

AN APPROACH TOWARDS EFFECTIVE MONITORING OF ENVIRONMENTAL POLLUTION RESULTING FROM PETROLEUM INDUSTRY ACTIVITIES

FRANCIS D. UDOH AND OFFIONG I. AKPANIKA

Department of Chemical & Petroleum Engineering, University of Uyo, Uyo- Akwa Ibom State, Nigeria.

Key words : Environmental Pollution, Exploration, Production, Petroleum Industry, Nigeria.

ABSTRACT

The environmental impact of exploration and production activities of the Petroleum industry is diverse, ranging from negligible effects of landscape through severe degradation, health hazards to significant and unavoidable impacts like pollution from oil spills and subsidence due to fluid withdrawal from the subsurface. Operating strictly according to environmental regulations significantly increases drilling, waste disposal and site restoration costs, thereby cutting down profits. Thus, industry operators cut corners. The industry for fear of exposing damage done and being asked to pay "huge" compensation play down Environmental Impact Statements. Backed by government run on oil, the industry is portrayed as a system that promotes research and development in areas that lead to strategic profitability rather than as one that is systematically disturbing the delicate natural balance of our environment. Public opinion and pressure is thus seen as perhaps the only effective monitor of environmental pollution and will continue to play this role for a long time in the future. The need for the formation of organized agencies with significant legal responsibilities towards localities that oil operations might endanger is therefore stressed. Although a review of the Mineral Acts of Nigeria and legislation on strict environmental standards is suggested, the oil industry is urged to turn and face the pollution effect of its activities as huge profits have already been made.

INTRODUCTION

Environmental systems can be thought of as complex dynamic "organism" comprised of numerous physical, chemical and biological interactions and interdependencies, functioning at various levels (Zylstra, 1997). They respond to stimulus or input in a manner similar to free-living, independent organism, in that they have the capacity for self-regulation and repairs and one or more parts can be damaged or missing, yet the larger system may continue to function albeit at a less optimal level.

Pollution and attendant danger occur when the

"stressors" (adverse inputs) are more than what the natural ecosystem can absorb and recycle without external aid. Unfortunately, the effect of these anthropogenic stressors is usually identified only after they have caused some measure of damage to the ecosystem.

In the new global order of sustainable development, emphasis is on effective management and efficient monitoring of anthropogenic stressors in the environment along with remediation of damage caused by past unwholesome activities.

This paper assesses the negative impact of petroleum industry activities on the environment of

the Niger Delta and the Industry/government attitude towards existing monitoring and remediation regulations. It is found that Industry Operators have failed to show enough concern for the environment and well being of the host communities while Government has been negligent in enforcing environmental regulations. A call is therefore made for more active participation of communities and interest groups (in line with Principle 10 of Agenda 21, United Nations Rio Conference, 1992) in monitoring the environment as public perception and opinion rather than legislative actions are the ultimate drivers of environmental actions.

Oil Industry Activity in the Niger Delta

The Niger Delta is a triangular shaped area located at the southern tip of Nigeria. Believed to be one of the world's richest wetland areas, it covers about 75,000 Km² consisting of mangrove swamps and a number of distinct ecological zones such as coastal ridges, barriers, fresh water swamp forests and lowland rainforests (Nyananyo, 1999).

Politically, the area has nine of Nigeria's thirty-six states-Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers with a combined population of 8.9 million people (1991 census) and a human population density ranging from 1.95 persons per hectare in Rivers/Bayelsa to 7.12 persons per hectare in Akwa Ibom State (Azaiki, 2003).

Niger Delta is the 13th largest sedimentary basin in the world (Selley, 1985) and a prolific hydrocarbon province with an estimated reserve of about 30 billion barrels of oil and 167 trillion cubic feet of natural gas (Reijiers *et al.*, 1997; Sonibare and Ekweozor, 2001). Since the first commercial production of 5000bpd commenced at the Oloibiri Oil fields in 1956, over 5,300 wells have been drilled in about 500 oil fields discovered within the area (NNPC, 2004). Oil industry activity in the area is characterized by about 13,000 km of pipelines (both offshore and onshore), 112 flow stations, 6 FPSOs, 3 FSOs, 7 terminals and an installed capacity of 3 mmbpd operating at 70% to 80% efficiency (Kupolokun, 2007). The flurry of exploration and production activities ranging from appropriation of community land for running seismic lines and building construction, through improper disposal of drill cuttings, spent drilling mud as well as waste water and domestic waste to oil spillages and gas flaring has led to severe degradation of the Niger Delta environment. A three-fold impact emerges from the oil exploration

and production activities in the areas. First, the environment has been polluted, secondly, there is depletion in the quality of life and livelihood of the inhabitants and finally the communities have not been developed.

Among several documented cases are:

- Severe corrosion of galvanized roofing sheets in houses (Agbon, 1995; Akpan, 2003).
- Alteration of agricultural soil quality not just through loss of nutrients but in the increase in amount of heavy and toxic metals (Kakulu, 1985). Physical coating and interaction of hydrocarbon and chemical components of oil with soil chemicals lead to changes in soil texture and reduction in soil quality (Nwadiaro, 1993; Grevy, 1995).
- Negative impact on aquatic ecosystem. Contaminated waste water and sometimes oil spill get into underground and surface water causing a deterioration of water quality. This in turn leads to destruction of aquatic planktons, a phenomenon that results in loss of breeding grounds and nursery for fishes and other marine organisms (Chukwu *et al.* 1998; Fumiyywa, 1998; Onosode, 2003).
- Severe overall health problems such as cancer, increased skin irritation, impairment of respiratory function due to carbon monoxide toxicity (Shridhar, 2001; Ononge, 2002).

Ekuerhare and Orubu (1996) have shown that the ultimate economic effect of oil industry activity impact on environment translates to pecuniary effects that can be measured in terms of reduced real incomes and loss of alternative use of resources consumed by oil companies. Another long term effect is that the increase in incidence of poverty among vulnerable groups such as farmers and fishermen and their dependents culminates in intensified exploitation of existing natural resources such as timber and non-timber forest resources (Orubu *et al.* 2004). For example, pollution of major fishing waters leads to massive exploitation of marginal waters. The pressure on land due to spills and acquisition also leads to the exploitation of marginal farmlands, over-farming and deforestation all of which results in a new wave of environmental degradation. Thus a vicious cycle relationship between environmental degradation and poverty has been created in the area particularly in the face of inappropriate compensation programmes of Oil Companies which do not provide for alternative sources of livelihood for the deprived land owners. Yet there are regulatory

legislations for proper conduct and operation in existence both locally and internationally.

International and Local Environmental Protection Laws

There is no dispute over the existence of pollutants and degradation of environment generated and occasioned by oil and gas exploration and production activity. The controversy has always been over the magnitude of the degradation and its long term effect on development as well as the response of the Operators (Benstein and Alsayegh, 1991). In Table 1, potential environmental impact in oil and gas exploration and production are enumerated. These "impacts" depend on several factors such as the stage of the process, the size and complexity of the project, the nature and sensitivity of the surrounding environment as well as the effectiveness of planning, pollution prevention, mitigation and control techniques.

Several international instruments exist to protect various components of the environment by regulating the operational discharge of the oil and gas industry (Table 2). The control and enforcement of these instruments are, however, strictly the responsibility of national governments. Borthwick *et al.* (1997), however, noted that at National levels, petroleum laws rarely impose detailed requirement for environmental control programmes; rather environmental regulations are usually embodied in a variety of national laws. This is true for Nigeria where regulations on environmental policy relevant to the petroleum industry can be found in several legislations (Table 3).

Evolution of Nigeria's environmental regulating legislation began with the Mineral Ordinance of 1914 enacted by the colonial Administration at the onset of exploration activity in the Nigerian Oil and Gas Industry. The objective of the ordinance was to prohibit the pollution of water courses in the process of mining and prospecting for minerals including petroleum. Since Independence, a number of statutory efforts directed at environmental protection in the petroleum industry have been made. These include the Mineral Oil (safety) Regulations of 1963, Petroleum Regulations (1967) as well as the Oil in Navigable Waters Acts of 1968 and Federal Environmental Protection Agency (Decree No. 58, 1988) among others. The Federal Ministry of Environment and the Department of Petroleum Resources (DPR) have remained the watchdogs of the Petroleum industry as encapsulated in the statutory framework

for environmental policy (Figure 1).

A critical examination of the various legislations and regulations reveal no explicit provision to incorporate the host communities of the oil companies in the process of implementing protection and management strategies. Thus too often, too many within the industry indicate by their actions or inactions, a low regard for the environment considering environmental safety no more than another business expense.

Environmental Disequilibrium in the Niger Delta

Industry reports show that operating in the Niger Delta poses some of the toughest challenges in the world (Kragha and Adepoju, 1994; Ifebajo and Ibizugbe, 2002). The region has witnessed unprecedented attacks on oil and gas facilities, staff and contractors resulting in losses ranging from downtime to shutdowns. Indeed the region is today a militarized zone. Much of this has occurred due to the insensitivity of the operators in the industry to the plight of the people and the recourse to government might to suppress genuine demands of the people. Table 4 chronicles a few of the instances where operating companies used brute force to disperse communities they had desecrated. The argument of the Companies is that since they pay royalty and taxes to the Federal Government, the primary responsibility of developing the oil producing communities is that of the latter and that the contributions of the former should be seen not as mandatory but based on the principle of good neighbourliness and responsible corporate citizenship. Sound as this argument may appear, it cannot be made about environmental conservation where the responsibility to maintain a pollution-free environment in the oil producing areas rests on the oil companies.

Industry Response and Compliance with Environmental Regulations

The traditional method of environmental regulation has largely been through prescriptive legislation although it is recently being complemented by performance assessment, goal setting negotiated agreements and self-evaluation. Under the prescriptive legislation, a company is supposed to maintain procedures to identify systematically, the hazards and effects which may arise from its activities and from the materials employed in them, the scope of the identification including all activities from inception through de-commissioning. This is encompassed in the environmental Impact Assessment (EIA) which is defined as the systematic identification and eval-

uation of potential impacts (effects) of proposed projects, plans, programmes or legislative actions relative to the physico-chemical, biological, cultural and socio-economic complements of the total environment (Shridhar, 2001). The primary purpose of the EIA process is to encourage the consideration of the environment in planning and decision-making and to ultimately arrive at actions which are more environmentally compatible.

Industry operators maintain that they employ best practices in their operations and comply with existing laws (Adeyemi-Wilson *et al.* 1992; Ibanga, 1992; Udofoia, 2000). However, most of the documents that pass as EIAs are superficial and contextually implicit. Although these documents are supposedly reviewed by independent Review Panels, they are prepared mainly to satisfy project requirement as stipulated and paid for by Operators (Dadiwei, 2003). Spills are not reported as stipulated by the Environmental Guidelines and Standards for the

Petroleum Industry (EGSPI) and when they are reported, they are grossly understated and there are no serious penalties for polluting the environment. The oil communities have thus lost confidence in the ability of the Agencies of Government to enforce environmental protection guidelines. The perennial crisis in the Niger Delta Region is therefore, a result of the increased sensitivity of the oil communities to the degradation of their environment and the attendant pollution related problems and the suspicion that neither the oil industry nor government through its various Agencies are ready and willing to address these problems.

The New Approach

Realizing the inevitable conflicts that arise from exploitation of natural resources, the Rio Declaration on Environment and Development called for "the creation of new levels of cooperation among states, key sectors of societies and people" (United

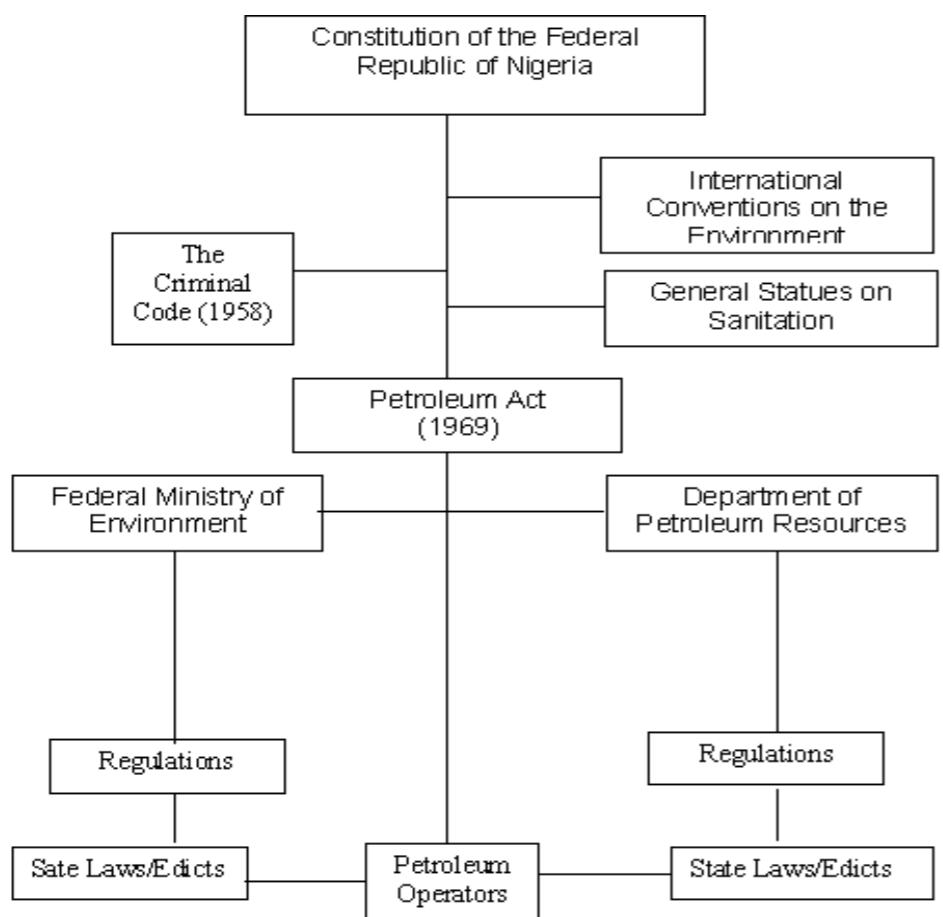


Fig.1 Statutory Framework for Environmental Policy in the Petroleum Industry Source: Orubu *et al.* (2002)

Table 1. Summary of Potential Environmental Impacts of Oil Industry Activities

Activity	Source	Potential Impact	Component affected	Comments
Aerial survey	Aircraft	Noise	H/At/B	Low-level flights, disturbance to humans and wildlife (consider seasonality).
Seismic operations (onshore)	Seismic equipment	Noise	H/At/B	Short-term, transient.
	Base camps	Noise/	H/At/B	Short-hole drilling; acoustic sources (vibrations, explosions); disturbance to humans and wildlife (consider seasonality). Short-term and wildlife.
				Low level noise and light from camp activities light disturbance to local environment. Short-term, transient.
Access/		H/B/Aq/T		Vegetation cleared; possible erosion and changes in footprint surface hydrology; immigration of labour; waste disposal, effluent discharges (sewage), emissions from power generation; spillages; fire risk; land use conflict secondary impacts.
				influx/settlement through new access routes. Mainly short-term, transient. Potential long-term impact from access.
			H/B/Aq/T	Removal of vegetation, possible erosion, changes in footprint drainage patterns and surface hydrology; secondary impacts-influx/settlement through new access routes. Mainly short-term and transient. Long-term potential impact from access.
Seismic operations (offshore)	Seismic equipment	Noise	B	Acoustic sources, disturbance to marine organisms (may need to avoid sensitive areas and consider sea sonality). Short-term and transient.
	Vessel and discharges	Emissions	At/Aq/T	Atmospheric emissions from vessel engines to ocean; bilges, sewage, spillages, waste and discharges garbage disposal to shore. Low level, short-term, transient.
operations				Interaction with other resource users (e.g. fishing). Short-term, transient.
Exploration and appraisal	Roads	Interference	H	Vegetation cleared; possible erosion and changes in surface hydrology, emissions vibration and noise from earth moving equipment, disturbance of local population and wildlife. Secondary impacts related to influx and settlement
		Access	H/At/B/Aq/T	through new access routes. Mainly short-term, transient impacts. Potential long-term impacts from access construction.
				Requirement for proper site selection to minimize possible impact. Removal of vegetation and topsoil; possible erosion and changes in surface hydrology; drainage and soil contamination; land use conflict loss of habitat; construction noise, life, aesthetic visual intrusion. Short-term provided adequate decommissioning
				and rehabilitation is conducted.
				Camp and operations
				Waste
	Discharges	Footprint	H/At/B/Aq/T	Water supply requirements; noise, vibration and emissions from plant equipment and transport; extraneous light; liquid discharges - muds and cuttings wash water, drainage; soil contamination - mud pits, spillages, leakages; solid waste disposal; sanitary waste disposal sewage, camp grey water; emissions and discharge from well test operations; additional noise and light from burning/flare.
	Emissions			Disturbance to wildlife. Short-term, transient.

H = Human, socio-economic and cultural; T = Terrestrial; Aq = Aquatic; At = Atmospheric; B = Biosphere

Continued...

Socio-economic Cultural H Land-use conflicts, disturbance and interference to local population, special considerations required for native and indigenous population; interactions between workforce and local population; immigration; potential effects on local infrastructure - employment, education, roads, services; hunting, fishing, poaching.

Decommissioning and Footprint H/B/Aq/T Proper controls during construction and operations and careful decommissioning and aftercare should effectively remove risk of long-term impacts. Impacts after care controls can result in soil and water contamination; erosion and changes in surface hydrology; wildlife disturbance; loss of habitat; impacts to bio-diversity, human and cultural disturbance; secondary impacts to socio-economic infrastructure; immigration, changes in land and resource use. Short-term, transient.

Exploratory and appraisal drilling (offshore) Site selection Interactions H/B/Aq Consider sensitivities in relation to biota, resource use, cultural importance, sea sonality. Secondary impacts related to support and supply requirements and potential impact on local ports and infrastructure.

Operations Discharges Emissions H/At/B/Aq/T Discharges to ocean - muds, cuttings, wash water, drainage, sewage, sanitary and kitchen wastes, spillages and leakages. Emissions from plant equipment; noise and light; solid waste disposal onshore and impact on local infrastructure. Disturbance to benthic and pelagic organisms, marine birds. Changes in sediment, water and air quality. Loss of access and disturbance to other marine resource users. Emissions and discharges from well test operations, produced water discharges, burning and flare; additional noise and light impact. Short-term and transient. Effects of vessel and helicopter movements on human and wildlife.

Decommissioning and water contamination, damage to benthic and pelagic habitats, organisms, biodiversity. Onshore in terms of solid waste disposal, infrastructure and re-development Roads Access H/Aq/B/T Long-term occupation of sites requires access to facilities. Long-term loss of habitat and land use, possible barriers to wildlife movement, increased exposure to immigration & secondary effects, long-term effects from vegetation clearance, erosion, changes to surface hydrology, introduction of barriers to wildlife movement. Increased disturbance from transportation, traffic volumes, density, impact on local infrastructure, disturbance to local population and wildlife. Long-term and consultation.

Site preparation Footprint H/At/Aq/B/T Long-term occupation of sites requires permanent facilities. Permanent facilitates require increased size of site, increased footprint, more intensive construction methods. Long-term effects from

H = Human, socio-economic and cultural; T = Terrestrial; Aq = Aquatic; At = Atmospheric; B = Biosphere

Continued...

UDOH AND AKPANIKA

Socio-economic Cultural H Land-use conflicts, disturbance and interference to local population, special considerations required for native and indigenous population; interactions between workforce and local population; immigration; potential effects on local infrastructure - employment, education, roads, services; hunting, fishing, poaching.

Decommissioning and Footprint H/B/Aq/T Proper controls during construction and operations and careful decommissioning and aftercare should effectively remove risk of long-term impacts. Impacts after care controls can result in soil and water contamination; erosion and changes in surface hydrology; wildlife disturbance; loss of habitat; impacts to bio-diversity, human and cultural disturbance; secondary impacts to socio-economic infrastructure; immigration, changes in land and resource use. Short-term, transient.

Exploratory and appraisal drilling (offshore) Site selection Interactions H/B/Aq Consider sensitivities in relation to biota, resource use, cultural importance, sea sonality. Secondary impacts related to support and supply requirements and potential impact on local ports and infrastructure.

Operations Discharges Emissions H/At/B/Aq/T Discharges to ocean - muds, cuttings, wash water, drainage, sewage, sanitary and kitchen wastes, spillages and leakages. Emissions from plant equipment; noise and light; solid waste disposal onshore and impact on local infrastructure. Disturbance to benthic and pelagic organisms, marine birds. Changes in sediment, water and air quality. Loss of access and disturbance to other marine resource users. Emissions and discharges from well test operations, produced water discharges, burning and flare; additional noise and light impact. Short-term and transient. Effects of vessel and helicopter movements on human and wildlife.

Decommissioning and water contamination, damage to benthic and pelagic habitats, organisms, biodiversity. Onshore in terms of solid waste disposal, infrastructure and re-development Roads Access H/Aq/B/T Long-term occupation of sites requires access to facilities. Long-term loss of habitat and land use, possible barriers to wildlife movement, increased exposure to immigration & secondary effects, long-term effects from vegetation clearance, erosion, changes to surface hydrology, introduction of barriers to wildlife movement. Increased disturbance from transportation, traffic volumes, density, impact on local infrastructure, disturbance to local population and wildlife. Long-term and consultation.

Site preparation Footprint H/At/Aq/B/T Long-term occupation of sites requires permanent facilities. Permanent facilitates require increased size of site, increased footprint, more intensive construction methods. Long-term effects from

H = Human, socio-economic and cultural; T = Terrestrial; Aq = Aquatic; At = Atmospheric; B = Biosphere

Continued...

AN APPROACH TOWARDS EFFECTIVE MONITORING OF

vegetation clearance, erosion, changes in surface hydrology. Larger scale construction activities, noise, vibration, emissions related to earth works. Aesthetic impacts and impacts and visual intrusion. Proper site selection to avoid socio-economic, cultural due consideration of local/indigenous populations. Possible re-access, long-term occupation of land re-operations. Land-use conflicts. Visual and aesthetic intrusion.

Operations Discharges H/At/Aq/B/T Long-term occupation of sites and permanent production facilities lead to long-term and increased potential for impact. Increased demand on local infrastructure water supply, sewage, solid waste disposal. Increased discharges and emissions from: production processes (Waste water, produced water, sewerage and sanitary waste drainage); and power and process plant (waste gases, flaring, noise, vibration, light). Potential effects on biota, wildlife disturbance, habitats, biodiversity, water, soil and air quality. Increased risks of soil and water contamination from spillage and leakage.

Socio-economic H Long-term permanent presence of facilities and workforce; increased demand on local infrastructure, socio-economic and cultural impacts (labour force, employment, education, medical and other services, local economy), effects on indigenous populations. Land-use conflicts. Visual and aesthetic intrusion. Cultural Interactions H/B/Aq Long-term site selection based upon biological and socio-economic sensitivities and minimum disturbance. Risk of impact to sensitive species, commercially important species, resource conflict, access. Long-term support and supply base requirement and impacts on local port infrastructure.

Operations Discharges A/At/Aq/T Long-term, chronic effects of discharges on benthic and pelagic biota; sediment Emissions drainage, sewage, sanitary and kitchen wastes, spillage and leakage. Emissions from power and process plant and impact on air quality. Noise and light impact disposal and impact on onshore infra Socioeconomic- H Loss of access and resource use interactions. Local port, harbour and community Cultural

Source: Borthwick *et al.* (1997)

H = Human, socio-economic and cultural; T = Terrestrial; Aq = Aquatic; At = Atmospheric; B = Biosphere

Table 2. Operational Discharge Standards Prescribed by International Instruments

Convention	Legal basis	Produced water	Oily cuttings	Chemicals	Sewage/Garbage
OSPAR Convention 1992	Recommendation 1986; Decision 92/2	Average 40mg/L and production not more than 10g. of oil per Kg of dry drugs	For both exploration and production not more than 10g. of oil per Kg of dry drugs	Defines handling and disposal requirements for different chemicals. All discharges must be authorized	Treated sewage discharge prohibited < 4nm. from the coast. Untreated discharge permitted > 12nm. Disposal of garbage restricted Prohibited < 4nm. from the coast. Disposal of garbage restricted
Helsinki Convention 1992	Article 10, Annex IV; Recommendation 9/5	15mg/L (40mg/L if 15 cannot be met)	Not permitted in sensitive areas. Permitted elsewhere subject to a number of provisions	Chemical Use Plan required	N/A
Barcelona convention 1976	Mediterranean Seabed Protocol 1994 Articles 10, 11, 12	Average 40mg/L (Max < 100mg/L). 15mg/L limit for machinery drainage	100g/kg prohibited in specially protected areas.	Chemical Use Plan required	Prohibited < 4nm. from the coast. Untreated discharge permitted > 12nm. Disposal of garbage restricted
Kuwait Convention 1978	Kuwait Protocol 1989 Articles IX, X, XI	Average 40mg/L (Max < 100mg/L). 15mg/L limit for machinery drainage	Oil contamination minimization required		

Source: Borthwick *et al.* (1997)**UDOH AND AKPANIKA**

Nations, 1992). Specifically, Principle 10 of the Declaration notes that "environmental issues are best handled with the participation of all concerned citizens at the relevant levels" and that "indigenous people and their communities and other local communities have a vital role in environmental management and development because of their knowledge and traditional practices" (Principle 22).

There is therefore, the need to recognize and encourage non-governmental organizations (NGOs) and community based organizations (CBOs) to monitor the effect of industry operations in the area. Some of these organizations like Niger Delta Human and Environmental Rights Organization (ND-HERO), Environmental Rights Association (ERA), and Wetlands Environmental Protection Association working in concert with the media, will form an effective buffer between industry operators and the host communities. An added advantage is that, these bodies are more likely to be objective, less sentimental and militant in their assessment of situations. In this connection:

- If recognized and encouraged, these NGOs and CBOs could take active part in Environmental Impact Assessment for accuracy of prediction, transparency and credibility.
- There is need for international donors to support capacity building of the NGOs and CBOs to make them capable and effective in monitoring the changes in the environment to ensure compliance.
- The NGOs and CBOs should then collaborate with Agencies of government in post impact assessment of oil producing communities.
- These civil organizations could, therefore, ensure that neither the Government nor her Agencies are collaborators in the degradation of the Niger Delta Region.

On the other hand, if the oil companies have confidence in these groups and carry them along for the purpose of educating local people on issues concerned with environmental degradation or clean-ups

AN APPROACH TOWARDS EFFECTIVE MONITORING OF**Table 3.** Some Relevant Statutory Instruments of Environmental Policy in Nigeria

S/No.	Statutory Instrument	Objective/Remark
1.	Minerals Ordinance (1914) amended 1925, 1950, 1958	To prohibit the pollution of water courses in the process of mining and prospecting for any mineral, including petroleum.
2.	Oil Pipeline Act (1956) amended 1965	Provides among others, for the prevention of pollution of land and water resources as a result of petroleum and production activities
3.	Public Health Act (1958)	Provides Legal Framework for the preservation and management of public health
4.	Criminal Code (1958)	Provide legal framework for seeking redress from environmental dis-economies, among others
5.	Mineral Oils (Safety) Regulations (1963)	Provides framework for health, safety and environmentally- friendly exploration and production activities
6.	Petroleum Regulations (1967)	Provide framework for safe petroleum operations, including environmental protection
7.	Oil in Navigable Waters and Related Regulations (1968)	Prohibits discharge of oil into navigable water courses and other areas.
8.	Petroleum Act (1969) and Related Regulations	Major legislation on petroleum industry to date. Provides encompassing framework for the regulation of upstream and downstream petroleum activities so as to protect the environment
9.	Land Use Act (1978)	To reform existing land ownership rights through nationalization. Adequate and fair compensation to be paid for loss of surface rights. Provide statutory basis for the regulation of gas flaring in Nigeria
10.	Associated Gas Re-injection Act (1979), amended 1984, 1985.	
11.	Harmful and Toxic Wastes (Criminal Provisions) Decree No. 42 (1988)	Provides legal anchor for redressing the dumping of toxic and hazardous wastes.
12.	Federal Environmental Protection Agency (Decree No. 58, 1988). And related legislations	Provides a quasi legal framework for checking environmental crimes, and to set environmental standards for different pollutants.
13.	Industrial Pollution Abatement Regulations (1991).	To regulate the generation and disposal of industrial waste through the principle of environment
14.	Effluent Limitations Regulations (1991)	Provision of standards for industrial effluent discharge and emissions into the atmosphere.
15.	Environmental Impact Assessment Act (1992)	Provides statutory basis for EIAs, as a part of project development authorization process.
16.	Environmental Guidelines and Standards for the Petroleum Industry (DPR), 1991, 1999	Most comprehensive framework for environmental policy and management in the petroleum industry.

Source: Orubu *et al.* (2004)

after spills or on issues of adequate compensation for loss of properties and livelihood, there is no gainsaying that much of the crisis in the region would have been avoided.

CONCLUSION

Petroleum industry activities, if not always, have environmental consequences that result from activities inherent in the exploration, production, and processing of oil and gas. Therefore, where oil and gas development is permitted, all projects should be subject to rigorous environmental assessment,

monitoring and review by all interested stakeholders. What is required is the commitment of all stakeholders with the Nigerian government, at various levels, leading the way. The Nigerian government can motivate the stakeholders by providing, propagating and fostering the enabling fiscal, economic and social environments including the maintenance of a favourable legal framework that will support the process.

Thus far, public awareness and concern about our environment has been growing thereby prompting the Nigerian government to develop and/or revise

Table 4. Some Incidence of Industry-Community Clashes Due to Environmental Disequilibrium

Date	Location	Action	Reaction
1980	Mkpanak	Women and Youths barricaded the offices of Mobil workers and stopped ferry from berthing for 3 weeks protesting destruction and under development of their community	Only part of the demands were met before the people were dispersed forcefully.
1982	Arharwarien	Community was protecting after oil spill had polluted streams and ponds. The community had no pipe-borne water, electricity, hospital or postal service. The secondary school had no roof.	4 people killed in the protest when police opened fire to disperse crowd.
1987	Iko/Okorote	Villagers demonstrated against environmental pollution and lack of development. SPDC workers were stopped from working. 12 wells in Iko were shut down leading to loss of 9,000 bpd	Police were called in. They burnt 38 houses, looted property and molested women
1990	Ummechem	Women and youths barricaded the roads to SPDC offices	Police were called in. They destroyed 495 houses, 46 villagers were killed, many more wounded.
1993	Ogoni land	Villagers protested the destruction of farm crops by a pipe-laying company	Soldiers called to quell riot opened fire killing one woman wounding several others.
1999	Ogulagha	Youths demanding employment at SPDC Forcados Terminal	Shot at by soldiers. 19 deaths recorded; several others injured.
1999	Ikeremor Zion	Youths protesting failure of Chevron to honour MOU with community	Soldiers in Chevron Helicopters and sea trucks invaded the area, burning down houses. Several deaths recorded.

existing policies, laws, regulations, guidelines, and performance standards to ensure environmentally sound petroleum industry operations. The Nigerian government has the sole responsibility of setting the ground rules and providing the framework for appropriate industrial development while ensuring that our environment is adequately protected. In the same token, our petroleum industry professionals must work round the clock to ensure that the operations for which they are responsible are conducted in a sound environmental manner that complies with the laws and regulations of our country. In this regard, the petroleum industry management and their employees must understand the basic environmental regulatory structure of Nigeria and how it may evolve over the lifetime of the projects that they get involved in. Generally, a nation's regulatory cycle consists of four basic and interdependent elements, namely (Armstrong *et al.* 1999):

(i) Policy setting which involves establishing the basic principles and approaches for environmental protection generally codified in laws and regulations.

(ii) Implementation which involves establishing and implementing a permitting or licensing system that defines who is authorized to pursue specific activities and the terms under which those authorized activities can be undertaken.

(iii) Verification and monitoring which involve establishing and implementing a system to ensure compliance with required environmental practices and standards as specified by laws and regulations and by permits and licenses, and

(iv) Enforcement which involves establishing and implementing procedures and penalties to punish those who do not adhere to the established environmental requirements.

Adhering to this regulatory cycle along with the incorporation of NGOs, CBOs, ND-HERO, and ERA, etc, to monitor the effect of petroleum industry operations in the operational areas will go a long way to help promote the concept of "sustainable development" that is widely endorsed by many governmental and non-governmental organizations around the world as perhaps the primary framework for promoting economic development that is envi-

ronmentally sustainable and socially equitable.

REFERENCES

- Adeyemi-Wilson, O.A., Sagoe, K.O. and Bailey, J.P. 1992. Management and minimization of exploration and producing wastes in the petroleum industry in Aina, E.O.A. and Adedipe, N.O. (eds.) *The Petroleum Industry and the Environmental Impact in Nigeria. FEPA Monograph. 5* : 141-151.
- Ifelabajo, A.J. and Ibuzugbe, O. 2002. Environmental responsibility: A Panacea for operational disturbance in offshore West Africa. *Nig. SPE 26th Annual Int. Conf. Abuja.* 8-15.
- Kakulu, S.E. 1985. *Heavy Metals in Niger Delta: Impact of the Petroleum Industry on Baseline Levels.* Ph.D. Thesis, University of Ibadan.
- Kragha, P.U. and Adepoju, P.J. 1994. Community Problems and 3D Seismic in the Niger Delta. SPDC Experience. *NAPE Bulletin.* 9 (1) : 47-50.
- Kupolokun, F. 2007. Evolution of NNPC/Oil Industry and Challenges. *NNPC Mag.* 4 (3) : 7-11.
- NNPC, 2004. *The Nigerian Oil and Gas Industry.* 66p.
- Nwadiaro, C.S. 1993. Oil Mineral Production and Environmental Impacts - Some Issues for OMPADEC Attention in the Niger Delta System. *OMPADEC Quarterly Report.* 1(1) : 101-104.
- Nyanayo, B.L. 1999. *Vegetation in E.J.Alagon (ed.). The Land and People of Bayelsa State: Central Niger Delta.* Onyoma Publication, p. 27-38.
- Onosode, G. 2003. *Environmental Issues and Challenges of the Niger Delta: Perspectives for the Niger Delta Environmental Survey Process.* CIBN Press, Lagos. 185p.
- Orubu, C.O., Odusola, A. and Ehwarie, W. 2004. The Nigerian oil industry: environmental diseconomies, management strategies and the need for community involvement. *Jr. Hum. Ecol.* 16 (3) : 203 -214.
- Reijers, T.J.A., Petters, S.W. and Nwajide, C.S. 1997. The Niger Delta Basin. In Selley, R.C. (ed.) *African Basins. Sedimentary Basins of the World,* p. 151-172.
- Selley, S.C. 1985. *Elements of Petroleum Geology.* Academic Press. San Diego, CA. 470p.
- Shridhar, M.K.C. 2001. Environmental Impact Assessment (Human Health Effects). Invited paper presented at the *National Workshop on Environmental Impact Assessment.* Centre for Environmental Protection & Natural Resources (CEPNAR), University of Ibadan, Nigeria.
- Sonibare, O.O. and Ekweozor, C.M. 2001. Distribution of pentacyclic triterpenes & sterane in relation to the origin & thermal maturity of crudes from the Niger Delta Nigeria. *Jr.of Mining and Geol.* 37(1) : 37-43.
- Udofia, J. R. 2000. Management of environment, health and safety for sustainable development of the Nigeria Upstream Petroleum Industry. *Proceedings of the 30th Annual Conference of the Nigerian Society of Chemical Engineers.* 1-10.
- United Nations 1992. Report of the United Nations Conference on Environ.& Development. Conf.151/26 Vol.1.
- Zylstra, S.J. 1997. *A Framework for Measuring Ecological Status and Trends Ch. 4 in P. N. Cheremisinoff (ed). Ecological Issues and Environmental Impact Assessment.* Gulf Publ. Co. Texas, p. 101-143.

INDIA'S ONE OF THE MOST LEADING SCIENTIFIC JOURNALS

POLLUTION RESEARCH
(Quarterly) ISSN 0257-8050

Editor

DR. R.K.TRIVEDY
Pune

POLLUTION RESEARCH is one of the most established and Internationally known environmental journals of India. Established in 1982, the journal is now widely subscribed and referred. It publishes research papers on all aspects of pollution and its control. Prominent topics are Air pollution, Water pollution, Soil pollution, Waste water treatment, Noise pollution, Solid waste, Environmental laws, Risk assessment, Eutrophication, Aerobiology radiation hazards, Occupational health, Biomonitoring are some of the topics covered in the Journal. Book reviews, Information about National and International events are also published.

POLLUTION RESEARCH is abstracted in Chemical Abstracts, U.S.A. Cambridge Science Abstracts, U.S.A., Ecology Abstracts, U.S.A., Pollution Abstracts, U.K., Paryavaran Abstract, India, Environmental Abstracts, India and Current Contents.

POLLUTION RESEARCH publishes a minimum of 180 quality research papers' in a year and is widely quoted all over the world.

SUBSCRIPTION RATES

INDIA	One year
Individual	1000.00
Organisation	1800.00

For subscribing the journal, please send the necessary amount by DD/MO in favour of

EM INTERNATIONAL
C-101, Prakratii, Balewadi, Baner, Pune - 411 045, M.S., India
 : 020 27210103; 09326712474
E-mail : str_rktem@sancharnet.in; rktem@pn3.vsnl.net.in