it remains a viable long-term adaptation strategy for communities facing irreversible environmental threats.

**3. Methodology**

The researchers adopted descriptive survey design. The population comprises 300 households which were randomly selected from three communities in Okrika LGA using purposive sampling technique. These communities were selected due to its proximity to the coast and its reliance on fishing and agriculture. Structured questionnaire was administered to 100 households to gather information on livelihood activities, income levels, and perceived changes in climate and environmental conditions. Out of 100 copies of questionnaire distributed, 94 copies were retrieved as dully filled and was used for data analysis. Statistical measures used to analyze data to answer various research questions were based on response frequencies and means.

**Result:**

**Research Question One: To** what extent has climate change impacted on the biophysical environment of coastal communities in Rivers State?

**Table 1: Mean responses by farmers (households) on** **the extent to which** **climate change has impacted on the biophysical environment of coastal communities.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **ITEMS**Extent of climate change impact on biophysical environment |  **FARMERS** | **TOTAL** | **X** | **Decision** |
| **VHE****4** | **HE****3** | **LE****2** | **VLE****1** |
| **1.** | Rising sea level causes flooding and erosion, that affects the livable lands.  | 60(240) | 25(75) | 5(10) | 4(4) | 94(329) | 3.5 | High |
| **2.** | Prolong or irregular rainfall leads to proliferation of diseases. | 55(220) | 25(75) | 10(20) | 4(4) | 94(319) | 3.4 | High |
| **3.** | Constant rainfall affects crop yields. |  26(104) | 23(69) | 10(20) | 35(35) | 94(228) | 2.4 | Low |
| **4.** | Pollution of the seas and rivers increases ocean acidification. | 53(212) | 30(90) | 9(18) | 2(2) | 94(321) | 3.4 | High |
| **5.** | Flooding causes overflow of fresh water into farmlands thereby destroying the ecosystems. | 40(160) | 40(120) | 9(18) | 5(5) | 94(303) | 3.2 | High |
| **Aggregate Mean (X) =** | **3.18** | **High** |

**Source: Researcher Field Survey**

Table 1 shows that mean scores for items 1, 2,4 and 5, depicting various extent to which climate change has impacted on the biophysical environment, were respectively greater than the criterion mean of 2.50 except for item 3 which is lesser than it. The table shows that climate change to a high extent has impacted on the biophysical environment of coastal communities in Rivers State by contributing to rising sea level which causes flooding and erosion, that affects the livable lands, prolong or irregular rainfall that leads to proliferation of diseases, pollution of the seas and rivers that increases ocean acidification and Flooding that causes overflow of fresh water into farmlands thereby destroying the ecosystems.

**Research Question Two (RQ2):** In what ways has climate change Impacted on socio-economic livelihoods of members in these communities?

**Table 2: Mean responses by Community Members on Ways Climate Change has Impacted on Their Socio-Economic Livelihoods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **ITEMS**Climate change impact on the socio-economic livelihoods of community dwellers.  |  **Farmers** | **Total** | **X** | **Decision** |
| VHE4 | HE3 | LE2 | VLE1 |
| **6** | Community members are being displaced of their means of livelihood due to flooding from sea rises.  | 37(148) | 26(78) | 23(46) | 8(8) | 94(280) | 2.9 | High |
| **7** | Aquatic lives are being reduced due to extreme weather events.  | 30(120) | 30(90) | 20(40) | 14(14) | 94(264) | 2.8 | High |
| **8** | Saltwater intrusion damages agricultural lands.  | 35(140) | 31(93) | 10(20) | 18(18) | 94(271) | 2.9 | High |
| **9** | People’s health is being affected due to air pollution. | 31(124) | 35(105) | 23(46) | 5(5) | 94(280) | 2.9 | High |
| **10** | Income level of community members has reduced drastically due to pollution of groundwater that has affected their means of livelihood.  | 55(220) | 30(90) | 7(14) | 2(2) | 94(326) | 3.5  | High |
| **Aggregate Mean (X2)** | **3.0** | **High** |

**Source: Researcher Field Survey**

Table 2 above shows that mean scores for items 6-10, depicting various degrees by which climate change has impacted on the socio-economic livelihoods, were respectively greater than the criterion mean of 2.50. Furthermore, the table show that climate change has affected the socio-economic livelihoods of coastal communities by displacing community members of their means of livelihood due to flooding, reducing the aquatic lives they depend on for food and income, damaging agricultural lands, people’s health is being affected due to air pollution and also reduction in income level of community members due to pollution of groundwater. The aggregate mean of 2.80 also shows overall high impact of climate change on the socio-economic livelihoods of communities in Rivers State.

**Research Question Three:** What are the coping strategies currently employed by these communities?

**Table 3: Mean responses by households on the coping** **strategies currently employed for mitigating the impacts of climate change on biophysical and socio-economic livelihoods.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **Items**Coping strategies currently employed by these community members  |  **Farmers** | **Total** | **X** | **Decision** |
| **SA****4** | **A****3** | **D****2** | **SD****1** |
| **11.** | Households engage in multiple income-generating activities, such as small-scale trade, and animal husbandry **(Diversified livelihoods**).  |  **40****(160)** |  **25****(75)** |  **20****(40)** |  **9****(9)** |  **94****(284)** | **3.0** | **Agree** |
| **12.** | Improved water management practices, such as the use of raised beds for crops and fishponds to prevent water- logging during heavy rains or flooding.  | **55****(220)** | **20****(60)** | **12****(24)** | **7****(7)** | **94****(311)** | **3.3** | **Agree** |
| **13.** | Relocating agricultural activities to upland due to coastal flooding and erosion.  | **60****(240)** | **28****(84)** | **3****(6)** | **3****(3)** | **94****(333)** | **3.5** | **Agree** |
| **14.** | Indigenous purification of water for domestic use. | **50****(200)** | **21****(63)** | **18****(36)** | **5****(5)** | **94****(304)** | **3.2** | **Agree** |
| **15.** |  Planting of mangrove trees for prevention of coastal erosion. | **35****(140)** | **20****(60)** | **24****(48)** | **15****(15)** | **94****(260)** | **2.8** | **Agree** |
| **Pooled/Aggregate Mean (X3)** | **3.2** | **Agree** |

**Source: Researcher Field Survey**

Table 3 shows that all the mean scores (including the pooled/aggregate mean) are not only greater than the criterion mean of 2.50, but also show agreement with the items 11 – 15. In other words, the respondents agreed that the various coping strategies such as **diversified livelihoods,** the use of raised beds for crops and fishponds to prevent water- logging, relocating agricultural activities to upland, indigenous purification of water, and planting of mangrove trees for prevention of coastal erosion are already employed by community dwellers to mitigate the impacts of climate change on the biophysical and socio-economic livelihoods of coastal communities.

**Discussion**

The data in the table reveal that diseases like dengue fever and malaria spread due to prolonged or irregular rainfall; ocean acidification is caused by pollution of rivers and seas; flooding causes freshwater to overflow into farmlands, destroying ecosystems; and rising sea levels lead to erosion and flooding, which harm livable lands. This is consistent with the finding by Okorie and Ijah (2020) that the delicate balance of the ecosystem is being disrupted. The amount of light that reaches offshore plants that rely on photosynthesis for life is altered by rising sea levels and antecedent floods. Rising sea levels are causing the mangrove ecosystem to disappear rapidly; the impact of climate change is causing forest resources like medicinal plants and mushrooms to go extinct; fish and fish bells, which are community fisheries resources, are frequently overrun by seawater intrusions with drastic salinity changes; and biodiversity is being lost. The acidity of the sea brought on by the sea's absorption of carbon dioxide created by human activity makes it difficult for other aquatic life to breathe. It may be more difficult for shellfish, crabs, lobsters, and corals to form their calcium carbonate shells, resulting in fewer catches for the riverine inhabitants that rely on them for sustenance and a living.

Furthermore, human activities sometimes exacerbate mangrove decline, which has reduced the natural barriers that prevent erosion. Erosion was a major issue, resulting in several municipalities' loss of property and land. Mangrove degradation, which is sometimes exacerbated by human activities, has reduced natural barriers against erosion. This is in support Okorie and Ijah (2020) view that dredging, which involves removing vast tracts of the seafloor, lifting or sucking it up, and dumping it somewhere else, usually into deeper water or for use in reclamation areas, where the sea is turned into land, is another human activity that contributes to climate change and has an equal impact on the livelihood of riverine communities. In addition to affecting fishing operations, dredging adds to biodiversity loss, coastal erosion, and soil contamination from chemical leaks. Due to dredging operations, many aquatic species that provide food and a living for the riverine community's residents on the dredged sea's seafloor are rapidly disappearing.

Findings from this study reveal that climate change has significantly altered the biophysical conditions of coastal settlements in Rivers State. Responses from households (farmers) indicated that climate change has negatively impacted the socioeconomic livelihoods of community members, according to the consequences of climate change on inhabitants' socioeconomic standard of living. With a pooled mean (the average of all responses) of 2.80 and a criteria mean (the expected average based on previous studies or established standards) of 2.50, the complete response is shown in Table 2. It is evident that flooding brought on by sea level rise is forcing people to abandon their means of subsistence; extreme weather events are diminishing aquatic life; saltwater intrusion is damaging agricultural lands; air pollution is harming people's health; and groundwater pollution has significantly reduced community members' income levels. Furthermore, the increase in floods has affected people's health, and the salt in the water has contributed to the spread of waterborne diseases, further straining the already limited healthcare resources (Ajibade, 2018).

The study revealed that ommunity members engage in a range of income-generating activities, such as small-scale trade and animal husbandry, to lessen the impact of climate change on the biophysical and socioeconomic livelihoods of community members. They also implement improved water management techniques, such as using fishponds and raised beds from crops to prevent waterlogging during heavy rains or flooding, moving agricultural activities to upland areas due to coastal erosion and flooding, purifying domestic water locally, and planting mangrove trees to stop coastal erosion. The data above not only supports Agbo et al. (2016) findings that diversifying one's revenue streams is prudent but also showcases the remarkable resilience of these communities. This diversification helps disperse the risk and serves as an economic buffer during low agricultural harvests. In addition to showcasing the communities' resilience, these adaptive strategies highlight how crucial community engagement is in combating climate change. Improved Techniques for Water Management:

Some farmers have implemented better water management practices, like growing crops in elevated beds, to prevent water-logging during floods or periods of heavy rainfall (Efe, 2009). This technique reduces crop losses due to excessive water use and ensures consistent agricultural output. Mangrove restoration and protection: Mangrove habitats are natural barriers against storm surges, coastal erosion, and floods. Specific coastal communities in Rivers State are actively rehabilitating and maintaining mangrove forests. By establishing mangrove plants and preventing their degradation, these communities are bolstering their natural defenses against the consequences of climate change (Ifejika, 2010). Constructing flood barriers in places vulnerable to flooding: Communities have constructed levees, sandbags, and embankments, among other fundamental flood defences, to reduce the likelihood of floodwaters infiltrating homes and agricultural areas. These measures, though usually temporary and low-cost, provide immediate aid during catastrophic weather events, reassuring the audience about the communities' preparedness.

**Conclusion**

Climate change has negatively impacted the biophysical and socioeconomic conditions of coastal communities’ livelihoods in Rivers State, leading to pollution, erosion, flooding, and loss of livelihoods. Small-scale trade, animal husbandry, better water management, and moving farms to upland areas are some of the adaptation strategies employed by the communities. Also, they constructed flood defences like levees and embankments to lessen the damage. However, they are sometimes short-term and inexpensive solutions.

**Recommendations**

Based on the findings of this study, the researchers recommended that:

1. Community-based climate adaptation projects, like early warning systems, sustainable fishing methods, and climate-smart agriculture, can increase resistance to climate-related risks. Programmes for capacity-building and training should be offered to inform community members about the best ways to adjust to shifting environmental conditions.
2. To offer long-term protection against flooding and coastal erosion, the government and other stakeholders should invest in long-lasting flood defence infrastructure, such as strengthened embankments, seawalls, and enhanced drainage systems. These buildings should be built to resist severe weather conditions and rising sea levels.
3. Governmental and non-governmental organizations (NGOs) should encourage alternative revenue-generating endeavours, including ecotourism, agroforestry, and renewable energy projects, to lessen economic vulnerability. With the aid of cooperative funding and microfinance, affected community members can migrate to sustainable and climate-resilient livelihoods.

**Disclaimer (Artificial intelligence)**

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1.

2.

3.

**References**

Adeagbo, O. A., Ojo, T. O., & Adetoro, A. A. (2021). Understanding the determinants of climate change adaptation strategies among smallholder maize farmers in South-west, Nigeria. Heliyon, 7(2), e06156. <https://doi.org/10.1016/j.heliyon.2021.e06156>

Agbo, O. C., Ogwo, A., & Ibiam, A. (2016). Climate change adaptation strategies among rural households in Nigeria: Evidence from South-East Nigeria. Journal of Agricultural Extension, 20(1), 58–75.

Ajibade, I. (2018). Climate change and health: Understanding the impacts on vulnerable coastal communities in Nigeria. Journal of Environmental Health, 80(5), 12–19.

Akeem, A. A. (2010). Livelihoods and environmental challenges in coastal communities of Nigeria. Journal of Sustainable Development in Africa, 12(8), 79–88. Assessed online from: <https://www.ajol.info/index.php/ajfand/article/view/74288>

Amadi, P., & Wokocha, C. (2022). The role of early warning systems in climate change adaptation: Insights from coastal Nigeria. African Journal of Disaster Studies, 8(1), 67–79.

Nwilo, P. C and Badejo, O. T. (2004). Management of oil spill dispersal along the Nigerian coastal areas. Assessed online from: <https://aquadocs.org/items/cbf815ba-bae7-43eb-813e-f349109fa358>.

Badjeck, M., Bohn, B., & Sommerville, M. (2014). Climate change and water resources in West Africa: Coastal biophysical and institutional analysis. U.S. Agency for International Development. Assessed online from: <https://www.collegesidekick.com/study-docs/5540962>

Bebbington, A. (1999). Capitals and capabilities: A framework for analyzing peasant viability, rural livelihoods, and poverty. *World Development, 27*(12), 2021–2044. Assessed online from: <https://www.sciencedirect.com/science/article/abs/pii/S0305750X99001047?via%3Dihub>

Béné, C., et al. (2016). Contribution of fisheries and aquaculture to food security and poverty reduction: Assessing the current evidence. World Development, 79, 177–196. <https://doi.org/10.1016/j.worlddev.2015.11.007>

Chambers, R., and Conway, G. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century* (IDS Discussion Paper No. 296). Institute of Development Studies. Assessed online from: <https://www.ids.ac.uk/publications/sustainable-rural-livelihoods-practical-concepts-for-the-21st-century/>

Chapin, F. S., Kofinas, G. P., & Folke, C, & Chapin, M.C. (2009). *Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world*. Springer.

Department for International Development (DFID). (1999). *Sustainable livelihoods guidance sheets*. Department for International Development. Assessed online from:
<https://www.ennonline.net/attachments/872/section2.pdf>

Ebele, N., & Emodi, N. (2016). Climate change and its impact on the Nigerian economy. Journal of Scientific Research and Reports, 10, 1–13. Assessed online from: <https://journaljsrr.com/index.php/JSRR/article/view/570>.

Efe, S.I. (2009) Climate Change and Food Security in African: Delta State Nigeria Experience. Anyadike, R.N.C., Madu, L.A. and Ajaero, Eds., Conference Proceeding on Climate Change and the Nigerian Environment, Nsukka, 29 June-2 July 2009, 105-126.

Eheazu, B. A. (2011). Global warming and climate change: A sustainable alert to Ndigbo. Ahiajoku Lecture. Owerri: Imo State Ministry of Arts, Culture, and Youth.

Eheazu, B. A. (2016). Situational challenges of environmental degradation in Nigeria: Adult education response. University of Port Harcourt Valedictory Lecture Series, No. 6. Port Harcourt: University of Port Harcourt Press Ltd.

Food and Agriculture Organization of the United Nations (FAO). (2020). *The state of food security and nutrition in the world 2020*. Assessed online from: <https://www.fao.org/publications/fao-flagship-publications/the-state-of-food-security-and-nutrition-in-the-world/en>

Ibama, K., Amachree, S., & Nwogu, L. (2020). Socioeconomic adaptation to climate change in Rivers State: A review. Nigerian Journal of Economic Studies, 15(3), 120–135.

Ifejika, S. C. (2010). Resilient adaptation to climate change in African agriculture. German Development Institute (DIE).

Intergovernmental Panel on Climate Change (IPCC). (2007). Climate change 2007: Fourth assessment report (AR4). Assessed online from: <https://www.ipcc.ch/assessment-report/ar4/>

Intergovernmental Panel on Climate Change (IPCC). (2019). Special report on the ocean and cryosphere in a changing climate. Assessed online from: <https://www.ipcc.ch/srocc/>

Intergovernmental Panel on Climate Change (IPCC). (2021). *Climate change 2021: The physical science basis*. Cambridge University Press. Assessed online from: <https://www.cambridge.org/core/books/climate-change-2021-the-physical-science-basis/415F29233B8BD19FB55F65E3DC67272B>

Matson, P. A., Parton, W. J., Power, A. G., & Swift, M. J. (1997). Agricultural intensification and ecosystem properties. *Science (New York, N.Y.)*, *277*(5325), 504–509. <https://doi.org/10.1126/science.277.5325.504>

Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Thomson Brooks/Cole. Assessed online from: <https://www.academia.edu/2181615/Fundamental_of_ecology>

Okon, B., Ekpo, R., & Udoh, J. (2021). Community-based resource management in Nigeria: A pathway to climate resilience. Journal of Rural Development, 11(3), 56–78.

Okorie, C. U., & Ijah, C. N. (2020). Community-based environmental education: A strategy for mitigating impacts of climate change on the livelihood of riverine communities in Rivers State. International Journal of Weather, Climate Change and Conservation Research, 6(1), 1–110. Assessed online from: <https://eajournals.org/ijwcccr/vol-6-issue-1-2020/community-based-environmental-education-a-strategy-for-mitigating-impacts-of-climate-change-on-livelihood-of-riverine-communities-in-rivers-state/>

Scoones, I. (1998). *Sustainable rural livelihoods: A framework for analysis* (IDS Working Paper No. 72). Institute of Development Studies. Assessed online from: <https://www.ids.ac.uk/publications/sustainable-rural-livelihoods-a-framework-for-analysis/>

United Nations Environment Programme (UNEP). (2019). *Global environment outlook – GEO-6: Healthy planet, healthy people*. Assessed online from: <https://www.unep.org/resources/global-environment-outlook-6>

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