

Assessment of Land Use Changes Induced by Oil industries in Oil-based Communities in Akwa Ibom State

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ABSTRACT

The research aimed at assessing the land use changes brought by oil activities in Ibeno LGA, Mbo LGA and Esit Eket LGA, Akwa Ibom State with the objectives of examining the major oil related hazards that bring about major land cover/land use changes in their areas of operation, assessing the severity of environmental degradation from oil sector and the effects of the rates of ecosystem protection in the study area, determining control measures necessary for effective management of land use changes and determining the environmental safeguard tools and measures necessary to promote land use sustainability in the study area. Purposive sampling was adopted in selecting the population of 407 respondents which included 122 personnel in oil and gas industries and 285 residents/oil host community members from the study areas. Primary and secondary data were used for the study. 2-Factor Analysis of Variance and Chi square statistical tools was adopted in testing the hypothesis formulated. On the basis of the calculation, $F_{Otrt1} = 6.64 > F_{Otrt1}(0.05; 3, 6) = 4.76$. The null hypothesis (H_{01}) was rejected and the alternative hypothesis (H_{11}) accepted since the calculated value $F_{Otrt1}(\text{calculated value}) (6.64)$ is greater than the table value $F_{Otrt1}(\text{critical value}) (4.76)$ at 95% confidence level. It was concluded that the perception of the severity of environmental degradation (F_{Otrt1}) by the communities is significantly related to the rate of ecosystem protection activities in the study areas. The major findings were that there is obvious reduction in the perception of the severity of the effects of environmental degradation by the community members as the rate of ecosystem protection increases. It is recommended that there is the need for the review of the land laws in the Niger Delta so that land use management will be the collective responsibility of the stakeholders.

Keywords: Land Use, Environment, Degradation, Exploration, Production

Introduction

The assessment of land use changes has provided an insight into the level of land degradation caused by exploration and production of crude oil in Akwa Ibom State. The generation of energy has led to the zoning of expanse of land with consequent [environmental impacts](#) upon the landscape. Mineral extraction has a long history of damaging the landscape (Raymond, 2013)

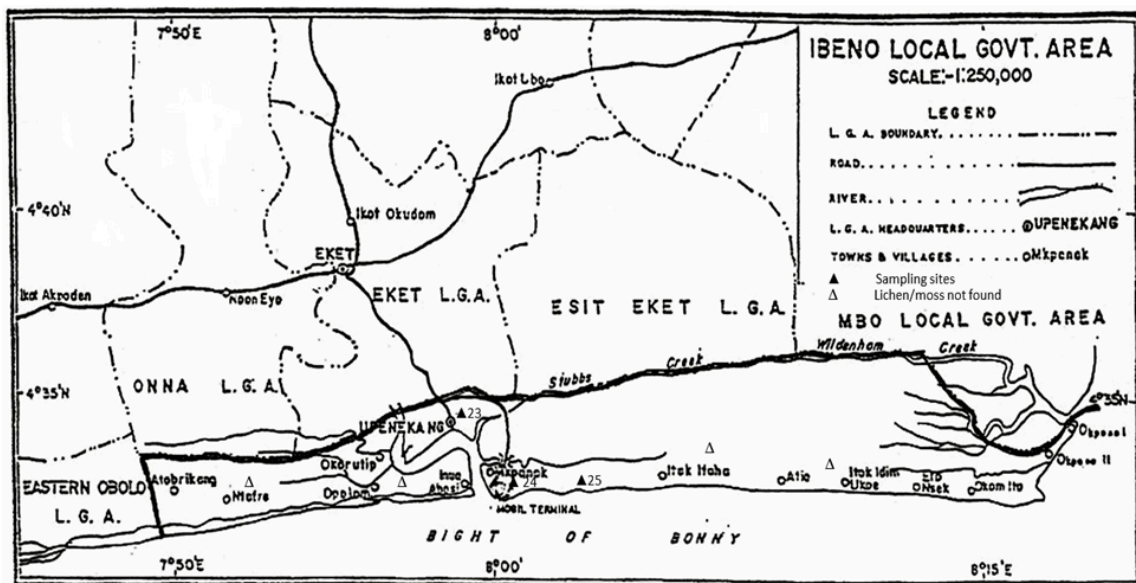
The land use changes owing to human activities such as crude oil exploration, construction and deforestation call for the improvements in our understanding of the assessment of land-use intensity and future growth in the human population in relation to employment, fuel, food and energy. The transformation arising from oil activities brought about increase in population, human activities and land use changes such as deforestation and infrastructural development in Akwa Ibom State.

The broad objective of the study was to assess the land use changes induced by oil industries in oil-based communities in Akwa Ibom State while the specific objectives were to: (i) identify oil activities that bring about major land cover/land use changes in order to assess the severity of environmental degradation from oil sector and the effects of the rates ecosystem protection activities in the study area based on the respondents perception; (ii) determine control measures necessary for effective management of land use changes, and (iii) develop control measures and environmental safeguards necessary to promote land use sustainability in Akwa Ibom State. The hypothesis formulated (H_{01}) states that the perception of the severity of land degradation from oil activities is not significantly related to the rate of ecosystem protection measures by the oil industries in the study area.

The justification of the study stems from the adverse [environmental impacts](#) upon the landscape that crude oil exploration has brought and the oil industry needs to be protected as oil and gas exports from Nigeria accounts for more than 98% of [export earnings](#) and about 83% of federal government revenue (United States Energy Information Administration, 2013).

Study Area

Ibena, Mbo and Esit Eket are the local government areas chosen for the study as these local government areas host the major oil facilities in Akwa Ibom State. Ibena Local Government Area, with the headquarters at Upenekang, is located at the South end of [Akwa Ibom State](#) of Nigeria, occupying a vast coastal area of over 1,200 sq. km. Ibena lies on latitude [4.57°N and longitude 7.98°E](#). It stretches from Okposo I at the eastern flank, bordering Mbo Local Government Area and [Bakassi Peninsula](#) to Atabrikang village on its Western flank. It is bounded in the South by the Atlantic Ocean and shares border with Eket, Esit Eket, Onna and Eastern Obolo local government areas. It lies in the mangrove forest belt of the Niger Delta region of Nigeria. Esit Eket is situated by the atlantic westline with boundaries with Ibena, Nsit Atai local government areas on a latitude of 4.393°N and longitude of 8.040°E. Mbo local government area is located in the coastal part bordered by Ibena, Udung Uko and Urue Offong Oruk. It lies between latitude 4.390°N and longitude of 8.140°E. (Aniefiok; Imaobong; and Udo, 2014). Figure 1 is map showing Ibena Local Government Area, Mbo Local Government area and Eket Local Government area of Akwa Ibom State



Source: Aniefiok; Imaobong and Udo, (2014)

Figure 1: A map showing Ibeno Local Government Area, Mbo Local Government area and Eket Local Government area of Akwa Ibom State.

Research Methodology

The research design includes the data needs, the procedure adopted for data collection and analyses, the types and sources of data, the research population, the sampling frame, determination of sample size and the method of data analyses.

Research Design

The research combined both experimental design which includes collecting soil, sediments and water samples for laboratory analysis and field survey design which includes on-site visits, interviews and use of questionnaires.

Data Needs of the Study

Biometric data (age, sex, educational qualification, and population of the study area), Environmental data (sources of water in the study area, intensity of land use for oil production, environmental degradation such as oil spill, biodiversity loss, losses in agricultural yield, incidence of fish poisoning, introduction of invasive species, destruction of mangrove forest, land biodegradation, and warming of the environment), Socio-economic data (infrastructural development in the study area, crop production/livestock in the study area, fishing, timber production, collection of sea and forest products such as periwinkles, fruits, vegetables, fire wood, artisanship such as carpentry, blacksmith, foundry; tourism; ports development and shipping; Oil and gas exploration, exploitation and refining), Laboratory data (air quality measurements and physico-chemical measurements for water and sediments) Geographic data (demography of the study area, location, geology, relief, and climate of the study area), Land cover and land use data (agriculture, industry, residence, vegetation, forest, mangrove).

Methodology

The research design adopted consists of experimental design which included collection of soil, sediments and water samples for laboratory analysis and field survey design which included on-site visits, interviews and use of questionnaires. Secondary data were collated from journals and internet. The null hypothesis (H_0) formulated was tested using 2-Factor Analysis of Variance (ANOVA). Interviews were conducted to select the respondents that would give the relevant information that are usually affected and conditioned by the attitudes and perceptions of both the interviewer and the respondent. Oral interviews as instruments of data collection were adopted in this research to get relevant information that may be difficult to obtain through other instruments. There were also structured questions to address the research objectives, research questions and the hypothesis formulated. A grab sampler (a clamshell bucket) made out of stainless steel was used for the extraction of sediments sample while a plastic container was used for the collection of water sample.

Population of the study area

According to the National Population Commission (2006), the total population of Ibeno, Mbo and Esit Eket LGAs was 242,740. Jarabi (2012) stated that there is a constant amount of increase in the number of people per unit of time and that the growth assumes a geometric series with a growth rate of 2.5%. It is expressed as:

$$P_t = P_0 (1 + r)^t$$

where P_0 = initial population

P_t = population t years later

r = growth rate (usually 2.5%)

t = number of years

From the formula, the present total population of Ibeno, Mbo and Esit Eket area is calculated thus:

$$P_0 = \text{initial population} = 242,740$$

t years later = 19 years (2006 to 2025)

r = growth rate (usually 2.5%)

$P_{19} = \text{population 19 years later} = 242,740 (1 + 0.025)^{19}$

$P_{19} = 242,740 (1.5987)$

$P_{19} = 388,068$

Determination of sample size

The sample population comprised of residents of the five chosen communities and the oil and gas staff/contractors in the oil locations in the five chosen communities. Taro (1967) developed a statistical formula is generally acceptable for the determination of sample size in relation to the population under study so that inferences and conclusions reached after the survey can be generalized to the entire population from which the sample is got.

The Taro Yamane statistical formula is thus:

$$n = \frac{N}{1 + N(e)^2}$$

Where n = required sample size from the population under study

N = total population under study

e = precision or sampling error (0.05)

$$n = \frac{388,068}{1 + (388,068 \times 0.0025)^2}$$

$$= \frac{388,068}{1 + 970.17}$$

$$= \frac{388,068}{971.17}$$

$$n = 399.59$$

$$n = 400$$

$$n = 400$$

$$n = 400$$

A sample size of 400 respondents out of the entire population of 388,068 people would be the lowest acceptable number of respondents to maintain a 95% confidence level.

Sample Size Distribution

Five communities chosen were Upenekang (the capital of Ibeno Local Government area), Okorutip (Ibeno), Iwo Okpom Opolom, Uquo (Esit Eket) and Uyenge (Mbo Local Government area). These communities were chosen owing to the crude exploration and production activities and facilities in the areas. Upenekang is the capital of Ibeno LGA and has oil wells and oil and gas marketing companies such as Mega Billion corporation with oil and gas trunk lines traversing it; Okorutip has manifolds and oil wells; Iwo Okpom Opolom has creeks and oil trunk lines; Uyenge in Mbo local government area is the site of a major oil facility construction company called Sinopet construction site (Stubb creek) and Uquo is the site of Uquo gas plant. Four hundred and seven (407) questionnaires were distributed in the five communities but 358 questionnaires were completely filled and returned. The analyses of the questionnaires distributed is shown in Table 1.

Sampling Techniques

Purposive sampling was adopted in this study. This sampling was selected based on the characteristics of the respondents, the subjective judgment of the researcher and the objective of the study. The selected respondents were residents of the communities and oil and gas staff/consultants.

Results

Data Presentation, Analyses and Discussion of Findings

Table 1: Analyses of Questionnaires Distributed in the Study Area

S/N	Host Communities	Questionnaires distributed	Questionnaires returned	Percentage re-turned (%)
1a	Ukpenekang residents/host community members	93	84	90.3
1b	Ukpenekang oil staff/oil contractors	36	34	94.4
2a	Uquo residents/host community members	47	38	80.9
2b	Uquo oil staff/oil contractors	22	18	81.8
3a	Okorutip residents/host community members	48	41	85.4
3b	Okorutip oil staff/oil contractors	20	16	80.0
4a	Uyenge residents/host community members	46	43	93.5
4b	Uyenge oil staff/oil contractors	21	19	90.5
5a	Iwo Okpom Opolom residents/host community members	51	44	86.3
5b	Iwo Okpom Opolom oil staff/oil contractors	23	21	91.3
	Total	407	358	88

Researcher's field survey, (2025)

Test of the Hypothesis (H_01)

H_01 : The perception of the severity of land degradation from oil activities is not significantly related to the rate of ecosystem protection measures by the oil industries in the study area.

Statistical technique: 2-Factor Analysis Of Variance (ANOVA) without interaction was used in testing hypothesis 2 (H_02). Factor I represents the perception of the severity of the environmental degradation by the respondents while Factor II shows the rate of ecosystem protection represented by 2022, 2023 and 2024. The test was carried out at 95% level of confidence.

Table 2A: 2-Factor ANOVA Table of Perceptions of the severity of the environmental degradation by respondents in relation to the rate of ecosystem protection activities in 2022, 2023 and 2024

YEAR	FACTOR 1	(y _j)			
	Perceptions of the total severity of the respondents to environmental degradation (oil spill, Biodiversity loss, Losses in agricultural yield, incidence of fish poisoning, introduction of invasive species, Destruction of mangrove forest, Land biodegradation, Warming of the environment)	TOTAL			
FACTOR 2	VERY SEVERE	SEVERE	MODERATE	LOW	
2022	925	637	851	471	2884
2023	782	667	857	568	2874
2024	642	637	927	658	2864
TOTAL (y_i)	2349	1941	2625	1697	8612

Source: Researcher's computation (2025)

Each level of severity is added for each response from the 358 respondents on any environmental degradation such as oil spill, Biodiversity loss, Losses in agricultural yield, incidence of fish poisoning, introduction of invasive species, Destruction of mangrove forest, Land biodegradation, and Warming of the environment.

$$SSE = SST - SS_{trt1} - SS_{trt2}$$

SST = Total Sum of Squares

SSE = Sum of squared errors

SS_{trt1} = Sum of squares for treatment factor 1

SS_{trt2} = Sum of squares for treatment factor 2

$$d.f_1 = \text{degree of freedom for treatment 1} = t - 1 = 4 - 1 = 3$$

t = number of columns

$$d.f_2 = \text{degree of freedom for treatment 2} = k - 1 = 3 - 1 = 2$$

k = number of rows

$$SST = \sum y^2_{ij} - y^2/kt = \{ (925)^2 + (782)^2 + (642)^2 + (637)^2 + (667)^2 + (637)^2 + (851)^2 + (857)^2 + (927)^2 + (471)^2 + (568)^2 + (658)^2 \} - (8612)^2/3*4$$

$$= 855625 + 611524 + 412164 + 405769 + 444889 + 405769 + 707281 + 734449 + 859329 + 221841 + 322624 + 432964 - 6183416.33$$

$$SST = 6414228 - 6183416.33$$

$$SST = 230811.67$$

$$SS_{\text{trt1}} = 1/k \sum y^2_i - y^2/kt = 1/3\{ (2349)^2 + (1941)^2 + (2625)^2 + (1697)^2 \} - (8612)^2/3*4$$

$$SS_{\text{trt1}} = 6351905.33 - 6183416.33$$

$$SS_{\text{trt1}} = 168489$$

$$SS_{\text{trt2}} = 1/t \sum y^2_j - y^2/kt = 1/4\{ (2884)^2 + (2874)^2 + (2864)^2 \} - (8612)^2/3*4$$

$$SS_{\text{trt2}} = 6194957 - 6183416.3$$

$$SS_{\text{trt2}} = 11540.7$$

$$SSE = SST - SS_{\text{trt1}} - SS_{\text{trt2}}$$

$$SSE = 230811.67 - 168489 - 11540.7$$

$$SSE = 50781.97$$

Table 2B: 2-Factor ANOVA Table showing the Mean Squares and Observed Frequencies for Factor 1 and Factor 2.

Degrees of freedom (df)	Sum of Squares (SS)	Mean Squares (MS)	Observed Frequency (FO)
Factor 1 = (k - 1) = 3	168489	56163	6.64
Factor 2 = (t - 1) = 2	11540.7	5770.35	0.68
Error (k - 1) (t - 1) = 6	50781.97	8463.66	
Total = 11	230811.67		

Source: Researcher's computation (2025)

$$FO_{\text{trt1}} = 6.64 > FO_{\text{trt1}}(0.05; 3, 6) = 4.76.$$

$$FO_{\text{trt2}} = 0.68 < FO_{\text{trt2}}(0.05; 2, 6) = 5.14$$

On the basis of the above calculation, we reject the null hypothesis and accept the alternative hypothesis since the calculated value FO_{trt1} (calculated) (6.64) is greater than the table value FO_{trt1} (table) (4.76). It is concluded that the perception of the severity of environmental degradation (FO_{trt1}) by the communities is significantly related to the rate of ecosystem protection in Akwa Ibom State.

Summary of Findings

The study assessed the changes in land use resulting from oil exploration activities by oil industries in Ibeno Local Government Area, Mbo Local Government Area and Esit Eket Local Government Area of Akwa Ibom State. From the study, ecosystem protection activities such as environmental sensitivity mapping, HSE gap analysis, Land use management workshop, Hazards and Effects Management Process workshop and Fire drill and asset protection are practiced by oil industries in Akwa Ibom State for the conservation of the natural ecosystem and sustainability of adequate land use in the study area. The research revealed that the perception of the severity of environmental degradation on land decreases as the frequency of ecosystem protection by oil and gas exploration industries increases. There is also an observation that there are reductions of oil spill on land, reduction in biodiversity loss, reduction in invasive species introduced on land, reduction in the incidence of fish poisoning, reduction in the destruction of mangrove for-

est, reduction in temperature and reduction in bioremediation activities for land degraded by oil as the rate of participation of host community in ecosystem protection and land use management activities increases. The study also revealed that Emergency preparedness and response plan will promote adequate land use sustainability by its proactive measures put in place to nip in the bud the land use exacerbation by oil and gas activities.

Conclusion

The regular participation in land use workshop and ecosystem protection by both the oil industry personnel and host community members is of paramount importance in the protection of the natural ecosystem and the sustainability of adequate land use in the study areas. The increase in the rate of ecosystem protection activities together with the increase in the host community participation reduces land degradation and promotes the sustainability of land use in the study areas.

Recommendations

The following recommendations were made for the sustainability of adequate land use, ecosystem conservation and human protection in Akwa Ibom State:

1. Identification of the sources of non-conformity in the land use pattern and conducting a root cause analysis where the non-conformity has a potential of exacerbating or distorting land use pattern and taking corrective action.
2. Reviewing of the land laws permitting the oil industries in the land use management of the activities of oil industries so that land use management will be the collective responsibility of the oil industries, government and host community members,
3. Integration of Nigerian Urban and Regional Planners into the business plan of land use management of oil and gas activities to ensure adequate development control and protection of host community land rights through land use policies and enforcement,
4. Regular conduction of land use planning workshop, environmental management gap analysis, and enforcement of best work practice, and
5. Increased participation of host community members in ecosystem protection owing to oil and gas activities.

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