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Impact of Marine Ecosystem Disturbances on Sources of Income in Ibeno Local Government Area of Akwa Ibom State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author ESU designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors Iniodu George Ukpong and Inibehe George Ukpong managed the analyses of the study. Author AU managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This research investigated the impact of marine ecosystem disturbances on the sources of income of the people in Ibeno Local Government Area of Akwa Ibom State. The main objective was to determine the influence of environmental disturbances on the sources of income of people in the oil producing coastal areas of Ibeno. The study took a period of two years and involved collection of water samples from twelve locations in six coastal communities in Ibeno for laboratory analysis, and administration of 410 questionnaires out of which 400 were used to extract data on sources of income (occupation) and environmental disturbances. Multiple regression analysis and Analysis of

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Variance (ANOVA) were employed to determine the relationship between sources of income (Y) and environmental disturbances (X_s). In the final analysis, the water physiochemical property test shows a relatively normal nutrients loading in the area but act in synergy with others in impacting on the environment. Seven elements of environmental disturbances were identified; erosion, acid-rain, deforestation, tidal actions, oil pollution, coastal flooding and rise in sea level. The study equally revealed that fishing was the major source of income of the coastal people and was mostly affected. In the regression analysis, the environmental disturbances and the sources of income (occupation) relate significantly at 0.5% probability test. The study concluded that the synergic effect of acid-rain due to oil activities, run-off sediments deposited in the river, direct and accidental discharge of crude into the river, coastal flooding/tidal actions that spread the pollutants along the coast and mangrove removal, destroyed fishes, reduced catch and cause serious decline in the income base of the people in Ibeno. Thus, it is important to promote environmental protection, conservation and sustainable harvesting to remedy the situation.

Keywords: Marine ecosystem; environmental disturbances; coastal areas; job opportunities.

1. INTRODUCTION

The coastal part of Ibeno Local Government Area in Akwa Ibom State, where the bulk of crude oil is extracted by Exxon Mobil, has been experiencing severe socio-economic crisis over the past years. Before the discovery and exploitation of crude oil in Ibeno, the people depended on their well-endowed environment for survival. The poorly managed oil exploitation methods adopted by the company caused emission of gases, pollution of the soil and contaminations of water bodies. The multiplier effects of these actions include occurrence of acid rain, destruction of the people's valuable structures, contamination of drinking water sources, deforestation and destruction of fauna and flora, as well as loss of gainful employment and income [1,2].

The coastal mangrove ecosystem provided the coastal dwellers with arrays of job opportunities, with the mangrove twigs are used for charcoal and fuel-wood [3]. The marine ecosystem, apart from providing various species of fish and wildlife, also store other forest products including timber, honey, charcoal, firewood, fruits and mineral resources. The unique ecosystem though fragile provides both aquatic and non-aquatic animals with shelter, food, good drinking water, breeding space, anchor for fish's eggs and interactions with species or other species in the food web. Today the story is different, as the technology adopted by the oil company leaves the area highly polluted and the rural dwellers paying for the cost of externalities, while economic activities in the area are jeopardized [4].

The coastal people are predominantly fishermen; who fish and carry out hunting on the aquatic mud field as well as, engage in trading on those products. The Fishing business provides a great deal of employment and economic opportunities because it is labour intensive and dominated by small fishermen who take up to 90% of natural catch [5]. Like other coastal areas in the region, the sustained mismanagement of environmental resources in the area has resulted in physical ecological degradation and economic crises over the years [6]. The causes of this environmental and socioeconomic crises which are referred in this study as 'disturbances', range from oil pollution, acid rain, flooding, deforestation and erosion to rise in sea level and tidal actions. Some of the disturbing elements are natural while others are due to abuse of technology by the oil company.

In recent times, fishing boats are rather used to convey logs of woods, as low fish catch recorded by the locals have compelled them to rather engage in trading on logs of wood for commercial purposes. This latest act encourages deforestation which worsens ecological condition of the area.

This study aimed to determine the effect of the environmental disturbances on the income base [occupation] of the people in the coastal communities of Ibeno Local Government Area of Akwa Ibom State, where activities of Exxon Mobil-a multi-national oil company, have affected the environment and livelihood profiles of the people.

2. MATERIALS AND METHODS

2.1 The Study Area

This study was carried out in Ibeno Local Government Area which situates in the south end of Akwa Ibom State, Nigeria. The area covers coastal land area of over 1,200 km with coordinates of $4^0\ 34^I\ 07^I$N and $7^0\ 48^I\ 35^I$ E. The people are predominantly fishermen. The area plays host to an oil giant- Mobil Producing Nigeria (Exxon Mobil) Unlimited that carries out upstream exploration of crude oil.

2.2 Sample and Sampling Population

Based on the 2006 census Fig. [7], Ibeno has a total population of about 74,840 people which was projected to 2018 for the purpose of this study using geometric growth rate formula; $P0 = P1 + (1 + r)^\wedge$ where P_0 = year projected to, P_1 = base year, and r = rate of change.
Thus,

$$P0 = P1 + (1 + r)^\wedge \quad (1)$$
$$2018 = 74840 + (1 + 2.3)^{1.2}$$
$$= 74840 + (3.3)^{1.2}$$
$$= 74840 + 4.19900260964$$
$$= 474844$$

2.3 Finite Population of the Study

The sampling size of the population was obtained using Yamana Toro formula [8], indicated as equation 2: $n = N \div 1 + [N(e)2]$; Where n = the sample size, N = population value of the year (or the finite population); e = limit of tolerable error (or level of significance); 1 = unit (constant).

Hence,

$$n = N \div 1 + [N(e)2] \quad (2)$$
$$n = 474844 / 1 + [\ 474844\ (0.05)^2$$
$$n = 474844 / 1 + [\ 474844\ (0.0025)$$
$$n = 474844 / 1 + 118711$$
$$n = 474844 / 118811 = 399.663 = 400$$

2.4 Methods of Data Collection

Multiple evidence method was used in obtaining primary and secondary data for this study. 400 out of 410 questionnaires retrieved and sorted were used alongside structured group discussion for primary data while secondary data came from the internet, libraries, textbooks and journals.

2.5 Experimental Design

The study adopted research and development survey method to identify the ecosystem disturbances and various sources of income of the people. Twelve locations in six villages in Ibeno were selected for water samples collection. The villages are: Atabrikang, Inua Eyet Ikot, Iwonchang, Mkpanak, Ukpenekang, and Iwo Okpoma Okpoma.

2.6 Physiochemical Property of the Water in the Study Area

The collection of water samples was necessary as fishing was the major occupation from which the people derived their income. The water samples were collected from twelve locations in six villages listed above. Samples for Demand Oxygen (DO) and Biological Oxygen Demand were collected in brown glass stopped bottles, carefully filled to avoid bubbles. 2 ml. of $Mncl_2$ solutions were added to DO (200 ml each) and then 2 ml alkaliodide – Cozide reagent was added, well below the surface of the water using separated dropping pipettes. Temperature of the water samples were determined insitu by dropping the mercury in glass Celsius thermometer (0ºC – 1000ºC) for about five minutes to observe a steady temperature. Ca^{2+} Na^+ K^+ [exchangeable cations] were determined using plane atomic absorption spectrophotometer after extraction at pH 7 using 1.0 m ½ 1 mol dm^{-3}. $PO_4{}^{-3}$, $SO_4{}^{-2}$, and NO_3 N^- (nutritive salt) were determined via turbidimeter, colorimeter and volumetrically respectively, using vanadate molybdate reagent [9,10].

Total hardness was determined by the EDTA traumatic method using Erichrome Black T as indicator, while Total Dissolved Solid level in the water was determined by measuring 50 ml of the water into a pre – weighed 100 ml beaker. This was slowly evaporated using a hot plate (the formula here was weight of empty beaker in mg multiply by 10^0 and divided sample volume ml). In determining acidity, phenolphthaleins (PA) 50 ml of each water were measured into 250 ml conical flasks. 3 drops of phenolphthalein indicator were added in each case and the solution titrated with CO_2 free NaON solution (0.02 m) until pink colour (pH 8.3) was observed. Total hardness was determined by putting 25 ml of sample into 250 ml conial flask, 2 ml of buffer solutions was added, followed by 2 drops of Erochrome black T indicator. Rose pink solution obtained and titrated with MEDTA until colour became blue. For NO_4N^-, 10 ml of each water samples were transferred into different 225 ml of Brucine reagent were added, then, 10 ml of concentrated follows. H_2SO_4 was added rapidly for 30 seconds and allowed to stand for 5 minutes. The flasks were set in cool water for 5 minutes and then made up to volume with deionized water, after about 30, the absorbance was read at 420 nm with Unicam 8625 UV/VIS Spectrometer [10].

2.7 Statistical Analysis of Dependent and Independent Variables

Acid-rain, deforestation, rise in sea level, erosion, oil pollution, flooding and tidal actions were the elements of ecosystem disturbances. These factors made up the independent variables (X_s). The dependent variable (Y) was sources of income (occupation). The Y elements were farming, trading, business/corporate unit, artisan, middlemen civil/public servant, fishing and contractor/suppliers. Analysis of variance (ANOVA) was used to determine the relationship between ecosystem disturbances and sources of income (occupation), in order to test the null hypothesis (H_0) – there is no significant relationship between ecosystem disturbances and the sources of income (occupation) in Ibeno Local Government Area of Akwa Ibom State [11,12].

3. RESULTS OF FINDINGS

3.1 Physiochemical Property of Water

The physiochemical property of water was indicated as relatively normal. The presence of ammonium ion (NH_4^+) and Total Dissolved Solid (TDS) were life support nutrients, as Nitrogen was important for protein including DNA; the carrier of genetic information. Ammonium ion (NH_4^+) was in the form organism takes in nitrogen. After nitrogen fixation, water algae converted it into organic forms and make it reachable in the ecological food chains. The amount of organic matter and Total Dissolved Solid determine the mineral content or residue in water. Phosphorus acid (PO_4^-) and Chloride ion (Cl^-) were the eutrophication element. Though they were essential nutrients for aquatic lives, phosphorus tends to form compounds that were insoluble in water and not readily eroded as part of hydrogen cycle, leading to high concentration in water. This scenario gives rise to increase photosynthetic algae and blue bacteria population and prevented light penetration in water [13]. The amount of Cl^- indicated the level of pollution, Salt water intrusion, taste and corrosion in the water. Biological Oxygen Demand (BOD) becomes gradually high, as more and more PO_4^- and Cl^- increases. As the amount of organic matter with other nutrients increases, resulting in high loading in the population of algae, more oxygen is required.

The Total Suspended Solid (TSS) aided the turbidity in water bodies. The estimated suspended sediment of run-off discharge into the water increased TSS amount of Electrical Conductivity loading is significant because of salt water nature of the river. Excess salt in water apart from causing pollution of drinking water sources, also makes the water inhabitable for aquatic animals. Potassium (K^{2+}) though a minor nutrient element in water encourages the increase in photosynthetic algae and micro bacteria, leading to high BOD.

In sum, the amounts of individual element in water in the study area were relatively normal, but their loading in synergy with other factors has direct consequences on the environment and its components.

3.2 Ecosystem Disturbance

The field survey, structured group discussion, and questionnaires furnished the study with factors that were responsible for disturbances in and around the study area. These factors were; acid-rain, deforestation, erosion, oil seepage/spillage/discharge, low and high tide, rise in sea level and coastal flooding, others include construction of oil platform/wells, turbine fire/heat and constant emission of gas.

3.3 Sources of Income (occupation)

The major source of income was fishing. This contributed about 66% of the total work force in the area. Table 2 clearly shows that the local coastal dwellers derived their means of livelihood from the aquatic environment, meaning that collapse of the aquatic ecosystem impacted directly on the income sources of the people.

3.4 Regression Analysis of Dependent (Sources of Income) and Independent (Ecosystem Disturbances) Variables

The result of the regression analysis of sources of income (Y) and ecosystem disturbances (Xs) were as shown in Tables 3, 4 and 5. Table 3 showed the model summary of the regression, while Table 4 is an ANOVA Table indicated a strong relationship between sources of income and coastal ecosystem disturbances. The

Table 1 . Water analysis: Physiochemical property of water

Villages	Ph	EC ds/M	TSS mg/LL	TDS mg/LL	Acidity mg/LL	Alka nity mgLL	Hard-Ness mg/LL	Cl^-	SO_4^-	PO_4^-	Ca^{2+}	Mg^{2+}	Na^{2+}	k^{2+}	DO	BOD
Mkpa-	6.60	0.074	0.09	0.002	0.09	0.08	10.00	3.50	2.75	0.35	6.0	4.0	0.20	0.40	3.0	2.0
Nak	6.20	0.110	0.002	0.010	0.90	0.90	17.0	4.74	5.50	0.20	12.00	5.00	0.20	0.30	3.00	1.60
Iwuon-	630	0.102	0.003	0.010	1.20	1.40	17.0	3.82	4.08	0.06	10.20	4.00	0.10	0.20	3.20	1.70
Chang	6.20	0.112	0.002	0.008	0.90	0.09	17.0	4.71	5.51	0.20	12.0	5.10	0.20	1.20	3.10	1.60
Esuk-	6.00	0.102	0.008	0.009	1.20	1.60	18.0	2.20	1.20	0.06	11.00	7.00	0.10	0.71	3.20	1.30
Ikim U	6.40	0.080	0.003	0.010	1.30	1.70	20.20	3.00	1.11	0.07	16.00	4.00	0.10	0.31	4.10	1.50
Ukpe-	6,60	0.079	0.003	0.006	0.96	1.11	19.11	2.88	0.99	0.10	12.0	7.00	0.10	0.30	3.40	2.60
nekang	6.70	0.110	0.004	0.008	1.30	1.20	11.00	2.11	0.80	0.08	7.00	4.00	0.06	0.20	4.40	1.70
Atabri-	6.00	0.092	0.006	0.008	1.40	1.63	12.80	3.11	2.40	0.07	10.00	2.80	0.08	0.20	3.20	2.10
Kang	6.10	0.077	0.007	0.009	0.68	0.90	14.50	3.40	3.43	0.03	10.00	4.50	0.11	0.30	3.10	1.40
Atai	6.30	0.084	0.008	0.020	0.70	0.90	15.00	2.99	2.08	0.04	15.00	5.00	0.03	0.40	3.20	1.30
	5.99	0.088	0.008	0020	1.20	0.98	17.80	1.99	4.20	0.07	10.00	7.80	0.10	0.10	3.20	1.30

Source: Field survey, 2018

Table 2 . Percentage values of sources of income

Sources of income	Total number of respondents	Percentage values (%)
Farming	15	4.93
Trading	10	3.29
Business/corporate unit	26	8.55
Oil workers	07	2.3
Artisans	15	4.93
Civil servants	13	4.28
Public servants	05	1.64
Middlemen/agents	09	2.96
Fishing	202	66.45
Contractors/suppliers	02	0.66

Table 3 . Model summary[b] of Y and Xs

Model					Change Statistics				
	R	R sSquare	Adjusted square	Std. err.Est.	R square change	F change	df1	df2	Sig. F Ch.
1	.999[a]	.998	.998	.03978628	.998	35952.762	7	392	.000

a. Predictors: (Constant), Erosion, Acid-rain, deforestation, Rise in sea level, Water nutrients, Tidal actions and coastal flooding

b. Dependent Variable: Sources of income

Table 4 . ANOVA[b] of Y and X_s

Model		Sum of Square	df	Mean Square	F	Sig.
1	Regression	398.378	7	56.911	35952.762	.000[a]
	Residual	.621	392	.002		
	Total	399.000	399			

a. Predictors: (Constant), Erosion, Acid-rain, deforestation, Rise in sea level, Water nutrients, Tidal actions and coastal flooding

b. Dependent Variable: Sources of income

Table 5 . Coefficient[a] of Y and Xs

Model	Unstd.coefficent		Std. coeff	t	Sig.	Collinearity statistics	
	B	Std.err.	Beta			Tolerance	VIF
1 (Constant)	-3.220	.017		-195.131	.000		
Erosion	.484	,014	.237	34.983	.000	.086	11.593
Acid- rain	.995	.004	.544	260.950	.000	.913	1.095
Deforestation	.052	.002	.042	20.940	.000	.991	1.009
Rise in sea Level	-.775	.004	-.359	-177.346	.000	.970	1.031
Water nutrients	.224	.004	.101	49.738	.000	.967	1.0034
Tidal actions	.008	.003	.006	3.054	.002	.994	1.006
Coastal flooding	.620	.014	.314	45.909	.000	.085	11.790

a. Dependent Variable: Sources of income

ANOVA table shows a mean square value of 56.911, F value of 35952.762 and significant value of 0.000. These values show that the null hypothesis (Ho) of no significant relationship between marine ecosystem disturbances and sources of income of the people in Ibeno Local Government Area was rejected and the alternative hypothesis of significant relationship accepted. It is worthy to note here that the more the significant value tends to zero the more significant the test statistics. Table 5 shows a strong individual relationship between the ecosystem disturbances and sources of income of the people.

4. DISCUSSION OF FINDINGS

In the water analysis as shown in Table 1, it was observed that the level of nutrients loading in water in the study area were relatively normal. This may be due to the fact that flowing river water has an inbuilt mechanism to treat pollutants unlike stagnant water as experienced in some areas [14,15]. However, the continuous intake of some nutrients through erosion run-off coupled with the constant gas flaring, accidental/deliberate discharge of crude oil into the environment by the Oil Company severely polluted the river on which the locals depended for survival. Fishing constituted the main source of income to the coastal Ibeno people of Akwa Ibom Ibom State.

The regression analysis of sources of income and ecosystem disturbances as clearly shown in Table 4, indicates that the ecological disturbances contributed greatly to the degradation experienced in the area. This confirms that the decay due to environmental disturbances resulting in ecological collapse significantly influenced the main income sources (fishing) of the majority of the people in the coastal area [16].

Table 5 , indicated a strong relationship among the different independent variables in determining the sources of income of the people. In the t-test of individual parameter, the positive relationship indicates that the more these factors (erosion, acid-rain, deforestation, tidal actions, water nutrients and coastal flooding) persisted in the area, the higher the decline of the returns from the sources of income (fishing occupation) of the people. This implies that the synergic effect of acid-rain due to oil activities, run-off sediments deposited in the river, direct and accidental discharge of crude into the river, coastal flooding that spread the pollutants along the coast and mangrove removal as experienced in the area, destroyed fishes, reduced catch and causes serious decline in the income base of the people in Ibeno. The negative relationship between tidal actions and sources of income indicates that tidal actions on its own do contribute to the decline of the return from the sources of income of the people. This suggests that the people, mostly local fishermen could become poorer pushed by ecosystem collapse below subsistence level, hence, to survive, the locals need to feed from the polluted water, relocated to unfamiliar territories or protest for compensation that may not come [17,18].

5. CONCLUSION

In sum, it was observed from the research findings that the nutrients loading in water in the study area on its own were insignificant and were not contributing to the ecosystem disruption or collapse as they were relatively normal in the study area. This means that given the nutrients level in the area, the aquatic animal most especially the fish would have survived and with a high fecundity. The study revealed that fishing was the major source of income of the people and was severely affected by the disturbances experienced in the area. In synergy, it was observed that factors such as erosion, acid-rain, deforestation, acid-rain, coastal flooding, tidal actions and oil pollution contributed to the ecological disturbances and subsequently the ecosystem collapse experienced in the area. As indicated by the regression analysis result, these factors which contribute to the ecosystem collapse also have significant negative influence on the resource base and main income source of majority of the people in the coastal area. Constant burning fire from turbines and gas flaring by the Oil Company kept the area perpetually polluted. The acid rain and other disruptions caused by other factors mentioned, allow the area to remain polluted irrespective of the running river/sea that has inbuilt mechanism to treat pollutants. It only the moving section of the water that can clean the pollutants over time while residue left behind in the stagnant section close to the mud field continually feed the river with the pollutant

Hence, given the dialectical relationship between man and the environment, the abuse of the ecosystem through pollution produced costs to the society. These costs were seen to include ecosystem malfunctioning, isruptions/ dislocations, health damages and undesirable effects on the means of livelihood of the people. Thus, unless these externalities are internalized by the company, they would continue to constituted serious hazard to the society. Hence, it is important to promote environmental protection, conservation and sustainable harvesting to remedy the situation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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