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THE ECONOMICS OF GAS FLARING IN IBENO, AKWA IBOM STATE, NIGERIA

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ABSTRACT
In this paper, attempt was made to establish the relationship between pollution effects occasioned by gas flaring resulting from petroleum production and its socio-economic impact on Ibeno Community in Akwa Ibom State where gas flaring has been a major part of petroleum production over the years. A survey design was adopted for the study to assess particularly the effect of gas flaring on human health and building structures. The data generated were analyzed with the aid of descriptive statistical techniques. The study revealed that gas flaring occasioned by petroleum production by Mobil Oil Company generated pollutants into the environment. These pollutants had consequential effects on human health and building structures. In monetary terms, the cost of pollution to the community was estimated to be ₦122.9 million annually and ₦1.8 billion in fifteen years period (1996 – 2010). This huge amount could have substantial economic benefits on the community if well managed. It was recommended that appropriate regulation and control measures/policies should be adopted to ensure acceptable levels of pollution.
Keywords: Gas flaring, pollution, public health, housing, economy, Ibeno.

INTRODUCTION
Environmental degradation is often linked to both production and consumption patterns of goods and services in any society. Production/ consumption activities produce some by-products; these being externalities generate a flow of pollutants that eventually accumulates in the air, water and land. This tends to have effect on others who are not directly involved in generating them, thus causing imbalance inter-dependent relationship between those generating them and those being affected. The relationship is the result of market failure to reflect proper values for both resources and outputs, and this may lead to the production of goods which have either desirable impact or deteriorating effect on mankind and the environment in general (Irefin and Akuma 2001). Without doubt, petroleum production and consumption, especially in Nigeria are activities which lead to enormous environmental degradation. Petroleum is at present Nigeria's and indeed the World's most important produced and consumed environmental resource. Intimately associated with oil is a natural gas. However, the production of natural gas in Nigeria has so far been merely incidental to oil production, since no specific drilling for natural gas has been under taken. The gas has simply been escaping from wells drilled for oil. But it has been noted that "the country is a gas province with a bit of oil in it… in oil equivalent terms we have not begun looking for gas yet" (Holmes, 1980).
The nations proven natural gas reserves are abundant, over 2,600 billion cubic metres. Of this tremendous quantity, it is estimated that only 20 billion cubic metres is produced annually and a mere ten percent of this yearly production figure is utilized. The remaining percentage is deliberately flared as constituting a nuisance in oil exploitation operation. NEST (1991) reported that by 1986, petroleum production companies were

flaring about 17 billion cubic metres of natural gas per year to emit 2,700 tonnes of dust particles, 160 tonnes of oxides of sulphur, 5,400 tonnes of carbon monoxide and 27,000 tonnes of oxide of nitrogen into the air with attendant disastrous environmental consequences. The gaseous remittance form the flares mixes with the humid air around to produce contaminated rain termed acid rain. Acid rain occasioned by air pollution is reported by Oyeshola (1995) to corrode sandstone, limestone, ladder, paper, certain metals, historical monuments and stained glass. Stocker and Seager (1976) noted that a wide range of damage can occur in materials such as metals. This means that zinc roofs on buildings are usually affected, necessitating replacement and maintenance. Oyeshola also observed that painted surfaces are susceptible. In respect to human health, Oyeshola noted that the combination of the toxicity and size of the particles determined their effect on people such as carcinogenic or cause brain, kidney, liver and nerve damages and causing respiratory problems like asthma and other diseases such as pneumonia, catarrh, cough, liver cirrhosis, meningitis etc. The consequence of these on the environment and socio-economic development is the motivating factor for this study.

It is estimated that at present, the loss sustained by Nigeria through the burning of natural gas must be well over 20 billion naira annually. Apart from the monetary loss, gas flaring has major adverse socio-economic and environmental impacts which include: atmospheric pollution by combustion contaminants, thermal pollution of air, water and land, damage of buildings and other structures by acid rain occasioned by the flaring, damage to soil, vegetable and crops by heat and the deposition of primary and secondary contaminants; photogenic pollution (i.e. light glare) both by day and by night; severe discomfort and misery from fumes, odours, heat and combustion gases on communities located around the area; human illness, enforced modification of residential buildings to screen out some of the glare among others.

All these consequences and costs are borne by the individuals (local inhabitants) and the society as a whole in terms of unpaid costs, uncompensated damages or uncharged disservices. This study attempts to establish a relationship between pollution effects occasioned by gas flaring resulting from petroleum production, and its socio-economic impact on Ibeno Community in Akwa Ibom State, where gas flaring has been a major part of petroleum production over the years. The objectives of this study were to assess the effects of gas flaring on the socio-economic welfare of the people of Ibeno; assess the cost of gas flaring on human health; and examine the cost of gas flaring on buildings and other structures.

MATERIALS AND METHODS

Study area is Ibeno, one of the 31 Local Government Areas of Akwa Ibom State. It is a crude oil rich community, where Mobil Oil Producing Nigeria Unlimited has been exploiting crude oil and flaring the associated natural gas in the process over the years. It is a coastal area, located by the Atlantic sea shore and between latitudes 4.35^{o}N and 4.40^{o}N and longitudes 7.48^{o}E and 8.00^{o}E. Because of it coastal location, it is influenced by on shore wind which blow regularly and consequently direct the heat from the flame and other pollutants from the flared gas on shore. The area has an estimated population of about 91,362 people spread over three major settlement of Mkpanak, Upenekang and Iwuchang. Over 80% of the working populations engage in fishing, farming, petty trading and service industry while the remaining 15 – 20% is employed by the government and the Mobil oil company.

The concept of this study was based on the fact that man's consumption/ production activities produce some by products which tend to have effect on others. These by-products being externalities are problems created by disequilibrium in market mechanisms. For externalities to

occur, one or two conditions must exist: the existence of interdependence and or non-price condition. Irefin and Akume (2001) quoted from Scitovsky (1984) analyzed the concept of externalities with a view of determining how it influence resources allocation in a competitive market. These authors employed the general equilibrium theory both in its general and partial forms to analyze the characteristics of economic systems; and revealed that externalities cause divergence between private profit and social benefit, thus resulting in the failure of perfect competitive market to lead to optimum allocation of resource. The intention of his analyses is that there will be no equilibrium in a perfect competitive economy that will obtain Pareto Optimality unless the interdependence among the agents in the economy is not direct (i.e. without regards to market mechanism). Scitovsky's general equilibrium theory analysis therefore proves that direct interdependencies (which in most cases are unbalanced) are the main sources of conflict between private profit and social benefits.

Meade (1972) worked on the external economies and diseconomies of direct interdependence among producers, noted that external economies or diseconomies will exist whenever the output (X_1), of a firm depends not only on the factors of production (L_i, C_i) he employs, but also on the output (X_1) and factors (L_2, C_2,) of another firm(s),

where $Xi = F (L_1 C_1 \ldots X_2, L_2, C_2)$.

Consequently, once such transactions occur, externalities would be created and the market mechanism would be unable to solve it. Buchanan, et al (1962) and Heller et all (1976), in their independent analysis proved how externalities of an economic agent effect the utility of others. Applying the utility model they concluded that Mr. A's utility is depended not only on demands ($X_1, X_2 \ldots X_m$) under his control, but also by those activities ($Y_1, Y_2 \ldots Y_m$) under Mr. B's control. The individual's utility without externalities is:

$U^A = U^A (X_1, X_2 \ldots X_m)$

$U^B = U^B (Y_1, Y_2 \ldots Y_m)$

The total utility of the economy without externality is:

$U^{A+}U^B = U^{a+B} = U^o (X_1, X_2, \ldots X_m, Y_1, Y_2 \ldots Y_m)$.

But where externalities exist;

$U^A = U^B (X_1, X_2, \ldots X_m, Y_1)$ where Y_1 is the activity under the control of Mr. B. Mr. A's utility function under this condition may also be influenced by a third or more agents in the economy i.e. Mr. B's Yij, Mr. C's Zij, etc. Given this circumstance, Mr. A's Utility function will be:

$U^a = U^a (X_1, X_2 \ldots X_m, Yij, Zij)$

From the above analysis, the effect of Mr. B's (Yij) and Mr. C's (Zij) are not zero.

$U^a y, = dU^a \div dy^1$

The variation of Yij and Zij will be evaluated with respect to a set of equilibrium values for the Zij adjusted to a given value for Yij and Zij. The values of the partial derivatives will therefore depend if the interdependence is economies or diseconomies. Where $Uy^a > O$ then a marginal external economy exist. A small change in Mr. B's conditions will change Mr. A's utility positively. Otherwise where $U^a y<O$ marginal diseconomies exist and any change in Mr. B's condition will affect Mr. A in the same light. The above analysis was based on consumption externalities.

Inference from both analyses was that production and consumption analyses have a similar procedure and are essentially the same. Therefore, the analysis of a firm's production function could be used to substitute the utility function in the analysis without modifying the outcome of the analysis: $U^b = U^b (Y_1, Y_2 \ldots Y_m) = QB = FB (Y_1, Y_2 \ldots Y_m)$. Therefore, this study adopts the same approach which uses the same analytical tool in determining both externalities.

A survey design was adopted for this study. Two types of data were used namely primary and secondary. Primary data were generated from a simple structured interview and questionnaire administered through stratified random sampling of the 564 households/house owners identified within the study area (see table 1). A total of 174

Table 1: Sample distribution

Major town	House Owners	Sample house owners	Percentage of sample
Mkpanak	246	72	41.4
Upenekang	187	60	34.5
Iwuchang	131	42	24.1
Total	564	174	100.0

Source: Field survey, 2011

Table 2: Disease occurrence

Disease	Frequency of occurrence (F)	Probability of occurrence	Chance of occurrence
Pneumonia	1505	0.13	13.1
Meningitis	107	0.01	0.9
Asthma/bronchitis	304	0.03	2.6
Cough/catarrh	1865	0.16	0.6
Liver cirrhosis	72	0.01	0.6
Total	3853	0.34/100%	33.4%

Source: Field survey 2011

Table 3: Cost of treatment

Disease	Frequency of occurrence (f)	Mean charge (x)	Annual expenses on treatment (fx)
Pneumonia	1505	11,655.00	17,540,775
Meningitis	107	18,320.00	1,960240
Asthma/bronchitis	304	36,400.00	11,065,600
Cough/catarrh	1865	1,725.00	3,217,125
Liver cirrhosis	72	1,725.00	9,7200,000
Total	3853		43,503,740

Source: Field survey 2011

copies of questionnaire were administered constituting 31% of the household head sampled. Secondary data were collected from records of medical centers (Government hospital and private clinic) in the area under study. The data generated were analyzed with the aid of descriptive statistical techniques. Descriptive method of data analysis was used because of the nature of the data collected and as a result of its simplicity.

The study collected and used data on Diseases (Diseases associated with gas flared related pollutants found in the area); Residential buildings (Frequency of housing maintenance); Roof replacement (number of times housing maintenance roofs are replaced and the cost of replacements); and Maintenance (e.g., painting and the cost of maintenance).

RESULTS AND DISCUSSION

A population of 564 house owners was identified in the study area. Out of this figure, a stratified random sampling was used to sample 174 house owners. These represent 31% of the sample population. The sample distribution is shown in Table 1 and was based on the intensity of the population as reflected in the three major towns of the area under study.

On human health effects, the sample covered by the study was household and medical officers of clinics and public hospitals who were interviewed with the help of a structure questionnaire to determine the human health effects of pollutants due to gas flaring. The clinical records revealed that there were five (5) major gas flaring pollutant ailments in the area and are reoccurring. Table 2 gives a breakdown of the pollutant ailments.

The mean medical costs of treatment of gas flared pollutant-ailments using data collected from public hospitals and private clinics in the area was generated by weighting the medical centers with the formula:

Table 4: Estimates of shadow price

Price range (₦)	Mean price (₦)	Frequency of patient (F)	Estimated price (FX)
00,01-9,999	4,999.50	982	4,909,509
10,000-19,999	14,999.50	807	20,174,596.50
20,000-29,999	24,999.50	1096	16,439,452
30,000-39,999	34,999.50	618	21,629,691
40,000-49,999	44,999.50	350	15,749,825
Total		3853	78,903,075.50

Source: Estimate from field survey

Table 5: Monetary cost of building maintenance from 1996 – 2010.

Features affected	Frequency of maintenance (F)	Mean cost (x)	Expenditure
Roofing	252	19,034	4,796,568
Painting	185	61,821	1,261,885
Limestone	81	14,347	1,162,107
Total	174		7,220,560

Source: Field survey, 2011

Table 6: Total financial losses (1996 – 2010)

	Estimates losses (₦)	**Annual loses (₦)**
Health cost	1,836,102,203.00	122,406,813.50
Building main cost	7,220,560.00	48,370.67
Total	1,843,322,763.00	122,888,184.17

Source: Field survey 2011

Mean cost (x) of treating:
$Dij = (\sum cij + Mci) \div (N + 1)$
where, Dij = Diseases – cough pneumonia, asthma etc
Cij = Charges in private clinics
Mci = Charges in public hospital
N + I = Number of clinics + public hospital

The analysis as shown in Table 3 revealed that 3853 patients were infected by pollutant ailments annually. The community spent an estimated sum of ₦43,503,740 annually in treating these ailments, while it costs a patient an average of ₦11,290.87 to treat a pollutant related ailment (i.e. ₦43,503,740 ÷ 3853 = ₦11,290.87).
The analysis revealed that pollutant ailments usually incapacitated its host; and the patient may not engage in any productive activity. This study referred to this condition as the opportunity cost of health care. The patients were therefore willing to pay certain amount of money to prevent or avert flared gas pollutant in their environment. Shadow price was used to estimate the opportunity cost of health. Shadow price (B) of pollution $\sum fpx$ (communities) where fp = number of patients willing to pay a particular amount; X = Prices patients are willing to pay to avert pollution.
From the computation in Table 4, the community is willing to pay up to ₦78.9 million annually to prevent the flaring of gas in the environment. The community's health cost was therefore the summation of the annual medical cost (A) and the shadow price of pollution (B). Total cost of health (TC) = A + B
= ₦43, 503,740 + ₦78,903,073.50
= ₦122, 406,813.50
This represented the community's annual health cost of ailment due to gas flaring. Everything being equal, if the result was multiplied by the number of years when gas had been flared in the community, then the total cost of health (TC) for the community could be ascertained. However, in fifteen (15) years on which this study based its investigation, the total cost (TC) for the community was: (A + B).15 or
₦122,406,813.50x15= ₦1.836, 102,203.00.
This study attempted an exposition into the impact of gas flared pollution on buildings.

It revealed that house owners in the area had to grapple with repairing parts of their buildings affected, repaired metal zinc roofs, painted surfaces, especially walls, and limestone cement structures. The study revealed that house owners were aware of the effect of gas flared pollutants on zinc roof, but they were indifferent of its effects on painted surfaces and on limestone cement walls. However, the frequency with which they carried out maintenance on these aspects of their building left them in no doubt that these aspects of their building were also affected by gas flared pollutants.

Estimating monetary losses in building maintenance was based on money spent on building maintenance affected by gas flared pollutants. It estimated the monetary value of building maintenance during the periods from 1996 – 2010.

The above Table 5 shows that the community incurred huge financial losses due to damage on buildings caused by gas flaring. It further reveals that the community estimated loss was ₦7.2 million over the period under review.

The financial implication of Mobil Oil Petroleum production relationship with Ibeno community was estimated by summing the health cost and building maintenance cost.

Based on the computations above, it was estimated that the community loss an average amount of N122.9 million annually to medical health charges, lost opportunities and building maintenance cost, as seen in Table 6. This puts the community estimated losses at N1.8 billion from 1996 – 2010.

CONCLUSION

The findings of this study indicate clearly that the operation of Mobil Oil Company via gas flaring impedes on the socio-economic development of its host community. The study indicates that the host community's total loss in health and building maintenance could be as high as N1.8 billion. Nobody doubts what economic benefits N1.8 billion could do in an economy of that size if well managed. This study therefore proffers that more serious and decisive action should be taken by Mobil Oil Company, government and environmental managers if the dwindling socio-economic fortunes of the host community are to be reversed. Furthermore, environmental agencies should as a matter of urgency enforce some welfare economic solutions for industrial pollution. This will pave way for a lasting solution on producers host community conflicts.

REFERENCES

Adegbulugbe, A. O. and Dayo A. (1990). Establishment of an environment information network in Nigeria. FEPA Monograph 1: Lagos FEPA

Buchanan, J. M. and Stubblebine (1962) "Externality in straaf, R. J. and Tannian, F. X (eds 1972). *Externalities: Theoretical dimensions of political economy*. New York, Dunellen.

Gupta, A. and Asher, M.G. (1998). *Environment and the Developing World*. New York, John Wiley and Sons.

Heller, W. P. and Slaurette, D. A, (1976). *Environmental Economics*: New York Longman Inc.

Holmse, P. F. (1980). Future prospects of oil industry in Nigeria. Shell Bulletin: Lagos, Shell Publication.

Irefin, D. and Akuma, M. (2001). The economics of environmental pollution: A case study of Benue cements Plc. *Seminar paper*, University of Maiduguri.

Meade, J. C. (1972). *External Economic and Diseconomies Competitive situation*. New York, Dunellen.

NEST (1991). *Nigeria's threatened environment: A national Profile*. Ibadan, NEST publication.

Osae-Ade, A. (1990). *Nigeria Environmental Assessment Project: Back to office Report.* Washington DC, World Bank.

Oyeshola, D. (1995). *Essentials of Environmental Issues*. Ibadan, Daily Graphics Publication.

Sham Sani (1987) *Urbanization and the atmospheric environment in the low tropics: Experiences from the Kelang valley region*, Malaysia, Penerbit University Kebangsaan Malaysia.

Stoker, H. S. and Seagar, S. L. (1976). *Environmental Chemistry. Air and Water Pollution.* Glenviews Scott, Freemen and Co.