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Economic impacts of oil and gas exploration on fish value chain in the Atlantic Coast of Akwa Ibom State, Nigeria

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Abstract

This study investigated the economic impacts of intense oil and gas exploration activities on the fish value chain in the Atlantic Coast of Nigeria, using the Eastern Obolo Local Government Area of Akwa Ibom State. Results show decreasing returns to input supplies, fish output, fish processing and marketing, as only income from fish and the selling of canoe witnessed an increase. Regression analysis reveals that crew size had a statistically significant effect on fish output/fish. Explanatory variables accounted for 51% of the variations in the fish output. The number of fishing trips, fishing technology, and years of fishing experience were found to be fish output inelastic whereas the number of fishing crew was output elastic. Returns to scale were 1.66 implying that there is room for an increase in fish output using the included variables.

***Key words**:* Oil and gas exploration, Fish value chain, Nigeria, Akwa Ibom, Returns to scale.

Introduction

Akwa Ibom State is situated in the southernmost coastal region of Nigeria, bordered by the Atlantic Ocean, which covers its entire southern boundary. Several Local Government Areas (LGAs) along the Atlantic coast, including

Eastern Obolo, Ikot Abasi, Ibeno, Eket, Mbo, Okobo, and Onna, are rich in oil reserves. Eastern Obolo is one such oil-rich LGA in the state.

Oil exploration and exploitation in Eastern Obolo began in the 1950s. According to Enemugwem (2009), oil was discovered in Eastern Obolo in 1957, around the same time as in Oloibiri, by the Shell D'Arcy Petroleum Development Company (SPDC). This activity predates the establishment of Eastern Obolo as an LGA and the creation of Akwa Ibom State in September 1987. Omorogbe (2003) notes that oil exploration in Nigeria began in earnest in 1938 when the colonial government granted concessions to SPDC, which were later revised in 1959 to include other oil companies. These concessions spurred oil exploration, exploitation, and production in Nigeria, including Eastern Obolo.

SPDC initiated crude oil exploration in Eastern Obolo in 1957, by drilling numerous oil wells in locations such as Okoroete, Okoroinyong, Emeroke, and Iko between 1957 and 1966. However, exploration was interrupted by the Nigerian Civil War (1967–1970) and resumed in 1972. By 1980, an oil flow station had been established at Iko in Eastern Obolo, known as the Utapat flow station. Today, the area hosts major oil companies like Exxon Mobil, Chevron (formerly Gulf), Agip, and Safra (ElF), with Sterling Oil Exploration and Energy Production Company (SEEPCO) being the latest addition. The arrival of SEEPCO has intensified oil exploration activities, accompanied by ancillary firms, leading to significant environmental and social challenges such as land grabbing, land degradation, destruction of aquatic ecosystems, and displacement of local communities.

Several studies (Okonta & Douglas, 2003; Onuoha, 2008; Enemugwem, 2009; Udofia, 2011) have documented the ecological and social impacts of oil exploration in Eastern Obolo. These impacts stem from processes such as site preparation, drilling, and production testing, which involve clearing vegetation, dredging waterways, and transporting equipment. These activities cause environmental degradation, noise pollution, and damage to fishing gear, disrupting local livelihoods. Oil spills have also been a major issue, with Eastern Obolo experiencing severe spills in January 1998 and November 2000. Between 1970 and 1987, approximately 360 oil spill cases were reported in the Niger Delta region, including Eastern Obolo.

The value chain encompasses the entire series of activities needed to bring a product from its initial concept through various stages of production which include physical transformation and the integration of producer services to its final delivery to consumers (Adeniyi, 2013; Obot et al., 2020). Value chain actors are individuals or entities engaged in supplying inputs, production, processing, marketing, and consumption of the product (Getnet, 2009; Antia-Obong et al., 2025). These actors can be directly involved, such as rural and urban farmers, cooperatives, processors, traders, and consumers, or indirectly involved, such as financial institutions, government bodies, researchers, and extension agents who provide support services (Ibok et al., 2014; Patrick et al., 2024).

In this study, the fish value chain was conceptualised as starting from the supply of fishing inputs, through fishing activities, to processing, transportation, marketing, and ultimately consumption. Each of these components is susceptible to disruption due to oil and gas exploration activities in Eastern Obolo Local Government Area. These activities may alter the natural flow and intensity of operations within the fish value chain, potentially affecting its overall functionality.

We consider economics in this study as the science of efficiency, implying either maximization of output/gains or minimization of losses. Intense oil and gas exploration can produce either of these outcomes. The fish input suppliers, fishers, fish processors, or fish marketers may experience increase or decrease output from their activities occasioned by oil and gas exploration activities. Influx of people into the oil and gas producing communities may raise aggregate demand for fish with attendant high prices and profit to the fishers and marketers, On the other hand, environmental perturbations and degradation, such as those arising from oil spills and the like, could reduce fish population and catch leading to lower catch and income of all those operating along the fish value chain.

Two strands of empirical literature on the impacts of oil and gas exploration can be identified in the literature. On the one hand, there are those dealing with environmental degradation arising from oil and gas activities (Elum et al., 2016; Chijioke et al., 2018; Atairet et al., 2024), and, on the other, those dealing with the impact on livelihoods (Akujuru & Ruddock, 2014; Okonkwo et al., 2015; Ukpong & Obok, 2018). Elum et al (2016) reported that the effects of oil spills are directly and indirectly dependent on the geographic location and area of the spill, however, these factors have extensively affected the environment resulting in loss of biodiversity, destruction of wildlife, air and water pollution, farmland degradation and damage to aquatic ecosystems. In tandem with the report of Elum et al., (2016), Chijioke et al., (2018) report that oil exploration gives off a devaluation of rivers, streams, and forests as it causes them to be contaminated daily according to the degree of exploration. An overview of other studies on environmental degradation depicts that the Niger delta region has experienced substantial level of unjustified environmental pollution as a result of decades of oil exploration (Umoh et al., 2013; Ikhumetse et al., 2022). The conclusions from these studies hold that the extended detrimental repercussions have over time affected the psychology, ecology, social, economic, and physical aspects of the inhabitants of the Niger delta region which, in turn, impacts the overall health of the affected individuals with emphasis on food security, malnutrition and outbreak of diseases (Elum et al., 2016; Chijioke et al., 2018; Ikhumetse et al., 2022).

Assessing the impact of oil exploration on the livelihoods of the inhabitant's/ host community, other studies (Akujuru & Ruddock 2014; Atairet & Umoh 2022) report that the standard of living of the inhabitants has been threatened as they are solely dependent on natural resources such as lands and fish. Also, it has been reported that their sacred sites (i.e., their shrines) have been tampered with as a result of oil exploration hence affecting their cultural beliefs. Ukpong & Obok (2018) revealed in their study that the threat of oil extraction can be seen in food prices (74.7%), food safety (60.5%), crop yield (48.2%), and animal production (28.3%), making the farmers and fishermen victims. These percentages show the level of decrease in each aspect of their livelihood. The findings of Okonkwo et al. (2015) corroborate with the report of Akujuru & Ruddock (2014). There has been a decrease in the yield of relevant food and cash crops including rice, cocoa, potatoes, and raffia palm, leading to a reduction in the inhabitants' income and living standard. Studies that take the approach to examine the impacts of oil and gas exploration on the entire fish value chain are scanty and far between — empirical information on how fish input suppliers, fishers, processors, distributors, and consumers are affected is not common. It is likely that these various components in the fish production chain and the operators along the chain would be impacted differently. Again, Nigeria and many other countries produce oil in coastal communities where fishing is the main livelihood. There is, therefore, the need to fill the yawning gap in empirical information on the impacts of oil and gas exploration activities on the fish value chain which could assist relevant stakeholders to take appropriate actions for continuous oil and gas production with a sustainable environment and livelihoods.

This study aims to examine the economic effects of intensive oil and gas exploration on the fish value chain in a coastal community, using Eastern Obolo LGA in Akwa Ibom State as a case study. The specific objectives were to:

(i) identify and profile key actors in the fish value chain in the Atlantic coast and;

(ii) estimate the economic impacts of intense oil and gas exploration on the fish value chain

Material and Methods

The research was carried out in the Eastern Obolo Local Government Area (LGA), one of the LGAs in Akwa Ibom State, Nigeria, situated along the Atlantic coast. Other LGAs in Akwa Ibom State bordering the Atlantic Ocean include Ibeno and Mbo. Among these coastal LGAs, Eastern Obolo has recently experienced the most intense oil and gas exploration activities. Eastern Obolo is geographically located between 4°53'5'' longitude and 7°53'8'' latitude. It lies within the tidal influence of the Bight of Bonny, stretching from the Imo River estuary in the west to the Kwa Iboe River in the east, both of which empty into the Atlantic Ocean (Israel & Mbikan, 2023). The area covers a landmass of 117,000 km² and comprises 32 villages, divided into two major clans: Okoroete and Iko. With an estimated shoreline of 184 km and a projected population of about 75,500 people (based on a 1.5% annual national population growth rate, 2022, Wikipedia), the people of Eastern Obolo are predominantly fishermen, with over 95% actively engaged in fishing.

A two-stage sampling procedure was used to select respondents for the study. In the first stage, five fishing communities/ settlements recently experiencing intense oil and gas exploration activities were purposively selected. These included Iko, Atabrikang, Elekpon, Kampa, and Okoroete. Iko and Elekpon host rig platforms and town farms, while seismic lines, pipelines, and other infrastructure crisscross Atabrikang, Kampa, and Okoroete. The extent of oil and gas operations in these communities made them suitable for this study. In the second stage, actors within the fish value chain input suppliers, fishers, processors, and marketers were selected. A total of 20 respondents were chosen from each settlement, resulting in a sample size of 100. Primary data were collected from these respondents using a well-structured questionnaire.

Descriptive tools such as tables, charts, and percentages were employed for a functional analysis in this study. This analysis involved tracing a product, in this case, fish, downstream through various marketing and processing channels to the final consumer, while also identifying upstream providers of inputs and services that support production. The roles and functions of these actors were identified and categorised. Separating these functions was essential for a technical analysis of operations along the value chain and for developing analytical accounts for each function. The functional analysis table outlines:

i. The main activities in the chain;

ii. The actors performing these activities; and

iii. The principal product of the chain (including its various transformed forms throughout the chain).

The economic impact of intense oil and gas exploration was assessed using two methods. First, income was used as a proxy for economic impact. Changes in the income of fish value chain actors before and after the intensification of oil and gas exploration activities were assumed to reflect the impact. Respondents were asked about their income levels during both periods, and the difference was taken as the measure of impact. The second method involved estimating the impact on fish output using the Cobb-Douglas production function. Economists often use statistical methods to study the relationship between changes in physical inputs and outputs, such as fish catch. The Cobb-Douglas production function, a widely used empirical model, is expressed as:

$Q = AL^{\alpha}K^{\beta}$

Where:

Q = output,

L = quantity of labour

K = quantity of capital employed

A, α, and β are positive constants.

The sum of the exponents ($\alpha + \beta$) determines the returns to scale:

If $(\alpha + \beta) = 1$, constant returns to scale occur.

If $(\alpha + \beta) > 1$, increasing returns to scale occur.

If $(\alpha + \beta) < 1$, decreasing returns to scale occur.

The exponents also measure output elasticity, which refers to the percentage change in output resulting from a given percentage change in a variable factor, holding other factors constant. When $\alpha + \beta = 1$, the Euler's theorem is satisfied, indicating that the total output is fully distributed among the factors of production when each factor is paid its marginal physical product. In this study, a four-variable Cobb-Douglas production function was employed, as fish production involves multiple inputs. The implicit form of the model is as follows:

$Q = f(X1, X2, X3, X4)$

Where, Q = fish output measured in kilogramme, X1 = Number of fishing trips per month (N), X2 = technology used in fishing represented by the type of canoe used (a motorised boat = 1, a hand-dug canoe = 0), X3 = Crew size, and X4 = years of fishing experience. This equation was estimated for fishing activities only.

The linearised equation is as follows:

$LnQ = b0 + b1LnX1 + b2LnX2 + b3LnX3 + b4LnX4 + ei.$

A priori, it is expected that the coefficient of all the explanatory variables will be positive, implying that increase in any of them will contribute to increase in fish output/ quantity of fish caught. We estimated the output elasticity of each of the four inputs as follows:

Output elasticity of the number of fishing trips = $\partial Q/Q.\ \partial X1/X1 = \partial Q/\partial X1.X1/Q$

Output elasticity of fishing technology used = $\partial Q/Q.\ \partial X2/X2 = \partial Q/\partial X2.X2/Q$

Output elasticity of crew size = $\partial Q/Q.\ \partial X3/X3 = \partial Q/\partial X3.X3/Q$

Output elasticity of the years of fishing experience = $\partial Q/Q.\ \partial X4/X4 = \partial Q/\partial X4.X4/Q$

Results and Discussion

Key actors in the fish value chain in the study area are presented in Figure 1. There were many actors in the fish value chain in the Eastern Obolo Local Government Area, Akwa Ibom State. They are discussed below along with their functions and relationship in the fish value chain.

It was found that input suppliers performed important functions supporting the fishers' activities and ensuring the sustainability and productivity of their operations. In the Eastern Obolo Local Government Area, input suppliers provide fishing gears and equipment including canoe (both hand-dug and motorised), outboard engines, paddles, nets of various sizes depending the type of fish to be used for, floaters, rackets, hooks, traps, and other fishing tools for fishing operations. Interestingly, fish rackets are produced by women using mangrove. The women sell the rackets to male inputs suppliers who in turn sell them to fishers. They also provide baits used for fishing, and ice blocks for preservation of fish by fishers, particularly those who spend many days per fishing trip.

In addition to supplying physical inputs and equipment, the input suppliers in the study area provide maintenance service to the fishers. They repair boats, and outboard engines, and assist with logistics of inputs and timely delivery. Input suppliers sometime provide information and linkages between fishers with local or regional markets.

The fishers comprise men, women and youths who go out to the sea to catch/ harvest fish in the wild. The primary role of the fishers is largely to catch fish. They ensure proper handling of fish immediately after capture to maintain quality and reduce post-harvest losses. They also sometimes engage in fish processing and preservation and even participate in marketing, that is, selling fish directly to consumers or through intermediaries such as processors or wholesalers. Also, they are involved in sharing knowledge and skills with fellow fishers and community members for mutual support.

Processing of fish in the study area is mainly done by women. They sort and grade fish for selling. They clean and remove scales from fish (from scale fish) immediately as the fish are brought out from the canoe. More important, the processors dry fish by smoking them using firewood. Women and children place small fish on the rackets for drying. Processors add value to fish and ensure it reaches consumers in a safe and desirable form. They apply traditional preservation methods such as smoking, drying, and salting to improve quality and cater to market preferences. Processors also implement quality control measures to maintain consistent standards in the product.

Several fish marketing arrangements were identified in the study area. There are those who buy fresh fish directly from the fishers and processors. They are mainly the fishers' wives or their relatives. The processors are wholesalers who sell to other wholesalers or large-scale buyers. The large-scale buyers distribute the fish to large markets in nearby Local Government Areas such as Ukam Market in the Mkpat Enin Local Government Area, Ete Market in the Ikot Abasi Local Government Area, Sea Food Markets in the Ibeno Local Government Area and to Port Harcourt, Rivers State. Respondents reported that about 80% of the fish from Eastern Obolo are taken to Port Harcourt, 5% to Ukam and 5% to Ete markets, respectively, 3% to Ibeno and the remaining 7% are consumed within the communities in the Eastern Obolo Local Government Area.

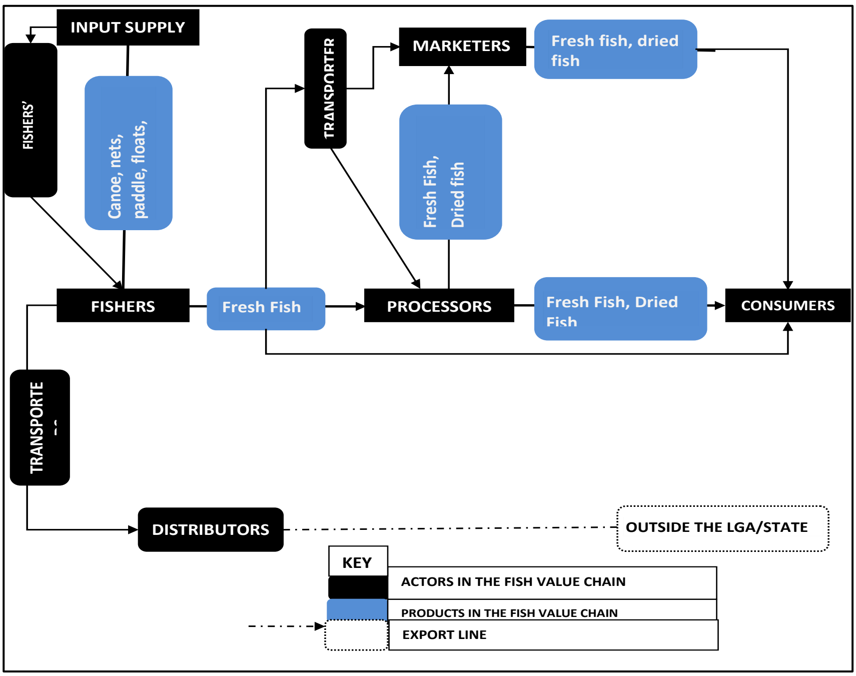

Fig. 1- Overall fish value chain in the study area

Transporters provide a vital link in the fish value chain in the Eastern Obolo LGA, ensuring that fish and fish products are moved efficiently and in safety from producers to markets and consumers. While fresh fish are mainly consumed in the communities in the study area, dried fish are transported, mainly by buses, to either Port Harcourt or markets in nearby Local Government Areas. The transporters sometimes play an additional role of, providing market information to both the processors and consumers. They also help provide information that helps track the origin and journey of fish products through the supply chain. Finally, they collaborate with fishers, processors, marketers, and retailers to ensure seamless integration of transportation issues to improve overall efficiency.

Fishers in the community used to have a Fishers' Cooperative in the distant past, but this ceased to exist due to internal conflicts. However, other players in the chain, namely processors and marketers have an association which they use to regulate their activities. The associations play both economic and social roles. They raise funds to support member's businesses in rotation and give psycho-social supports to members in times of distress.

Fish is a common and most sought-after source of protein in the study area, Akwa Ibom State as well as other states in Nigeria. Every household and individual prefer fish to other protein sources. The main fish consumers from the study area are restaurants, individuals/ households, hotels, companies, etc. Some of these consumers prefer fresh fish while others seek dried fish. It was estimated that over 90% of fish consumers preferred dried fish.

Socio-economic characteristics of fish value chain actors

As shown in Table 1, the majority (61%) of the respondents were male, while 39% were female. This indicates that males dominate fishing activities, likely due to the physical demands of the work. This finding aligns with Ifeanyi-Obi and Iremesuk (2018), who reported that 58% of artisanal fishers in Eastern Obolo were male. Similarly, Okeowo et al. (2015) found that males predominantly engage in artisanal fishing.

Table 1 reveals that the majority (68%) of respondents were above 40 years old, 21% were between 30–40 years old, and 11% were below 30 years old. The average age of respondents was 50.1 years, suggesting that many are approaching a less productive age. This contrasts with Ifeanyi-Obi and Iremesuk (2018) and Gbarabe et al (2020) who found that 76% of artisanal fishers were 50 years old or younger, indicating a more active age group.

Marital status showed that the majority (65%) of respondents were married, 17% were widowed, 14% were single, and 4% were divorced. This suggests that many respondents had family responsibilities, which could make them abandon fishing if it did not provide sufficient income to support their families. This finding is consistent with studies by Okeowo et al. (2015), and Antia-Obong et al. (2021), which reported that most respondents in Epe, Badagry, Eastern Obolo, and Akwa Ibom were married.

Their educational level indicated that 39% of respondents had secondary education, 35% had tertiary education, and 26% had primary education. This suggests that most artisanal fishers were literate enough to adopt new technologies that could improve their fishing activities, as education is known to enhance the adoption of innovations. This finding aligns with Ifeanyi-Obi and

Iremesuk (2018), who reported that 73% of their respondents in Eastern Obolo had primary, secondary, or tertiary education.

Sixty-eight percent (68%) of respondents engaged in trading as a secondary occupation, 21% were involved in farming, and 1% worked in civil service. This indicates that trading, which may include selling fish products and fishing resources, was a common secondary activity among respondents.

Tab. 1 - Socio-economic characteristics of key actors in the fish value chain

Socio-economic characteristics	Frequency (n=100)	Percentage (%)
Gender		
Male	61	61.0
Female	39	39.0
Age (Mean = 50.1 years)		
< 30	11	11.0
30 – 40	21	21.0
> 40	68	68.0
Marital status		
Single	14	14.0
Married	65	65.0
Widow/ widowed	17	17.0
Divorced	4	4.0
Educational level		
Primary	26	26.0
Secondary	39	39.0
Tertiary	35	35.0
Secondary occupation		
Fishing	10	10.0
Trading	68	68.0
Civil servant	1	1.0
Farming	21	21.0
Labour employed		
Family	94	94.0
Hired	6	6.0
Experience (Mean = 13.4 years)		
< 10	38	38.0
10 – 20	33	33.0
> 20	29	29.0
Membership in a cooperative		
Yes	62	62.0
No	38	38.0

Majority (94%) of respondents relied on family labour, while 6% hired labour for fishing operations. This suggests that respondents prefer to use household members to reduce costs associated with hiring labour, thereby maximizing their income.

The results reveal that 38% of respondents had less than 10 years of experience, 33% had 10–20 years of experience, and 29% had over 20 years of experience. The average experience was 13.4 years, indicating that most respondents have sufficient knowledge and skills in fishing operations. This aligns with Omitoyin et al (2021), who found that 96% of coastal respondents and 93% fresh water fishers in Ilaje fishing communities had over 10 years of fishing experience. This contradicts with the results of Lawal et al (2016) who reported that less than 10 years of experience was domicile in Lagos State. Membership in cooperatives shows that the majority (62%) of respondents were members of cooperatives, while 38% were not. This implies that cooperative members recognized the benefits of such organizations, particularly the support services they provide to members.

The impact on fishing input supply/ suppliers showed a reduction in the quantity of inputs supplied during the intense oil and gas activities in the study area.

Tab. 2 - Impact of oil and gas exploration activities on average quantity of fish input supplied per month

Input	Average quantity of input supply per month			
	Before intense oil & gas activities	After intense oil & gas activities	Difference	Percentage change (%)/ Direction of change
Bundles of net	40 (₦ 25,000)	70 (₦ 30,000)	30	75.00/increasing
Floaters	300 (₦1,200)	175 (₦ 2,000)	-125	-41.67/decreasing
Bundles of rackets	100 (₦ 1,500)	40 (₦ 3,000)	-60	-60/decreasing
Canoe	2 (₦ 200,000)	3 (₦ 350,000)	1	50.00/increasing
Paddles	20(₦ 1,500)	9 (₦ 2,5000)	-11	-55.00/decreasing

Tab. 3 - Impact of oil and gas exploration activities on fish input suppliers' average monthly income

Input	Average monthly income realised from input supplied (₦)			
	Before intense oil & gas activities	After intense oil & gas activities	Difference (₦)	Percentage change (%)/ Direction of change
Bundles of net	1,000,000	2,100,000	1,100,000	110/Increasing
Floaters	360,000	350,000	10,000	-2.78/Decreasing
Bundles of rackets	150,000	120,000	30,000	-20/Decreasing
Canoe	400,000	1,050,000	650,000	162.5/Increasing
Paddles	45,000	22,500	22,500	-50/Decreasing

It can be observed from Table 2 that the percentage change of two inputs supplied was above 50% decrease, while one saw over 41% decrease. In the same vein, Table 3 shows that this reduction in quantity supplied also impacted negatively their average income realised from input supplied as a result of low patronage. Input suppliers who play a key role in fishing operations were severely affected due to decreased patronage by fishers which resulted in devaluation of fishing equipment that remained in stock for a longer time without being used or sold. Input suppliers' income suddenly decreased as a result of low sales and devalued equipment sold at a cheaper rate lower than their cost price. Therefore, most of the fishers abandoned their fishing occupation for something else like temporary labour in an oil and gas firm. Worthy of note, quantity of canoes supplied increased by one during intense period of oil exploration activities which could be attributed to fast wearing out of canoe as the result of oil spillage.

Fishing as an economic activity was reduced due to oil and gas operations in the study area, as the demand for fishing equipment was reduced, thereby affecting the livelihood of input suppliers (Andrews et al., 2021).

The study revealed a 52% decline in the quantity of fish caught compared to the period before intense oil and gas activities began (Table 4). The quantity of periwinkle also dropped drastically by over 55% due to these activities. Areas once used for periwinkle fishing were sand-filled, with pipelines, roads, and bridges constructed, destroying breeding grounds and mangroves. This made it difficult for periwinkle pickers, primarily women and children, to continue their activities, thus increasing their vulnerability and leaving them unable to meet their economic responsibilities. Similarly, the quantity of crayfish caught decreased by about 63%.

Fishers reported that catching even the reduced quantities now required more time, longer distances, and increased fuel costs, significantly raising their expenses. This decline in fish catch also led to a reduction in their monthly income.

Tab. 4 - Impact of oil and gas exploration activities on fishing

Fish type	Average quantity of fish caught per month/ selling price			
	Before intense oil & gas activities	After intense oil & gas activities	Difference	Percentage (%) change/ Direction of change
Periwinkle (25kg bags)	45 (₦ 1500)	20 (₦ 4000)	25	-55.6/decreasing
Crayfish (4 litres custard container)	40 (₦ 400)	15 (₦850)	25	-62.5/decreasing
Fish (number of rackets)	250 (₦ 350)	120 ₦ 800)	130	-52/decreasing

Table 5 shows a 20% decrease in monthly income for crayfish fishers, while periwinkle pickers and general fishers experienced a slight income gain of over 18% and 9%, respectively. This increase could be attributed to an increase in the price of products and not an increase in the quantity caught. The operations of oil and gas companies disrupted the natural habitats of fish, leading to higher mortality rates, contamination, and a decline in fish populations (Sommer et al., 2019). These findings align with studies by Gordon and Tupper (2011) and Rouse et al. (2020), which reported that oil and gas activities resulted in the loss of access to fishing grounds, pollution of sediments, and displacement of inshore fishers.

Tab. 5 - Impact of oil and gas exploration activities on Fishers' average monthly income

Fish type	Average monthly income realised from fish output (₦)			
	Before intense oil & gas activities	After intense oil & gas activities	Difference (₦)	Percentage change (%)/ Direction of change
Periwinkle (25kg bags)	₦ 67,500	₦80,000	₦ 13,000	18.5 increasing
Crayfish (4 litres custard container)	₦ 16,000	₦ 12,750	₦ -3,250	-20.3 decreasing
Fish (in a racket)	₦ 87,500	₦ 96,000	₦ 850	9.7 increasing

Tab. 6 - Impact of oil and gas exploration activities on fish processing

Fish type	Average quantity of fish processed per month			
	Before intense oil & gas activities	After intense oil & gas activities	Difference	Percentage (%)/ Direction of change
Crayfish (4 litres custard container)	250	100	150	85.71/Decreasing
Fish (in racket)	400	180	220	75.86/Decreasing

The impact of oil and gas exploration activities on fish processing is presented in Table 6. A significant decrease in the quantity of crayfish and processed fish was observed. Before the intensification of oil and gas activities in the study area, processors typically purchased or processed up to 250 custard containers of crayfish and 400 rackets of fish per month on average. However, due to the increased oil exploration activities, these quantities dropped to 100 custard containers of crayfish and 180 rackets of fish, respectively. The table also shows an over 85% reduction in the quantity of crayfish processed and over 75% decline in fish quantity. This scarcity has led to higher fish prices, consistent with the law of supply, which states that prices rise when supply decreases. The destruction of fishing grounds has disrupted the availability of sufficient fish stocks for processing (Gordon and Tupper, 2011). Additionally, processors reported other challenges, such as reduced income and a shortage of processing materials caused by the destruction of mangroves.

Marketing involves the distribution and sale of fish products. Table 7 shows that before the intensification of oil and gas activities, approximately 60 bags of periwinkle were marketed monthly, compared to only 20 bags now. Similarly, an average of 450 custard containers of crayfish were marketed previously, but this number dropped to 180. The same trend was observed for fish products, with quantities declining from 1,000 rackets to 450. These results highlight the adverse effects of oil and gas operations on marketers in the study area. The scarcity of fish stocks and the increased distance required to purchase them have driven up prices, discouraging marketers from investing in this business. Odubo and Onyige (2019) noted that oil pollution from the oil and gas industry made fishing more challenging, as large amounts of fish migrated, leading to reduced catches. This has negatively impacted the livelihoods of marketers in the fishing community.

Tab. 7 - Impact of oil and gas exploration on marketing activities

Fish type	Average quantity of crayfish marketed per month			
	Before intense oil & gas activities	After intense oil & gas activities	Difference	Percentage (%) Difference/ Decreasing
Periwinkle (25kg bags)	60	20	40	66.67/Decreasing
Crayfish (4litres custard container)	450	180	270	60.00/Decreasing
Fish (in racket)	1000	450	550	55.00/Decreasing

Tab. 8 - Regression analysis results: Impact on fish output (double logarithm)

Variable	Coefficient	t-statistics	Significance level
Constant term	2.576	2.053	0.047
Number of trips	0.059	0.237	0.814
Technology	0.124	0.624	0.537
Crew size	1.266	6.319	.000
Years of fishing experience	0.207	0.110	0.482
Adjusted R^2 SE F-value	0.508 0.57447 11.569***		

The results of the regression analysis using the Cobb-Douglas production function are presented in Table 8. Among the four explanatory variables included in the model, only the crew size was found to be statistically significant, at a 0.05 level. The positive coefficient of the crew size indicates that it has had a favourable impact on fish output, suggesting that increasing the crew size by one person would raise fish catch/output by 1.266 kilograms. The adjusted R^2 value reveals that the included variables collectively explain approximately 51% of the variation in fish output.

The output elasticity of a factor refers to the percentage change in output resulting from a given percentage change in a specific variable factor, assuming all other factors and inputs remain constant. In the Cobb-Douglas production function, the exponents of the variables represent their elasticities. In this study, the aim was to determine how fish output responded to changes in four variable inputs: the number of fishing trips, fishing technology, crew size, and years of fishing experience (Table 9).

Tab. 9 - Output elasticity of inputs

Input	Elasticity	Interpretation
Fishing trips	0.059	Inelastic
Fishing technology	0.124	Inelastic
Crew size	1.266	Elastic
Fishing experience	0.207	Inelastic
Return to scale	1.656	Increasing return to scale

Source: Extracted from regression analysis results

At the individual level, increasing the number of fishing trips would raise the quantity of fish caught by 0.059 kg. The elasticity of fishing technology, measured by the type of fishing vessel used (a motorised boat or a hand-dug canoe), suggests that fish output would increase by 0.124 kg if the technology was upgraded by one unit. The crew size coefficient, which represents the number of individuals in a fishing expedition, was 1.266, indicating that adding one crew member could increase the quantity of fish caught by 1.266 kg. This input is elastic, whereas the number of fishing trips, technology, and fishing experience are inelastic, as their use results in elasticities of less than one.

As outlined in the research methodology, the sum of the exponents in the Cobb-Douglas function measures returns to scale. If the sum ($\alpha + \beta$) is greater than 1, returns to scale are increasing; if equal to 1, returns are constant; and if less than 1, returns are decreasing. In this study, the return to scale is 1.656, indicating the potential to increase fish output by scaling up the factors of production.

Conclusion

The findings of this study have revealed that the rise in oil and gas exploration activities in the study area has negatively impacted the entire fish value chain. Among the factors examined, only the supply of canoes and income from fish have increased, while others have declined. These findings have significant implications for fish production, household food security, and national food security in the long term. Fish output is likely to continue declining as long as oil and gas exploration persists in these communities, which could further reduce fishers' income, as reflected in Table 2. This decline in income may hinder fishers' ability to meet their basic needs and support their households. If this situation continues, both household and national food security could be at risk. To mitigate the adverse effects of intense oil and gas exploration on the fish value chain and local communities, oil and gas companies should conduct thorough environmental impact assessments and develop well-documented environmental management plans. These plans must be diligently implemented to ensure sustainable fishing communities alongside oil and gas operations. Additionally, alternative livelihood opportunities should be provided to actors in the fish value chain to supplement their declining earnings from fishing. This approach would ensure sustainable livelihoods for those involved in the fish value chain and enable oil and gas exploration to continue in Atlantic coast communities with fewer conflicts, unlike the current tensions observed in the Niger Delta region and other Atlantic coast communities.

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Економски утицај истраживања нафте и гаса на рибљи ланац вриједности на атлантској обали Савезне државе Аква Ибом, Нигерија

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Сажетак

Ово истраживање се бави економским утицајем који интензивне активности у циљу истраживања нафте и гаса имају на рибљи ланац вриједности на атлантској обали Нигерије, на подручју Источног Обола у Савезној држави Аква Ибом. Резултати показују смањен поврађај од улазних средстава, улова рибе, производње и продаје рибе, а само је дошло до пораста прихода од рибе и продаје кануа. Регресионом анализом откривено је да је величина посаде статистички знатно утицала на улов рибе. Експланаторне варијабле објашњавају 51% варијација у улову рибе. Број излова, рибарска технологија и године искуства у рибарењу представљали су нееластичност улова рибе, док су број чланова рибарске посаде били еластичност улова. Поврађај по обиму износио је 1,66 што подразумијева да постоји простор за повећање улова рибе уз употребу укључених варијабли.

Кључне ријечи: Истраживање нафте и гаса, Рибљи ланац вриједности, Нигерија, Аква Ибом, Поврађај по обиму.

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