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Pollution Levels of Coastal Water Resources and the Socio-economic Effects on Iko Communities in Akwa Ibom State

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ABSTRACT This study examined the pollution levels in the coastal water resources and its socio-economic effects on the Iko Group of Communities. Water samples were collected from 19 locations and analyzed while socio-economic data were collected using questionnaire. The input data from laboratory analysis were correlated with socio-economic data using correlation and regression analyses. The result shows significant relationship between pollution levels and poverty profile in the communities. The study recommends measures that would improve the quality of coastal water resources and economic viability of the coastal communities in the Niger Delta Region of Nigeria.

1. INTRODUCTION

Globally it is estimated that there are over 3.6 million tonnes of oil spilt into the sea every year mainly as a result of shipping accidents involving oil tankers, natural seepages from sea-beds, off-shore seepages from drilling and oil exploration as well as deliberate discharge into the sea as ecological terrorism (Mannion 1999). Environmental pollution has steadily grown in areas characterized by oil exploration, exploitation, transportation and marketing activities. In Nigeria, the Niger Delta region is one of the most abused environments. The piscatorial communities in this region have experienced unabated pollutions of water resources which result from oil spillages and other oil prospecting activities. The pains occasioned by deprivations suffered by people in the Niger Delta have resulted in youth restiveness as a way of expressing their grievances towards increased levels of environmental degradation. Iko group of communities sit on commercial oil deposit being drilled by Shell Petroleum Development Company (SPDC). Oil prospecting and exploitation activities in these communities have the potential to causes many socio-economic and ecological problems difficult to ignore because of their multiplier effects.

In Nigeria, the environmental characteristics of the Niger Delta ecosystems are being investigated at various locations and times using different indicators. Ukpong (2001) examined the quality of water and soil resources in the Niger Delta where samples were taken near Kwa Iboe River Estuary in Akwa Ibom and Warri in Delta States. The findings of the study indicated high levels of soil contamination by crude oil with total hydrocarbon contact ranging from 24.8 parts per million (ppm) – 1994.8ppm in Akwa Ibom State respectively. These values were found to be higher in water than in the soil (i.e. water sample values range from 503.0 – 1969.0 ppm). Eka and Udotong (2003) also examined the effect of the 1998 Mobil 40,000 barrels of spill into Akwa Ibom coastal waters and confirmed biodiversity reduction, occurrence of unidentifiable infections, known respiratory diseases and social disharmony in affected coastal communities. Udom (2008) reporting an independent record of Shell oil spills from 1982 – 1992, stated that about 1,626,000 gallons were spilled in 27 separate incidents. In a study conducted by Umoh (2001) it is indicated that between 1991 and 1994, the quantity of crude oil that Shell Company spilled in Delta State alone amounted to 6845 barrels.

Although the Niger Delta ecosystem has been variously investigated, little or no attention is paid to the piscatorial communities in Iko where the activities of Shell Petroleum Development Company dominate and are likely to constitute the greatest sources of environmental pollution in the area and adverse effects on the people. Against the background that the livelihoods of majority of the population rest squarely on the water resources, it becomes expedient to investigate the extent to which the coastal water resources are being polluted and the attendant effects on the piscatorial communities.

This study, therefore, has the objectives of investigating the pollution levels of coastal water resources, examining the relationship between water resource variables and socio-economic characteristics of the coastal communities and the perceptual impact of the activities of oil companies on coastal communities as well as assessing the implications of the overall findings for sustainable development of coastal communities

2. STUDY AREA

Iko communities are found in Eastern Obolo Local Government Area of Akwa Ibom State in the Niger Delta Region of Nigeria located between Latitudes 4°20‘ and 4°35‘N and Longitudes 7°40‘ and 7°49‘E. Iko communities are oil bearing piscatorial communities that experienced environmental degradation and neglect over the years. The area is part of the Imo River Estuary with similar climatic conditions which prevail in the rainforest belt of southern Nigeria. The annual rainfall in Iko is up to 4000 mm while mean temperature is about 27°C. The dominant factor influencing the climate in the area is the movement of the inter-tropical front. The area lies in the Imo River Estuary and it is characterized by fluviolagoonal deposit and littoral sands of the beach ridge complex, including organic silts, clays and sand which are features of the Imo River Estuary and thus, of mangrove environment (UniUyo 1999). The major occupation of the people in the study area is fishing. However, 22 years of oil related activities in the area have destroyed the rich fresh water resources, a development that affects adversely the economy of the area.

3. METHOD AND MATERIALS

This study is designed to investigate the pollution level of coastal water resources and its socio- economic implications on the people and the economy of the area. Iko comprises of 15 communities and 4 outstanding fishing settlements. These communities and four fishing settlements and their populations are shown in Table1.

Primary data on socio-economic indices were collected using questionnaire and interview as research tools whereby 10 percent of households in the communities were sampled using systematic random sampling and a skipping range of 10 percent. A total of 1190 questionnaire were administered in each community proportionately. Household heads were target respondents. Data on 27 socio- economic variables were obtained and analyzed. Water samples for laboratory analysis were collected from each of the 19 different locations/communities that constitute the study area for laboratory analysis in sterilized 2- litre plastic containers each covered and labeled with the sample points. A total of 18 water parameters were analyzed. Various titration methods were used to determine some physical properties while the flame photometer (DC Jenway) by Proton Wilter, Amsterdam and Perkin Elmer Atomic Absorption Spectrometer (AAS) model 403B were used in the analysis of elemental and chemical properties of water. Analysis was performed on both the 27 socio-economic variables and 18 water resource parameters in order to reduce the variables. Further analysis was carried out using stepwise regression model so as to determine the effects of water resource pollution factors on socio-economic profile of the coastal communities.

Table 1: Iko communities and their population

S. No.	*Communities*	*Population*	*Est. house-holds*	*Sample*
1	Ikonta	3738	622	62
2	Elile	4526	754	75
3	Amadaka	4436	739	73
4	Kampa	2058	343	34
5	Okoroette	15269	2545	254
6	Okoromboho	5575	929	92
7	Atabrikang**	2319	386	38
8	Utuenene**	1896	316	31
9	Elekpon**	1655	276	27
10	Ekpitim	9611	1602	160
11	Eqwenwe	1188	198	19
12	Okoroitti	3274	546	54
13	Akpabom	2544	424	42
14	Iko Town	2596	433	43
15	Ekperikpe	2325	388	38
16	Ubum	2278	380	38
17	Irung	2304	384	38
18	Edowick**	2183	364	36
19	Oroirim	2158	360	36
Total	71934	11989	1190	

Source: NPC 2006
**Fishing Port

4. POLLUTION LEVELS OF COASTAL WATER RESOURCES

The pollution level of coastal water for all the 19 communities is generally high as Table

2 shows. However, the magnitude of spatial differences among the communities is not wide.

The results of the factor analysis are in Tables 3 and 4. Seven components with Eigen-values greater than one are produced (Table 3). Together they accounted for 87.32% of the total variance in the 18 variables. Based on the weights on each of the seven components and the relative component score of each community, the seven components are named.

Factor one loaded highly on ammonium ion (NH_4^+) and Total Dissolved Solid (TDS) with corresponding total percentage variation of 25.3%. This factor is named life-support factor because nitrogen is essential for protein including DNA; the carrier of generation formation. Ammonium ion is the form in which organisms take in nitrogen. TDS accounts for total mineral content or residence in water.

Factor two loaded highly on potassium ion (K^{2+}) with a total percentage variation of 16.6%. It is named minor nutrient factor in water because potassium contributes to plant nutrient in water. Green algae feed on such nutrient and energy is passed to aquatic animals when they feed on green algae.

Factor three loaded strongly on Biochemical Oxygen Demand (BOD) with a total percentage variation of 14.1% and is named water decomposition factor because it is a measure of amount of oxygen necessary to decompose organic matter in a unit volume of water. As amount of organic matter increases, more oxygen is needed, resulting in a higher BOD.

Factor four loaded highly on phosphorus acid (PO_4) and chloride ion (Cl) and accounts for 10.7% of total variance. This factor is named eutrophication factor. Though an essential water nutrient for aquatic life, phosphorus tends to form compounds that are relatively insoluble in water and therefore not readily eroded as a part of the hydrologic cycle. This leads to a high concentration in water with resultant population boom of photosynthetic algae and blue-green bacteria that become so thick and prevent light penetration through the water. Chloride ion determines the degree of pollution, salt water instruction, taste and corrosion in water. Factor five loaded strongly on electrical conductivity (Ec) with a total percentage variation of 8.96%. It is named salinity in water. Excess salt in water renders it unsafe for human consumption and for aquatic life.

Table 2: Properties of water analysis in Iko communities

PH	*Ec*	*TSS*	*TDS*	*Acidity*	*Alkalinity*	*Hardness*	*Cl*	*So4*	*Po4*	*MH4*	*No3-N*	*Ca*	*Mg*	*Na*	*K*	*Do*	*BOD*
6.6	0.07	0.09	0	0.09	0.08	10	3.5	2.75	0.35	0.01	0.81	6	4	0.2	0.4	3	2.6
6.2	0.11	0	0.01	0.9	0.9	17	4.74	5.5	0.2	0.01	0.09	12	5	0.2	0.3	3	1.8
6.3	0.1	0	0.01	1.2	1.4	0	3.82	4.08	0.06	0.01	0.52	10.2	4	0.1	0.2	3.2	1.7
6.2	0.11	0	0.01	0.9	0.09	17	4.71	5.51	0.2	0.01	0.68	12	5.1	0.2	1.2	3.1	1.6
6	0.1	0.01	0.01	1.2	1.6	18	2.2	1.2	0.06	0.02	0.52	11	7	0.1	0.71	3	1.3
6.4	0.08	0	0.01	1.3	1.7	20.2	3	1.11	0.07	0.04	0.5	16	4	0.1	0.31	3.1	1.5
6.6	0.08	0	0.01	0.96	1.11	19.11	2.88	0.99	0.1	0.01	0.8	12	7	0.06	0.3	3.2	1.6
6.7	0.11	0	0.01	1.3	1.2	11	2.11	0.8	0.08	0.01	0.33	7	4	0.08	0.2	4.1	2.6
6	0.09	0.01	0.01	1.4	1.63	12.8	3.11	2.4	0.07	0	0.5	10	2.8	0.11	0.2	3.4	1.7
6.1	0.08	0.01	0.01	0.68	0.9	14.5	3.4	3.43	0.03	0.01	0.63	10	4.5	0.03	0.3	4.4	2.5
6.3	0.08	0.01	0.02	0.7	0.9	15	2.99	2.08	0.04	0.01	0.61	15	5	0.1	0.4	3.2	1.4
5.99	0.09	0.01	0.02	1.2	0.98	17.8	1.99	4.2	0.05	0.01	0.78	10	7.8	0.1	0.1	3.1	1.3
6.8	0.03	0	0.01	0.6	0.8	11.05	3.75	4.13	0.07	0.03	0.89	8	5	0.1	0.16	3.2	1.3
5.98	0.05	0	0.02	0.8	1.7	20	3	4.11	0.07	0.66	0.04	16	4	0.1	0.16	3.4	1.8
6.3	0.05	0.01	0.01	0.98	1.8	22.11	3	5.2	0.09	0.7	0.06	17.11	5	0.12	0.17	3.5	1.6
6.3	0.08	0.02	0.03	0.7	1.7	23.4	3.1	6.2	0.11	0.73	0.07	19.4	4	0.1	0.18	3.6	1.9
6.8	0.09	0.03	0.04	0.8	1.8	20.16	4.2	3	0.08	0.68	0.07	15	5.16	0.07	0.3	3.1	1.7
6.08	0.1	0.03	0.4	1.4	1.76	19.17	4.4	2.07	0.07	0.89	0.08	10.17	9	0.07	0.4	3.11	1.6
6.5	0.08	0.03	0.04	1.3	1.72	19.8	3.2	2.06	0.08	0.88	0.08	13.8	6	0.1	0.4	3.12	1.6

Table 3: Percentage of total variance explained by each component

Component	*Total variance explained*					
	Initial Eigen values			*Extraction sums of squared loadings*		
	Total	*% of variance*	*Cumulative %*	*Total*	*% of variance*	*Cumulative %*
1	4.557697014	25.32053897	25.32053897	4.557697014	25.32053897	25.32053897
2	2.99326803	16.62926683	41.9498058	2.99326803	16.62926683	41.9498058
3	2.54037492	14.113194	56.0629998	2.54037492	14.113194	56.0629998
4	1.931002131	10.72778962	66.79078942	1.931002131	10.72778962	66.79078942
5	1.613370323	8.963168462	75.75395788	1.613370323	8.963168462	75.75395788
6	1.07435865	5.968659165	81.72261705	1.07435865	5.968659165	81.72261705
7	1.007532289	5.597401607	87.32001866	1.007532289	5.597401607	87.32001866

Factor six loaded strongly on Total Suspended Solid (TSS) with a total percentage variation of 5.97%. This factor is named turbidity factor as it is used to determine the level of water turbidity. It is obtainable from suspended sediments caused by run-off discharge into the water. Factor seven loaded significantly high on pH and is termed the pH factor which explained about 5.60% of total variance.

The factor analysis of the socio-economic variables produced 5 significant Eigen-values which account for 86.90% of the variation in the data set. These factors are interpreted and named thus (Table 4). The first component accounted for 56.4% of total variance. This component is named educational development. The variable that loaded highly on the second component is occupational activities of the people. This component is named occupational factor and it accounts for 13.62% of total variance. The third component which accounts for 6.71% of total variance is loaded relatively high and positive on quantity of fish catch. This component is named production output factor. The two other components, particularly the fifth one does not exhibit a clear cut pattern in their loadings which makes it difficult to name them. This difficulty encountered here strengthens the arguments on the problems in the application of factor analysis.

Nevertheless, component four may be called health status factor while the fifth one is termed population factor and account for 5.9% and 4.2% of total variance respectively (see Table 4).

The step wise model of multiple regression technique is used in this analysis because it derives essentially a best equation by addition or removal of variables to the regression equation one at a time. The model helps to eliminate from the equation the independent variables that do not make a meaningful contribution to the explanation of the dependent variables while the five components on socio-economic profile constitute the dependent variables.

The results in Table 5 show that only two independent factors significantly affected the levels of performance of corresponding two dependent factors. Independent factor 4 eutrophication has significant relationship with dependent factor 2 occupational activities to the extent of accounting for the variance in occupational activities for about 22.9%. In other words, about 77.1% of the observed relationships are not explainable by the eutrophication factor of water resources. The unselected indicator would possibly be environmental, political and technological factors which are also important in influencing occupational activities of the people. When all the factors are in the equation, the regression model yields an F-ratio of 5.06 which is highly significant at 0.5 significant levels. Similarly, independent factor 2 (minor nutrient factor) exhibits significant relationship with dependent factors 3 (income and expenditure factor). As Table 5 shows, 38.0% of the variance

Table 4: Percentage of total variance for socio-economic factors

Component	*Initial Eigen values*			*Extraction sums of squared loadings*		
	Total	*% of variance*	*Cumulative %*	*Total*	*% of variance*	*Cumulative %*
1	15.22799683	56.39998825	56.39998825	15.2279968	56.39998825	56.39998825
2	3.677158865	13.61910691	70.01909516	3.67715887	13.61910691	70.01909516
3	1.812131416	6.711597838	76.730693	1.81213142	6.711597838	76.730693
4	1.599801694	5.925191458	82.65588445	1.59980169	5.925191458	82.65588445
5	1.146941788	4.247932548	86.903817	1.14694179	4.247932548	86.903817

Table 5: Result of regression analysis

	Initial Eigen values			Extraction sums of squared loadings	
Component	*Total*	*% of variance*	*Cumulative %*	*Total*	*% of variance*
1	15.22799683	56.39998825	56.39998825	15.2279968	56.39998825
2	3.677158865	13.61910691	70.01909516	3.67715887	13.61910691
3	1.812131416	6.711597838	76.730693	1.81213142	6.711597838
4	1.599801694	5.925191458	82.65588445	1.59980169	5.925191458
Parameters	*Factor 4*	*Factor 2*			
R	.479	.617			
R2	.229	.380			
Adj. R2	.184	.344			
f. change	5.060	10.426			
Sig. F	.038	.005			
B	.479	.617			
Durbin Watson	1.749	1.437			

in income and expenditure factor is explained by the minor nutrient concentration in the coastal waters.

In the food chain, one way individuals in a community interact is by feeding on one another. Energy, chemical elements and compounds are thus transferred from creature to creature along food chain (Botkin and Keller 1998). In the water bodies, food chain involves more species and tends to have more tropic levels than on land. In a typical ocean ecosystem, microscopic single-cell planktonic algae (green algae) are the first trophic level. The algae feed on potassium in the water and other small invertebrates called zooplankton while the fish feeds on algae and thus form the second trophic level, and so on. The availability of potassium in water in an adequate quantity for green algae - the primary energy producer – makes the water ecosystem rich for fish survival and growth. However, high concentration of potassium in water could have a negative effect on aquatic life especially animals and fishes. Since potassium is plant nutrient in water required by green algae as food, its high concentration in water will lead to a state of eutrophication because it cannot be easily eroded mostly in stagnant waters. This leads to increase in the growth of green algae and other aquatic plants and decomposition by bacteria. Thus, the nutrient loading leads to population boom of photosynthetic algae and other blue-green bacteria that became so thick and prevent light penetration through the water. High potassium in water leads to increase in BOD i.e. increase in demand for amount of oxygen necessary to decompose organic matter in a unit volume of water. With increase in green algae and bacteria, more oxygen is used by the decomposing bacteria, leaving little or none for fish and other aquatic animals. This leads to death and fall in fish population which indirectly affect fish output and income of the people.

It was necessary to find out the general and structured perceptions of the impacts of the flow station and gas flaring activities perspective by matching the predilective views of the community people with those of the handful Shell workers and "tourists" on the effects of the flow station on Iko communities. This type of presentation may likely express the emotional feelings as well as the opinions of the people. This interactive interview was facilitated by structured questionnaire, which allow the respondents to freely rank the impacts of the gas flaring on themselves and the environment and the average responses was then extrapolated on the community average ranking of the impacts as Table 6 shows.

A juxtaposition of sixteen related and applicable environmental variable indicators against thirteen weights, as illustrated in Table 6, shows that the total of the flow station activities and the gas flaring summed up to 127 which effect magnitude represent about 61.06% (127/208 x 100). This is quite high to justify worries by us and the community. The study observed that three components- security/ safety, education and infrastructure had zero impacts on the community. The greatest negative impact of the flow station was observed on houses (buildings) and water resources. Since it is rather difficult to fully understand the web of linkages among tangible and intangible environmental and socio-economic components, it is safe to conclude that the communities of Iko have been virtually affected by the flow station activities. From the quantitative analysis of physiochemical parameters of metals in different sources of water in Iko community, it is discovered that the levels of physiochemical variables and metals in water in the Iko stream and beach creeks, are at variance with Federal Environmental Protection Agency (FEPA) standard.

Table 6: Effect matrix of Shell Petroleum Development Company's flow station on Iko community

Environmental components	*Impact matrix weightings*													
	13	12	11	10	9	8	7	6	5	4	3	2	1	0
House	X													
Health			X								X			
Population				X										
Fishing industry		X												
Crop farming			X											
Atmosphere							X							
Noise, glare, odour, and vibration							X							
Culture (Morals)										X				
Land values						X								
Occupation					X									
Income/Expenditure		X												
Water resources	X													
Soil				X										
Security/ Safety														X
Education														X
Infrastructure														X
Total	26	24	22	20	9	8	14	0	0	4	0	0	0	0

Total Weight (Score) = 127

5. CONCLUSION

The findings of this investigation show Iko communities are adversely impacted. The result of the laboratory analysis shows that the coastal waters of Iko community are polluted and this in turn affects the socio-economic profile of the communities adversely particularly their occupational activities and income/expenditure. On the basis of the pollution levels in Iko coastal water resources and attendant effects on Iko community, it is expedient to recommend thus:

- We were shocked by the height of the stack of the flow station. Shell has violated all the available standards in gas flaring technologies. Shell should be made to increase the stack that spews the flame. This will reduce the effect of heat on the environment and will enhance aerodynamics of the particulates thereby taking the pollutants further inlands and scattered.
- The derelict environment is a testimony that shell development company has not ploughed back any of its profits into community development. There are no hospitals, educational institutions roads and social facilities. Shell should intervene in community development as part of corporate social responsibilities (CSR) in Iko community.
- In Iko community life is highly disturbed. The means of livelihood of fishermen have been disrupted by incessant "release" of oil and chemicals into the ocean and creeks. The fishermen should be compensated. We recommend forming them into co-operative societies and loan sought for them for a more advanced fishing techniques of trawling that will take them into waters away from the flow station point.

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