An Assessment of the Concentration of Heavy Metals in Surface Water within Akwa Ibom State, Nigeria

Robert Etim Ekpenyong
Department of Geography and Regional Planning University of Uyo, Nigeria

Abstract: *In this study, data on the concentration of heavy metals in surface water were extracted from existing Environmental Impact Assessment [EIA] reports and used for the assessment. Analyses of the datasets revealed that, the quality of some of the surface water have been degraded by excessive amounts of heavy metals. This is a threat to riverine ecology, food and water security. The paper concludes that because EIA studies and reports are usually based on standardized procedures and Methodologies and are usually carried out by experts/consultants in relevant fields as recommended by regulatory agencies and/or required by legislation and paid for by proponents/owners of projects, it is a cheap, cost-effective and reliable source of data for environmental monitoring and management.*

Keywords- *Heavy metals, surface water, Environmental Impact Assessment, food and water security*

I.   Introduction

Surface water constitutes one of the major sources of water supply for domestic use in most rural communities in addition to rainwater. This is partly because of the high cost of getting groundwater through the construction of boreholes and hand dug wells. In recent times however, there have been concerns about the safety and security of surface water for human consumption, following reported cases of excessive amounts of heavy metals, certain radioactive isotopes, phosphorus, nitrogen, sodium, and several bacteria in surface water which by nature are injurious to human health and threat to food security.

Of all these pollutants, this study focuses on heavy metals because of the numerous effects on vital organs of the human body. Generally, some heavy metals namely-Cobalt [Co], Copper[Cu], Chromium[Cr], Magnesium[Mn], Nickel[Ni] are necessary for humans in minute amounts while others like Magnesium[Mn], Mercury[Hg], Lead[Pb], Arsenic[As], Cadmium[Cd] are toxic, affecting among others, the central nervous system; the kidneys or liver (Hg, Pb, Cd, Cu) or skin, bones or teeth (Ni, Cd, Cu, Cr), heart disease, cancer and diabetes (fe). Furthermore, excess mercury in water can lead to loss of muscle control, kidney disease & brain damage. Over exposure to nickel has been found to decrease weight, irritate skin & cause heart and liver damage (Maduka, 2006; Obodo, 2002; Kosneth, 2001).

It is obvious from the foregoing that, the concentration of heavy metals in water needs to be monitored on a more regular basis [probably on monthly basis] because of human and indeed environmental health. Unfortunately this is not usually the case partly because of cost. This study shows that, EIA reports are a cheaper and cost-effective source of data for environmental monitoring and management. It is used in this study as the source of data for assessing the concentration of heavy metals in surface water within Akwa Ibom State, Nigeria.

II.   Materials And Methods

2.1   Location of the Study Area
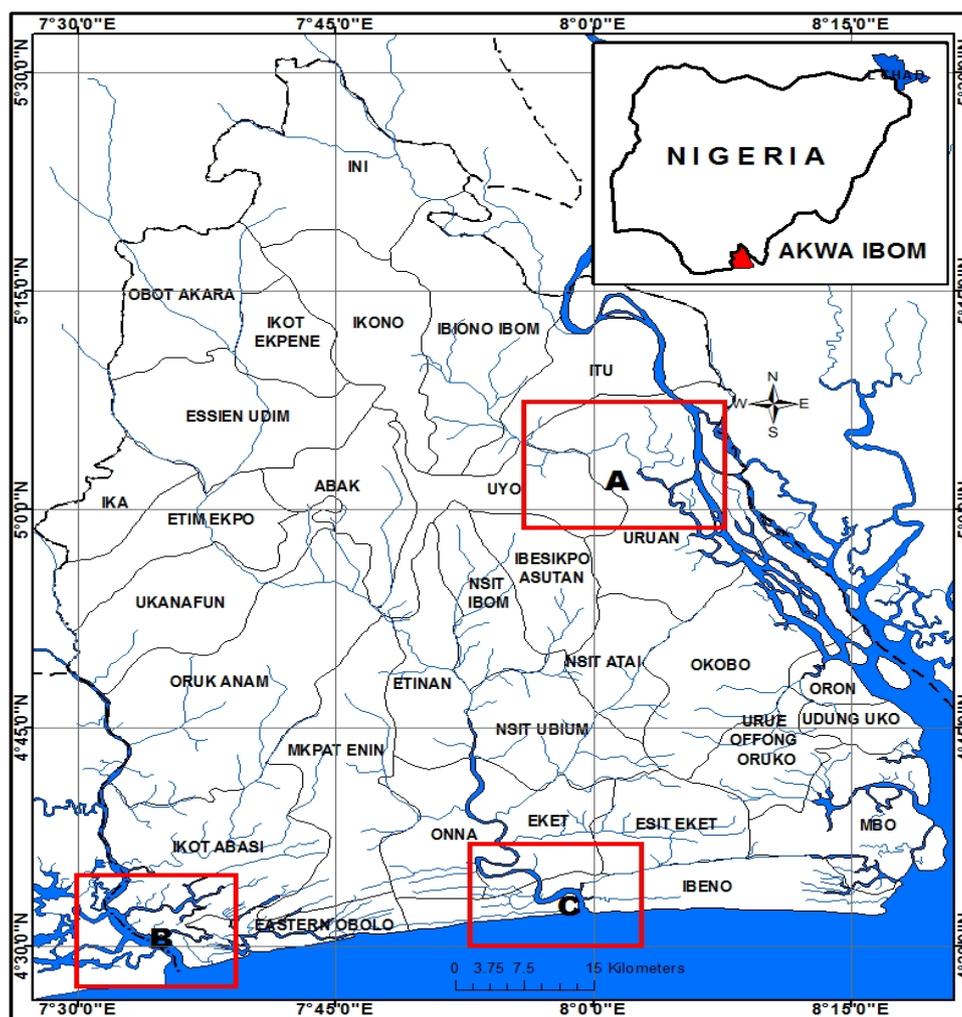
Fig. 1. Locations of the Study Areas in Akwa Ibom State, Nigeria

Akwa Ibom State is situated in South Eastern Nigeria. It lies between latitude 4^030^0 and 5^030^0N and long 7^030^0 and 8^015^0E (Fig.1). Mean annual rainfall over the area decreases gradually from about 4050mm near the coastal area (the southern part) to about 2100mm in the north. The area is noted for its wetlands, brackish or saline mangroves, fresh and salt-water swamp forests as well as low land rain forest.

The entire area is drained by three river systems namely: - Ikpa river/Cross river [sample location A], Imo river [sample location B] and Kwa iboe river[sample location C]. Water samples were taken from the estuaries of Imo, Kwa iboe and Ikpa river for analysis by experts working for companies that were involved in the EIA. Sample location 'A' was chosen because of closeness to Uyo capital city-the largest and most important center of human activities in the area. Locations 'B' and 'C' are industrial locations [ALSCON and EXXON MOBIL respectively].

2.2   Assessment of the Usability of Data from EIA reports

Environmental impact assessment (EIA) is an important procedure for ensuring that the likely effects of new human development activities on the environment are fully understood and taken into account before the development is allowed to take place. EIA is a procedure which relies on expertise from many disciplines. It is a process comprising a series of steps. The main steps in the EIA process are: screening, scoping, prediction and mitigation, management and monitoring and audit.

The EIA process is usually initiated by the proponent through a proposal to the responsible officer in the Federal Environmental Protection Agency [FEPA]/Federal Ministry of Environment. Based on specific criteria, a notification form is completed and submitted. The internal screening for the project is then carried out by the FEPA/FME to determine the category of the project based on the list of mandatory study activities. Where there are potential adverse effects on the environment, the FEPA/FME sends the screening report to the proponent for the preparation of Terms of Reference [TOR]. The scope of the EIA study is expected to be included in the TOR which is examined and approved by FEPA/FME. Thereafter, the study is executed by the

proponent using consultants who are certified by FEPA/FME [FEPA/FME also certifies reviewers and other relevant experts and the draft EIA report submitted to FEPA/FME]. On receipt of the draft report, the FEPA/FME evaluates and determines the method of review and communicates this to the proponent. Four methods of review are usually considered namely: in-house review in which no external interest is requested; panel review which may or may not be public; public review, which involves display of the report for 21 working days at venues determined by FEPA/FME for the convenience of stakeholders with considerable newspaper and other publicity inviting interested groups and persons to participate; mediation were review comments are sent to the proponent within one month and the final EIA report having addressed and proffered answers to the review comments, is expected to be submitted to FEPA/FME within six months. When the final EIA report is accepted as satisfactory, the technical committee gives approval and issues the Environmental Impact Statement [EIS]. An accompanying certificate which indicates the approval and validity period enables the proponent to commence with the project regulated by the conditions and specifications contained in the EIS.

The last stage of an EIA is to carry out an Environmental Audit some time after completion of the project or implementation of a programme. It is therefore usually carried out by a separate team of specialists from the one working on the bulk of the EIA. The audit determines whether recommendations and requirements made by the earlier EIA steps were incorporated successfully into project implementation [Ukpong, 2009; Udosen, 2009]. It is obvious from the foregoing that, the EIA process in Nigeria is rigorous and standardized in line with international/industry best practices. This study shows that, it is important that an EIA is not just considered as part of the approval process. Rather, EIA should be an action plan to be followed not only during implementation but after project completion/implementation for the purpose of monitoring other projects in an area.

The usability of data from EIA reports can be attributed to factors such as the convenience and speed of access, the relatively low-cost of the data and its integrity. Because EIA is usually carried out by certified experts in relevant fields and supervised by professionals representing the regulatory agency, the datasets are authoritative, more so because of the data producer's reputation and by being officially sanctioned by the regulatory agency, they develop a level of usability that enhances their value to consumers. Furthermore, the question of trust has a major impact upon information usability. Trust in a dataset is a highly valued asset for data producers and users alike, and may arise from a variety of actions such as the knowledge that an information product has been developed by a particular organization, official sanction, adherence to standards and industry best practice. Also, data quality and accuracy/freedom from error is an essential property in any list of usability elements since no user wants to apply error-prone data to tasks being undertaken. Data quality can take many forms. Apart from positional and attribute accuracy, logical consistency and completeness, temporal accuracy or currency is becoming increasingly important (Hunter et.al 2003). The datasets in EIA reports are usually collected processed and analyzed based on adherence to standards and industry best practice.

Moreover, the EIA draft report usually goes through a period of public/panel review. This makes it possible for members of the public to criticize and/or make inputs regarding any aspect of the assessment including methodology of data collection, processing and analysis. Proponents are usually expected to capture such inputs in their final report. Because of this requirement, datasets in EIA reports can be said to be valid and reliable. There is also the issue of cost. Expensive information would certainly have the potential to impact negatively upon the usability of a dataset. The issue of cost can also work in reverse where it raises usability, as in the case of highly expensive and exclusive business data, where users are willing to pay a premium for information that few others can afford, and often hold the belief that high-cost data has greater integrity. However, because the proponent usually bears the entire cost of EIA, it is a cheap and cost-effective source of data for data consumers.

2.3 Data Collection and Analysis

From the different EIA reports consulted/used, water samples were randomly collected along the estuaries. The samples were kept in clean plain one litre kegs. Prior to that, the kegs had been sterilized. They were completely filled with water before they were corked to avoid trapping of air bubbles. The samples were stored in cool dry place before the commencement of laboratory analysis. The samples were tested for the occurrence of heavy metals such as cadmium, cobalt, manganese, zinc, iron, lead, copper and nickel. The laboratory analysis involved the use of instruments such as, water spectrophotometer, arsenic kits turbidity meter, pH meter. Specifically, heavy metals were analysed by determining the trace of metal concentration in each water sample using the Atomic Absorption (Ministry of Culture & Tourism, 2006; Network E & P Nig. Ltd., 2005; ALSCON 2007).

III. Results

3.1 Study location A: Ikpa River Estuary

The results of the analysis of heavy metals in water samples collected from Ikpa river estuary is presented in figure 2

	WAT1	WAT2	WAT3	WAT4	WAT5	WAT6	WAT7	WAT8	WAT9	WAT10
■ Fe	7.39	3.29	1.92	2.47	5.75	3.21	2.75	2.41	4.55	1.14
■ Mn	0.28	0.23	0.13	0.07	0.11	0.08	0.19	0.21	0.04	0.11
■ Cu	0.12	0.09	0.09	0.08	0.08	0.07	0	0	0.08	0.09
■ Zn	5.12	1.85	3.21	2.08	1.18	1.50	1.64	2.01	1.41	0.54
■ Pb	0.08	0	0	0	0	0	0	0	0	0
■ Ni	1.83	0.38	0.59	0.78	1.61	0.31	1.02	0.93	1.01	0.05
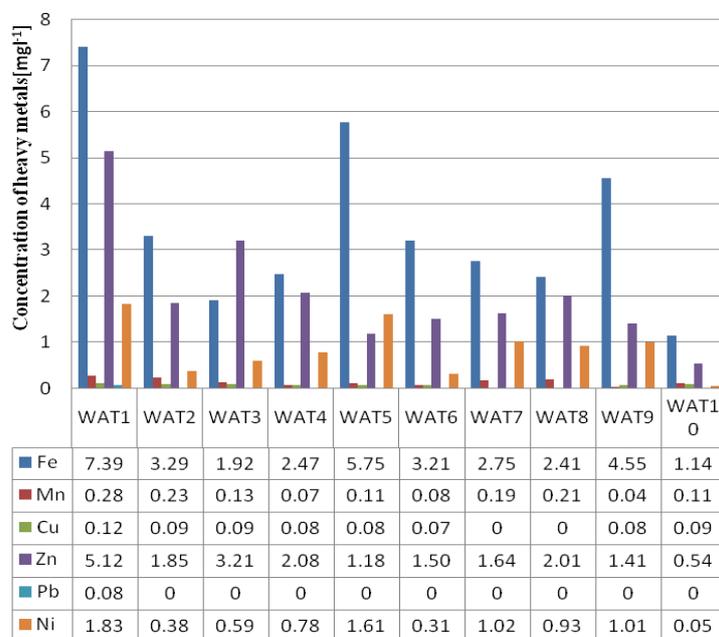
Fig.2: Concentration of heavy metals in water samples collected from Ikpa river estuary.

It is obvious from figure 2 that, except in the case of copper [Cu] and Zn, there was high concentration of all the other heavy metals at all the sampled points studied because they exceeded the WHO limit.

3.2 Study location B: Imo River Estuary

The river drains through some important urban centres within and outside the state. The results of analysis on water samples taken from the estuary of this river is shown in figure 3.

	Essene Creek	Jaja Creek	UAC Beach	Down Below	Opobo
■ Mn	0.17	0.189	0.209	0.28	0.277
■ Zn	0.01	0.029	0.021	0.026	0.011
■ Pb	0.45	1.019	1.339	1.438	1.641
■ Cu	0.006	0.011	0.029	0.016	0.013
■ Fe	0.119	0.011	0.083	0.05	0.074
■ Ni	0.96	0.09	0.05	0.15	0.08
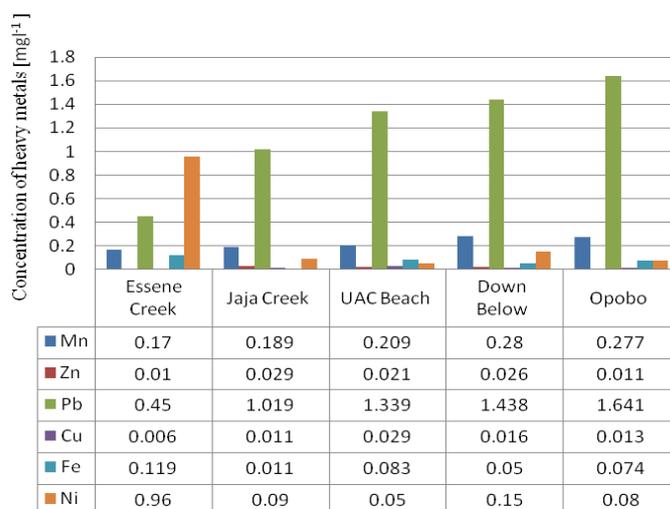
Fig.3: Concentration of heavy metals in water samples collected from Imo river estuary

It is obvious from fig.3 that, the levels of some heavy metals were higher than the WHO acceptable standards. For example, whereas the WHO standard for Pb is 0.01 mgl^{-1}, mean values recorded at most of the sites of the study location range between 0.45-1.641 mgl^{-1}. Also, Nickel, another toxic metal was found to be higher than the WHO standard of 0.02 mgl^{-1} in all the sites.

3.3 Study location C: Qua Iboe River Estuary

The concentrations of the heavy metals in the Qua Iboe estuary are presented in fig 4.

	Qua Iboe River Estuary	Douglass Creek
■ Mn	16.57	13.7
■ Zn	1.272	5.051
■ Pb	0.025	0.047
■ Cu	0.064	0.08
■ Fe	59.37	48.8
■ Ni	0.33	0.685
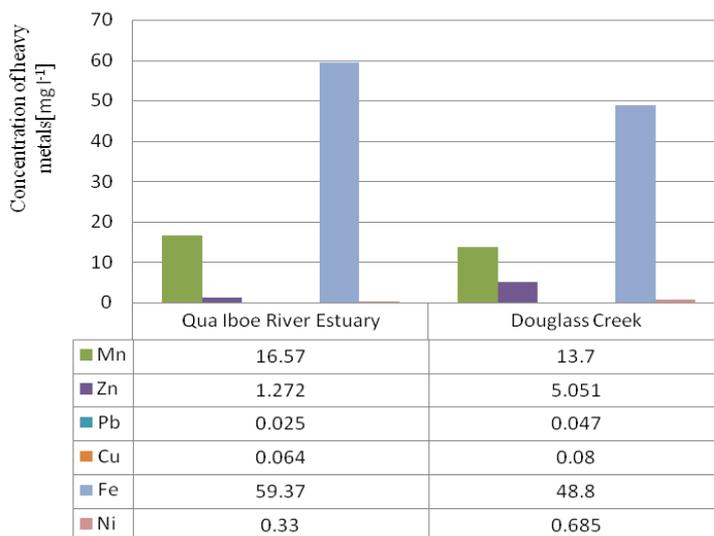
Fig.4: Concentration of heavy metals in water samples collected from kwa Iboe river estuary

Here the concentrations of most of the heavy metals in the rivers were relatively high. High concentrations were recorded for Mn, Pb, Ni and Fe.

3.4 Assessment of Surface Water Quality in the area

The table below gives details of the Permissible limits of heavy metals in drinking water (mgl^{-1})

Table 1: Permissible Limits Of Heavy Metals In Water (Mgl^{-1})

Organization	Cu	Pb	Ni	Mn	Zn	Fe
WHO maximum permissible limits in drinking water	2	0.01	0.02	0.5	3	0.03
DPR/FME Limits	<1.0	<1.0	-	5.0	<1.0	20.0

Source:WHO. 1993; FEPA Decree 1988 No. 58, pp33-34

Based on WHO limits, all the estuaries studied had high concentration [above acceptable limits] of many of the heavy metals. This means that surface water quality was degraded by high concentration of heavy metals. A closer look at the tables attached to figures 1 to 3 revealed that, Iron [fe], magnesium [Mn], copper [Cu] and zinc [Zn] were found more in the Kwa Iboe estuary than in others; Lead [Pb] was found more in the Imo river estuary and Nickel [Ni] was found more in the Ikpa river estuary at the time water samples were taken and analyzed. Based on these findings, the quality of surface water in the Kwa Iboe river estuary can be described as poor/low for domestic use as at the time of study.

IV. Discussion

It is obvious from this study that, because of the danger posed by high concentration of heavy metals and other pollutants in water, we need to monitor our sources of drinking water especially surface water on a regular basis. This is achievable if all the provisions of the EIA decree are enforced by the regulatory agencies. Presently, there are many organizations without the mandatory EIA and/or environmental audit reports. All that the regulatory agencies need to do is to monitor and ensure that all the private and public organizations operating in their respective area of jurisdiction carry out post project EIA regularly (preferably on yearly basis). This will ensure that the spatial and temporal aspects of data on the environmental parameters are satisfied.

For example, the EIA reports used in this study were carried out for the dry season of 2005, 2006 and 2007 only. This is a serious constraint that should be addressed to enhance data usability. This is because, there is no doubt that we would have had to contend with a different scenario if water samples were taken for both dry and wet seasons and/or all the estuaries sampled the same year and the results compared,. However, one way of dealing with this constraint is to make sure that all organizations in an area not only carry out the mandatory EIA but also undertake environmental audit. If this law is faithfully enforced, there is no way a particular year will pass by without many organizations being due for post project impact assessment. The report of such EIA

will guarantee that data on most of the environmental parameters measured are available for different parts of the State on yearly/seasonal basis.

Moreover, since EIA reports are usually, reviewed, it is possible for procedures, methodologies and equipment used to be queried by experts other than those that carried out the study. This aspect ensures that standards are not only maintained/complied with, but that well informed decisions are taken based strictly on findings and without fear or favours. This underscores the fact that EIA reports are veritable, reliable and cost-effective source of information for environmental monitoring and management.

Furthermore, in Nigeria, regulatory agencies like the Ministry of Environment do not undertake EIA to determine the impact of human activities on the environment apparently because of the cost implications among other things. Rather, the EIA Act number 86 of 1992 makes EIA mandatory for all new major public and private projects in Nigeria. The Act sets out to consider the likely impacts on the environment before embarking on any project or activity. However, the problem is that, the results of such studies are normally used to assess the proponent's project site only i.e. the organizations that undertakes the EIA for the purpose of getting impact statement. Yet, contained in such EIA reports are information that may expose the negative impacts of the activities of other organizations in the vicinity. In fact, the data usually collected for proposed project sites is and should be taken as a post project impact assessment of existing companies/projects in the area. Unfortunately, this is not usually the practice. The data used in this study resulted from EIA of companies that were under construction at the time but it also revealed the fact that some of the organizations already operating in the area were contributing heavy metals that degraded the quality of surface water in the area. Such organizations needed to be identified and sanctioned to ensure food/surface water security.

V.   Conclusion

It is evident from this study that there is none of the estuaries studied that does not have at least one of the heavy metals in excess of the acceptable limits by WHO. This is an indication that upstream, there are activities that are resulting in the pollution of surface water. This calls for a more intensive monitoring plan to determine the sources of such pollution to ensure a cost effective mitigation plan. Moreover, this study shows that, EIA reports are a veritable source of data on a wide range of environmental parameters such as soil, air, vegetation, landuse etc which are needed to enable us monitor and manage our environment to ensure sustainable development. In specific terms, using EIA reports can help regulatory agencies to only direct their energy and limited resources to areas, rivers, streams etc with high concentration of pollutants that are injurious to human and environmental health.

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