

*Full Length Research Paper*

# Environmental audit of a refuse dump site in the Niger Delta Region of Nigeria

Owoeye I. O. Gani<sup>1\*</sup> and Okojie O. H.<sup>2</sup>

<sup>1</sup>Department of Community Health, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.

<sup>2</sup>Department of Community Health, University of Benin, Benin City, Edo State, Nigeria.

Accepted 7th January, 2013

**The overall objective of this study was to perform an external compliance environmental audit of open refuse dumping at the Ugbor dump site by describing the physical and economic characteristics of the study area using a descriptive, cross sectional comparative study design. Data were collected via key informant interviews, focus group discussion, checklists and standardized measuring tapes. The major operational deficiencies identified were poor sanitation practices within and around the refuse dump site, inadequate manpower to oversee the day to day activities of the dump site and lack of equipment necessary for clean-up activities within the refuse dump site. The refuse dump also lacked antipollution equipment for detoxification of effluents, gas recovery systems, firefighting equipment, buffer zones and there was no fence around the dump site. A waste handler at the Ugbor refuse dump site does not require formal education; individuals learn on the job and are susceptible to disease conditions. Environmental audit revealed that Ugbor refuse dump site is out of compliance with the guidelines of the Federal Environmental Protection Agency of Nigeria and now poses public health risks and aesthetic burden to the citizens it meant to serve.**

**Key words:** Ugbor, Edo, environment, audit, morbidity, survey.

## INTRODUCTION

The rapid rate of uncontrolled and unplanned urbanization in the developing nations of Africa has caused changes in the environment, particularly that of generation of waste materials (Onibokun, 1999). The increasing production of waste materials has been a by-product of excessive population, poor domestic waste management systems, industrialization, lack of adequate funding, lack of trained / professional waste managers, absence of effective monitoring / control measures, lack of modern technology / lethargy in implementing efficient waste management methods (Fobil et al., 2002). Factories produce waste during manufacturing, mining and agriculture generate leftovers that must be disposed of, containers and packaging used and discarded in everyday life become waste. In the middle ages, garbage

and other refuse materials were thrown onto unpaved streets or vacant spaces. This unsanitary practice created a fertile environment for diseases transmitted by insects and rodents. The "black death" epidemic of the 14th century killed nearly half the population of Europe. Despite repeated epidemics, it was not until the middle of the 19th century that the relationship between improper waste disposal and public health was recognized and laws regulating the dumping of trash into water or onto land were enacted (Britannica Student Encyclopedia, 2006).

The law on the management of wastes in Nigeria has gradually emerged from solely focusing on basic environmental sanitation regulation and is in the process of transforming into a more comprehensive legislation that addresses other environmental management issues (Okediran, 2004). Legislations at the Federal level of government which address and regulate the generation, collection and disposal of industrial wastes include: The Federal environmental protection Act, 1988 (Decree No.

\*Corresponding author. E-mail: [ganigbenga@gmail.com](mailto:ganigbenga@gmail.com). Tel: +234-808-059-3531.

19 of 1992 as amended by FEPA), National Environmental Protection (effluent limitation) Regulations (1991), National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations 1991 and Environmental Impact Assessment Decree of 1992. In recent times, the number of State legislations on environmental protection has increased significantly. These State Laws or Edicts as they are currently described make general provisions for the control of certain environmental issues such as refuse disposal and other sanitation matters such as cleaning of gutters, drainages, enhancing the aesthetic quality of the environment, tree planting, etc. In other words, most of these legislations attempt to make provisions geared towards improving the environmental quality of the States in consonance with the objective of the policy on Environment and FEPA Act (Okediran, 2004). A closer perusal of these laws reveals that they concentrate on domestic wastes control and hardly address industrial waste management issues.

A few exceptions exist, however, such as in Lagos State which has been the consistent fore-runner in enacting pollution control laws and ensuring policy implementation (Okediran, 2004). The National Environmental Standards and Regulation Enforcement Agency (NESREA) Act of 2007 replaced the Federal Environmental Protection Agency (FEPA) Act. The Edo State government's response to poor waste collection and disposal conditions was the establishment of the Edo State Environmental Sanitation Task Force. The task force is essentially a quasi-military enforcement outfit that often uses police/soldiers to enforce compliance with state government environmental edicts, particularly those relating to environmental sanitation days, roadside trading and refuse clearance from public places such as markets (Ogu, 2000). Therefore, there is need for an efficient system for the periodic collection, removal and final disposal of waste without risk to health. There is no single method of refuse disposal which is equally suitable in all circumstances and the choice of a particular method is governed by local factors such as costs, availability of land and labour (Bopardikar, 2000). Reliable data regarding waste disposal are very few. For developing countries they are hardly gathered at all while in developed countries the tendency is to dispose of municipal waste in sanitary landfills or by incineration.

In developing countries, incineration is rarely undertaken because of its expense. Instead, collected waste are disposed off in controlled (unconfined) landfills, or, more frequently, dumped on the streets, in backyards or drainage ditches, buried in gardens or burnt in open fires (WHO, 1997). Waste treatment and disposal sites have the potential to create health hazards for neighboring populations when they are not properly sited. It can be a source of infection and it is an important cause of environmental pollution (Bopardikar, 2000; WHO, 1997). Landfills are a source of fires, dust, smoke, noise and disease from vectors such as insects, rodents and stray

animals. They may also pollute drinking water sources by infiltration of leachate or run-off (WHO, 1997). These are not only a burden on the community in terms of sickness, mortality and a low life expectancy, but a basic deterrent to social and economic progress (Bopardikar, 2000). Environmental audit is a process to review the effectiveness of environmental management. It is defined as a periodic, objective and documented assessment of an organization's operations compared to audit criteria. Audit criteria may be compliance requirements such as regulations or may be management practices that benefit the environment (United States Environmental Protection Agency, 2000). It is useful to think of an audit as a diagnostic exam and operations "tune-up."

By conducting the exam, a project gains a better understanding of where its operations stand compared with specified criteria, such as compliance and management systems. Like other "tune-ups," an audit should be performed periodically or whenever needed. The ultimate objective of this audit was to improve environmental compliance and management, and to build supporting programs appropriate for environmental compliance requirements.

## MATERIALS AND METHODS

The study area Benin City, capital of Edo state, located in the oil rich Niger Delta Region of Nigeria. There are eighteen local government areas (LGAs) in the state and it has an area of 17,802 km<sup>2</sup> and an estimated population of 3,218,332 people (Federal Republic of Nigeria, 2007). Ugbor community is located within Oredo Local Government Area, in the North-eastern part of Edo State. The population figure for Ugbor community was not available as at the time of this study but Oredo had a population of 374,671 inhabitants (Federal Republic of Nigeria, 2007). Initially, a squatter settlement, Ugbor is rapidly growing to become a viable commercial and residential area, boosting the presence of the Benson Idahosa University, numerous primary and secondary schools mostly privately owned, a number of privately owned clinics/hospitals and various shopping outlets.

### Study design

This was a descriptive cross-sectional study. The scope of the study included a transect walk through to obtain data in order to describe the physical, socio-economic characteristics of the study area and information was collected via checklist, field survey measurements, key informant interviews and focus group discussion.

### Checklist

This was applied in a walk-through survey; direct observation using a simple checklist prepared by the researcher. The main issues assessed included: Housing (types, occupancy and quality), distance of the housing units to the dump site, water source and methods of refuse disposal / sanitation. An external compliance audit of the dump site was conducted using a checklist prepared by the researcher which contained regulatory criteria obtainable in the laws of the Federal and State Environmental protection agency (FEPA, SEPA) of Nigeria, and other non-regulatory criteria. The major issues addressed by the audit checklist include: presence/

absence of 'buffer' zones, presence / absence of safe limits for location of wells and boreholes, established monitoring programmes including periodic surveillance, presence of antipollution equipment for detoxification of effluents and chemical discharges as well as gas recovery systems.

### **Key informant interviews**

In-depth interviews of the deputy director of the department of environment, Oredo LGA, Edo State and the assistant Director, Pollution Control Unit, Edo State Ministry of Environment about the refuse dump site were undertaken. The researcher formulated study questions relating to specific concerns of the study after which an interview guide was constructed listing issues to be covered under each study question; open-ended questions were used. After each interview, the result of the discussion was transcribed using the guide questions in recording the responses.

### **Focus group discussion (FGD)**

The FGD was used by the researcher to carry out checks on public attitude towards the refuse dump site. The method brought together a total of seven participants; these were six representatives of the waste handlers and the researcher. The waste handlers were selected by the researcher from those present at the refuse dump site to discuss the topic in order to provide deeper perspective on the problem while the researcher served as the facilitator for the FGD. A content analysis was performed for qualitative data.

### **Ethical consideration**

Approval for this work was granted by the University of Benin Teaching Hospital Ethical Committee while informed consent was obtained from each individual respondent.

### **Limitations of the study**

Some other works which would have enriched the outcome of this work such as borehole water analysis and air sampling of the refuse dump site were not done due to financial constraints.

## **RESULTS**

The landfill site was established in 1984, following excavation by a construction company in order to obtain sand for the construction of the Benin-Sapele-Warri road. The size of the initial excavation was rapidly increased by the activity of the local residents who cashed in on the opportunity, turning the site into a burrow pit for the sale/purchase of sand for construction purpose. The site has been managed by Oredo Local Government since inception even though it has been declared an illegal dump site due to unsanitary methods of refuse disposal. The excavation is roughly oval in shape though the sides currently have the shape of an irregular rectangle measuring approximately 222 x 234 m. The landfill site is approximately 6.7 m (22 ft) from the closest uncompleted building and approximately 6 m (20 ft) from the closest completed and inhabited building. The refuse dump site is registered with the Edo State Ministry of Lands and

Survey but without established buffer zones. There was no limit established for the location of wells and boreholes. Although, periodic surveillance of the dump site is undertaken, there are no monitoring programmes on ground for the site. The refuse dump also lacked:

- i) Antipollution equipment for detoxification of effluents;
- ii) Gas recovery systems;
- iii) Firefighting equipment;
- iv) Regulation of dumping activities.

There was no fence around the dump site. Sanitary landfill is the most satisfactory method of refuse disposal where suitable land is available. Initially, the Oredo refuse dump site was a suitable area. The Deputy Director Department of Environment, Oredo Local Government Area, Benin City revealed that:

*"Historically, the Oredo dump site was established in 1984 and was approved by the Edo State Ministry of Lands and Survey and the initial purpose it was meant to serve was that of land reclamation by the Local Government authority of Oredo through sanitary land filling. By then, it was very ideal because it was in the outskirts of town".*

The Deputy Director also revealed that, prior to the official closure of the refuse dump site, the LGA authority paid an undisclosed monthly sum to the State Government for the 'dressing' of the dump site which was 'expected' to be done monthly using heavy equipments (bulldozers and graders). In his words:

*"But you know now, the Nigeria factor are there. So, the dressing is not done every month. Also, the dressing is interrupted during heavy rains where accessibility to the dump site is hindered by massive flooding..... The major road leading to the dump site is tarred and paved and was constructed by the State Government but the feeder roads are yet to be constructed. This is why the place smells during rainy season".*

Further insight was gained on the role of the State Government on refuse disposal in Edo State in another interview with the Assistant Director, Pollution Control, Edo State Ministry of Environment. He stated that:

*"The Local Government under ideal circumstances is responsible for the management of refuse within the State. The Government of Edo State however, had to intervene in refuse management within the State due to deficiencies identified by the State Government, in the waste management practice of the Local Government and other private waste managers".*

The major deficiencies identified by the assistant director were: Poor sanitation practice within and around the refuse dump site, inadequate manpower to oversee the day to day activities of the dump site and lack of

equipment necessary for clean-up activities within the refuse dump site. To buttress the efforts of the State Government, he commented that, the State Government attempted technical support with the use of heavy duty equipment. Later on, a site supervisor was posted to the dump site to oversee its daily activities. According to the Assistant Director,

*“The site supervisor did not deliver!” He was supposed to collect revenue from private waste managers who used the refuse dump site and remit a certain amount to the State Government through its Ministry of Environment and these proceeds were intended to enhance operation and finance of activities at the dump site”*

The Assistant Director was particularly worried and said that:

*“The main problems are those from air pollution and ground water contamination by leachate. Although, we are aware of the Federal and State laws of the environmental protection agency regarding waste management and pollution control, it is difficult to enforce these laws mostly due to logistic problems and bureaucratic bottle necks. The refuse dump site was officially declared closed to use in the first quarter of 2007 due to its close proximity to residential premises. This official closure did not take effect until November of 2007 following the visit of the Edo State Special Administrator for Environmental and Waste Management.... No decommissioning exercise was carried out”.*

On the surface, the response to the question about qualification necessary to become a waste handler elicited a good round of laughter from the participants. As one of the waste handlers exclaimed:

*“Working here is due to the present economic situation. I would also like to have a white collar job. This is our own school, you can see primary one over there” (pointing to a set of new handlers).*

On the other hand, another waste handler commented that:

*“If not for the exposure to broken bottles, snakes that chase us (he chuckles) and the free smoke we inhale here, this work is not bad. I have worked as a laborer before earning a mere one thousand five hundred naira in a whole day but here, I make more than that before noon. I am my own boss and can decide when to come to work”.*

All these signify that the job of a waste handler at the Ugbor refuse dump site does not require a formal education and individuals learn on the job. When asked then about enrollment and their mode of operation, one waste handler responded that there is an unregistered association of the private waste handlers headed by an

elected chairperson. Intending members which could be a male or female, usually pay him homage by buying a bottle of ‘hot drink’ after introduction by an existing member and members pay a certain undisclosed amount as monthly dues. When asked of the purpose of their organization, another waste handler said that the main purpose of this organization is for negotiation with Government and the resolution of conflict within and outside the organization. The organization was said to have made huge financial contribution towards the acquisition of the automatic rear loading collection vehicles with the aim of joint partnership with the state government; a situation that led to series of conflict after the purchase of the vehicles and as such, the expected partnership in refuse collection between government and the private waste managers failed.

When asked about the legality of their operations, all of the waste handlers claimed to have paid monthly registration fees to the State Waste Management Board and as such their operations were legal. Some of the questions and general responses were as follows:

*Waste handler: We also pay that agent (pointing to the individual), before our waste trucks are allowed to pass.*

*Researcher: How much do you pay?*

*Waste handler: It depends on the type and capacity of the truck; the bigger the truck, the higher the charge.*

*Researcher: Which kind of trucks do you use to carry the waste?*

*Waste handler: Any truck that has space at the back.*

Waste collection is performed with trucks of varying sizes capable of taking cargo (no special design necessary); although, the refuse collected is covered by jute bags during the process of transportation to prevent littering of the streets. On the contents of the trucks, the handlers responded that the contents depend on the areas from which they are collected and include waste from homes, hospitals, markets, farms (including dead animals) and other small scale manufacturing industries like ‘pure water’ factories. Says one handler:

*“We get a lot of things here like cooking pots, bed, plate, cup, spoon, shoe, bag or office things like typewriter but the best are plastics or aluminum. They buy plastics or aluminum faster.*

*Researcher: Who buys them?*

*Waste handler: People come here to buy and sell to companies that need them.*

Although, the Ugbor dump site is not meant for the burial of dead humans, there were cases where human skeletons have been retrieved by scavengers.

Another waste handler revealed that the site was used as an execution ground for armed robbers during the military era of the mid 1980s and the bodies of the executed persons were left to decompose without proper burial usually in very shallow graves. Some of the residents

mostly of the lower socio-economic class who cannot afford proper burial for their dead relatives have at such instances buried them in graves located towards the centre of the dump site. When asked about the required personal protective apparels, the participants all agreed that boots and hand gloves were important although they are not worn all the time and some of them do not have. They all agreed that they are susceptible to disease conditions although one waste handler disagreed, saying that the work at the 'burrow pit' has made him stronger and his system more resistant to disease. They reported that, there have been cases of snake bite at the dump site as well as cuts from sharp objects for which treatment was sought either in the Central Hospital Benin City or from traditional medical practitioners.

Additional information revealed by one of the waste handler is that they sometimes have to set a part of the refuse ablaze to ease search especially where their 'treasure' is covered in dried leaves or other unwanted materials. Although, aware of the environmental pollution the dumpsite causes, majority of the waste handlers are of the opinion that the purpose for refuse dump at the site (that of reclaiming the land) would not be achieved following its closure and suggested that government play its part of covering the refuse with earth on a regular basis as the refuse is dumped to minimize pollution.

## DISCUSSION

A landfill is a place to dispose of refuse and other waste material by burying it and covering it over with soil, especially as a method of filling in or extending usable land. Technically, the construction of a landfill involves soil investigation, the construction of liners, sub base preparation, clay liner specifications, clay side liner specifications, cap and liner protection and repair, drainage layer or blanket placement and the placement of leachate collection transmission pipes (North Dakota Department of Health, 2007). The soil material to be used for the construction or installation of any backfill or subliner, subbase, clay liner, drainage layer, or landfill cap must be clearly identified and described in a soil investigation (North Dakota Department of Health, 2007). Documentation of each procedure becomes necessary to demonstrate that design or performance specifications have been achieved and a copy of such report submitted to the LGA. The Ugbor refuse dump site does not meet any of the technical requirements specified above. From the key informant interviews, it is clear that the initial intention was for the Ugbor refuse dump site to function as a sanitary landfill site. This intention failed for lack of adequate planning and little or no technological input prior to the commencement of dumping activities at the Ugbor refuse dump site. The site has functioned as an open dump site since inception. Although, the Oredo LGA is aware of their constitutional responsibility of refuse

management, the municipal budgetary allocation for operation and maintenance of the Ugbor refuse dump site is grossly inadequate.

The suggestion by officials of government during the key informant interview for zoning of the entire Oredo LGA should be applauded as a step in the right direction. The need for a paradigm shift from present wastes collection for total disposal approach to a Total Wastes Management (reduce at source, reuse or recycling system) of municipal solid waste and farmyard manure as a management solution for Nigeria has been identified in a previous study (Adewumi, 2004). Houses or premises in a city would be divided into management zones to be serviced by a municipal solid waste processing plant and it has been shown that such decentralized municipal solid waste management zones had been in use and effective in the pre-independent and early post-independent Nigeria especially in the old Western Nigeria. Such zones then had an incinerator constructed by Health officials as the main management facility. Instead of incinerators, the new municipal solid waste management facilities would have a refuse sorting machine and storage facilities for sorted paper, glass, metals, plastics and facility for biodegradable wastes that constituted the bulk of the wastes in this study. Whatever cannot be recycled or reused or converted to some other useful products would be taken to a final disposal site. Invariably, such rejects would have a negligible volume compared with the initial volume of wastes entering the processing plant (Adewumi et al., 2005).

It is obvious from the Focus Group discussion that the Ugbor refuse dump site is a major source of livelihood for a lot of individuals particularly those who were unskilled and without formal education. Some of these workers are happy with what they do particularly because they see it as self-employment and it offers them flexibility with their time. However, to aid their search, scavengers often set the perimeters of the refuse dump site ablaze causing emission of gases in a large cloud of smoke. Although, air sampling analysis were not done in this study, previous research show that landfill gas has a number of trace volatile organic compounds, some of which are potentially toxic (dichloromethane) and carcinogenic (benzene and vinyl chloride). A correlation was found between pulmonary disease and refuse dump in Portharcourt, Nigeria. Airborne pollutants and noxious gases produced from refuse dumps contribute to the increase in pulmonary diseases among the populations near dump sites (Ayotamuno and Gobo, 2004). A critical review of the North American literature indicated that headaches, wheezing, sleepiness, narcotic symptoms and mood disorders occur among residents living proximal to a landfill (Croen, 1998). By reducing the oxygen content of air from the normal of 21% to below 17%, asphyxiation can occur. While the causal agents are not known, low oxygen levels could be one cause. Methane and carbon (iv) oxide are some of the greenhouse gasses

released by anaerobic bacteria activities on refuse dumps and methane is about 21 times more potent greenhouse gas than carbon (iv) oxide. The earth absorbs incoming solar radiation and tries to cool by emitting long wavelength infrared radiation. This radiation is absorbed by greenhouse gases preventing its escape into space causing a net increase in mean annual temperature; the phenomena of global warming (Rosenzweig et al., 1998). This may cause climatic changes, alter weather pattern and influence the length of seasons. These are not without serious consequences to man's health; for instance, shorter rainy seasons or longer dry seasons may mean poor crop harvest and yield and poor household food security.

During the FGD, majority of waste handlers agreed that boots and hand gloves were important although they are not worn all the time. Solid waste collection workers in high-income countries routinely wear gloves to handle the dirty containers where solid wastes are stored, and are seldom directly in contact with waste itself. Conversely, in developing countries, solid waste workers and waste pickers routinely touch the waste they collect and/or sort through; and, because they typically are wearing only sandals, are stepping on waste. Parasitic and enteric infections are common, and, to a lesser extent, viral infections such as hepatitis and HIV infection occur. Comparable information is not available from developing countries, but the substantially greater contact between the solid waste worker and the waste in developing countries should create an even higher relative risk. The result of the checklist applied during the compliance audit assessment of the refuse site indicates a deficiency where the facility is currently out of compliance, now poses public health risks and aesthetic burdens to the citizens it meant to serve and requires enforcement action to avoid devastating health consequences on the neighboring population.

The purpose of an environmental compliance audit is to conduct periodic environmental examinations to determine if the Ugbor refuse dump site conforms to plan arrangements which have been properly implemented and maintained; and inform management of the results of the audits. Unfortunately, there is no audit guideline for the Ugbor refuse dump site neither is there any documented evidence of a previous compliance audit of the refuse dump site in the LGA.

## Conclusion

The Ugbor refuse dump site although initially intended for use as a landfill site, has functioned basically as an open dump site for refuse generated within and outside Oredo Local Government Area where it is located. Although, it offers employment to individuals who handle waste, it has been poorly managed by the Oredo Local Government Area as evidenced by results of the key informant interviews and external environmental compliance audit.

## RECOMMENDATIONS

### State Government

i) The State Government should look into proper disposal methods for waste from hospitals and other environs that will predispose workers to infectious diseases. Those kinds of waste should be disposed off in a different method preferably by incineration at source.

### Local Government

i) The Local Government Council should back the closure of the dump site with legislature outlining punitive measures to be taken against offenders.

ii) Invite experts in community health and related fields for a proper decommissioning, remediation of the dump site and possibly wall it off by fencing from the immediate neighboring population.

iii) Establish a well-engineered sanitary landfill in some other safe zone within the local government. The possibility of an integrated approach to waste management should be exploited.

iv) Among the changes that may take place is a "pay as you throw" fee for use of the new landfill. Such practices can result in a considerable reduction in the amount of waste that is produced by individuals. On the average, when a "pay as you throw" system is put in place, the amount of garbage added to landfills will decrease.

### Community

ii) Members of Ugbor community should receive periodic scheduled Health education sessions on handling of waste, outlining the importance of proper storage and disposal. They should be encouraged to adopt practices in waste beneficial to their health.

ii) Community should be mobilized especially the youths, to prevent further waste dumping activities on the dump site as well as open defecation within the refuse dump site.

iii) Burning activities in Ugbor dump site should be totally eliminated with some form of punishment for offenders.

## REFERENCES

- Adewumi I (2004). Municipal solid wastes management: The need for a Paradigm shift. *Ife Environmentalist*. 1 (1): 1-2
- Adewumi IK, Ogedengbe MO, Adepetu JA, Fabiyim YL (2005). Planning organic fertilizer industries for municipal solid wastes management. *J. Appl. Sci. Res.* 1(3): 285-291.
- Ayotamuno JM, Gobo AE (2004). Municipal solid waste management in Port Harcourt, Nigeria: obstacles and prospects. *Management of Environmental Quality: An Int. J.* 15 (4): 389-398.
- Bopardikar MV (2000). Disposal of wastes. In: Park K, editor. *Park's textbook of preventive and social medicine*. 18th edition. Jabalpur: Banarsidas Bhanot. pp. 561-563.

- Britannica Student Encyclopedia. Garbage and refuse disposal (2006). Encyclopedia Britannica Premium Service [serial on the internet]; Available from: <http://www.britannica.com/ebi/article-9274492>.
- Croen LA (1998). Health effects from hazardous waste sites: A critical review of the Non-European literature. Lecture. California Birth Defects Monitoring Program.
- Federal Republic of Nigeria (2007). Official Gazette of the 2006 National Population Census. Lagos: Federal Government Printer. Volume 94, No. 24.
- Fobil JN, Carboo D, Clement C (2002). Defining options for integrated management of municipal solid waste in large cities in low income economies: the case of the Accra metropolis in Ghana. *J. Solid Waste Technol. Manage* 28(2):106-117.
- North Dakota Department of Health (2007). Quality assurance for construction of landfill and surface impoundment liners, caps, and leachate collection systems. Division of Waste Management. Available from: [www.ndhealth.gov/wm](http://www.ndhealth.gov/wm) 2007.
- Ogu VI (2000). Waste management in Benin City, Private sector Participation and municipal waste management in Benin City, Nigeria. *Environment and Urbanization*. 12 (2): 103 -117.
- Okediran AY (2004). The legal framework for industrial and domestic waste management in Nigeria. Tripod [serial on the internet]; Available from: <http://www.folakeokediran.tripod.com/id3.html>.
- Onibokun AG (1999). Managing the monster: urban waste and Governance in Africa. International Development Research Center IDRC Books [serial on internet]; Available from: [http://www.idrc.ca/en/ev-9402-201-1-DO\\_TOPIC.html](http://www.idrc.ca/en/ev-9402-201-1-DO_TOPIC.html)
- Rosenzweig C, Hillel D (1998). Climate change and the global harvest: potential impacts of the greenhouse effect on agriculture. *J. Agric. Environ. Ethics* 11(1):71-74.
- United States Environmental Protection Agency (2000). The small business source book on environmental auditing. Office of the administrator. Washington DC. pp 23
- WHO Environmental Health Newsletter (1997). Poor sanitation: the global magnitude of the problem. No. 27-supplement.