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TRACE METALS IN DUST PARTICULATES FROM CALABAR MUNICIPALITY, NIGERIA

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ABSTRACT

In this study trace metal survey was carried out in air for Calabar Municipality by analysing dust particulates through gravity settlement method (Warner, 1976).
Results indicate low levels of dust particulates and trace metals with the following mean values: total dust cover 0.465 $\pm$ 0.269 $g/m^2/mo$, Fe 0.662, $\pm$ 0.422 Pb 0.469 $\pm$ 0.428, Cu 1.04 $\pm$ 0.819, Cr 0.144 $\pm$ 0.128 and Zn 0.480 $\pm$ 0.420 ppm respectively. The results also showed positive correlation between trace metals and dust particulate matter except Zn implying that trace metals increased with atmospheric dust particulates.
Although, the results showed that the municipality has atmospheric contaminants of some trace metals mainly Fe, Pb, Cu, Cr and Zn, the average levels were generally below their threshold limit values (TLVs) for safe air except for Pb and Cu. This implies that Calabar air was not seriously contaminated with trace metals as at the time of the study.
The low levels of air contaminants in Calabar may be attributed to heavy rainfall, low levels of traffic, industrial and construction activities.
However, constant monitoring of Calabar air is recommended in view of the proposed export processing zone (EPZ) in the area, to obtain to baseline data for possible future environmental control measures. Details of these and other environmental implications are discussed.

Key Words: Trace metals, dust particulate cover, air quality, gravity settlement, air contamina-

INTRODUCTION

Particulate matter which could be considered as non-gaseous concentration in the atmosphere represent an index of diverse classes of substances often referred to as aerosols (Ross, 1972, Warner, 1976; Sell, 1981). These materials which are both solids and liquids, are suspended particles and could be airborne for long periods of time (Giddings, 1972; Sell, 1981). They are often classified by their sizes, which are invariably responsible for the kind of effects they create in the environment. Particulate matters are chemically diverse and could contain variety of trace metals among others, that are responsible for their toxicity to the ecosystem (Jaffer, 1967; Lynn, 1976).

Dust particulates are very prevalent in urban atmospheric environment due to the large scale variety of anthropogenic activities that release huge amounts of terrestrial materials and their primary and secondary products into the air. Particulate air pollutants are a major problem in developing countries due to excessive use of fossil fuels, especially petroleum and coal with wood (Khan and Khan, 1996). In Nigeria there is a high proliferation of power generation plants due to the unreliable power source, and the use of fossil fuels that generate quantities of particulate matters (Giddings, 1973).

Their main sources include industries, construction and automobile transportation (UNEP, 1996; Sell, 1981; Young 1974). Specific sources could include smoke stacks from industries, bush burning, exhaust emission, power generating plants that use fossil fuels etc. Construction work involving large scale earth moving equipment could cause dust particulate cover in an aerial scale (UNEP, 1996), but massive airborne plumes of the desert dust particles is said to be responsible for dust particulate cover in continental and intercontinental scale (Moulin et al, 1997).
In a given ecosystem, there are interrelationships between trace elements in air, soil and plants (Vousta et al., 1996), in which metallic trace elements released from anthropogenic sources enter the environment and follow normal biogeochemical cycles (Vousta et al, 1996). The implications could be very wide including contamination of the ecosystem (Wittes and Wittes; 1972; Olson and Skogerboe, 1975).

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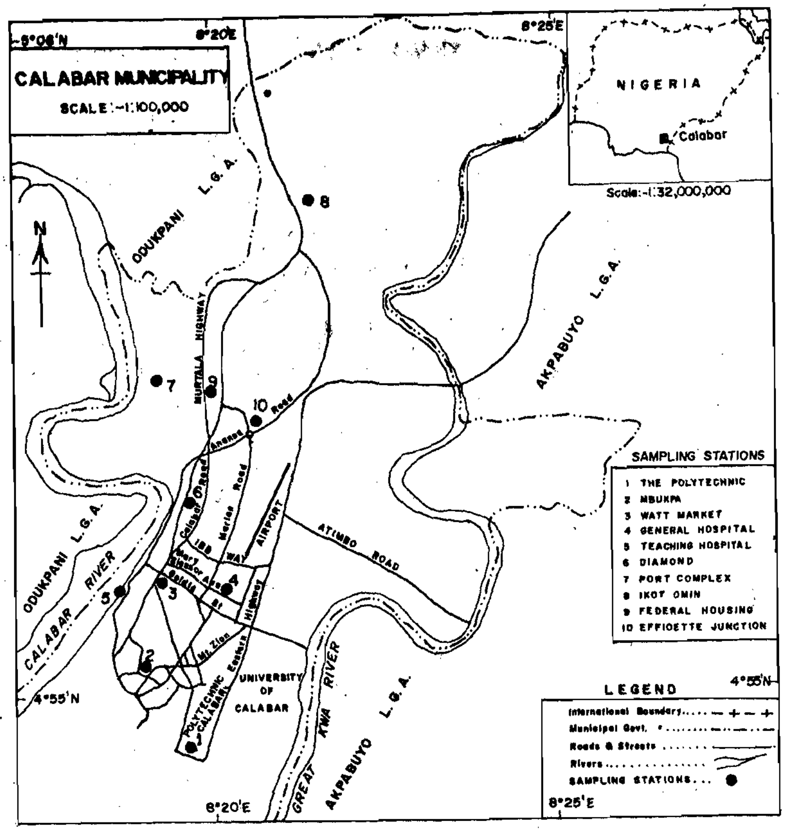

Fig. 1 SAMPLING STATIONS IN CALABAR MUNICIPALITY

In the urban environment dust particulate cover has been widely known to reduce visibility and disrupting traffic including air travels in extreme cases (Giddings, 1973; Dorman, 1974; Berry and Horton, 1974; Young and Bibbero, 1974; Franke and Franke, 1975). In many urban areas, dust particulate matter in a large scale is associated with dust haze that greatly disrupt air travels during the harmartan weather and other climatic effects. For example, particulate matters tend to form blankets that shield the land from the warming sunlight when excess UV- radiation from the sun is screened from the earth surface (a kind of greenhouse effect), (Giddings, 1973). They also form condensation nuclei for rapid cloud formation and rainfall (Gray, 1978; Sell, 1981), thus affecting local climate. In public health they have been associated with heart and lung diseases, with cancer of the lungs (Gray, 1978; Sell, 1981). Other effects of atmospheric particulate cover vary from damage to vegetation to even nuisance (Sell, 181).

According to American Public Health Association (APHA, 1977) large particulate matter which becomes suspended in the atmosphere by wind or mechanical forces eventually settle down by gravity. These and those washed down by rain or agglomeration can be measured using an open mouth container exposed for a period of time, approximately a month. This static measurement technique is simple but gives results that are highly reliable estimate of the level of particulate matter in the atmosphere. Chemical analysis can be performed on either fraction or whole sample to determine components of particular interest. This study attempted to determine the level of dust particulate matter and some metal contaminants in the urban atmospheric environment, using Calabar Municipality as a case study. The result could be useful as a base line study for a future air quality monitoring programme, in view of the proposed EPZ in Calabar Port Complex, whose effluents from industrial and commercial processes could adversely affect th quality of air in the area. The method is of particular interest at the time and situation where there is dearth of facilities for effective air sampling and analysis.

MATERIALS AND METHODS

(i) **Study Area:** The study area is Calabar Municipality (including Calabar South) in Cross River State of Nigeria. Samples were collected from ten (10) sites based on strategic locations, geographical spread and on grid bases (Fig 1, Table 1).

(ii) **Sampling Method:** Samples were collected by Gravity Settlement method

TABLE 1: LIST OF SAMPLING STATION

SITE	LOCATION	ENVIRONMENTAL SIGNIFICANCE
1.	Polycal (control site)	Very low in traffic, industrial and commercial activities (chosen for control)
2.	Mbukpa	Large commercial activities (market area)
3.	Watt Market	Large scale industrial and commercial activities and automobile transport terminals.
4.	General Hospital	Busy traffic area, the University area with traffic and high population concentration and small scale industrial and commercial activities.
5.	Teaching Hospital and Beach Area	Beach and commercial activities and solid wastes from the Teaching Hospital
6.	Diamond	Cement factory location
7.	Ports Complex	Shipping and general ports activities
8.	Ikot Omin	High way with high traffic density
9.	Federal Housing Estate	High population density area and location near high way.
10.	Effio-Ette Junction	High traffic density area

(Warner, 1976) using high density polyethylene (HDPE) container with 10cm diameter funnel. About 50cm^3 of 0.1mg/l solution of $CuSO_4$ algicide was added to prevent algal growth. The set up was mounted at each location on a flat elevation of at least 6m in height and supported at the base, exposed for a period of 20 days with constant checking, and collected to the laboratory for storage and analysis. The study was done in a rainy season month of September, 1997.

PRE-TREAMENT AND DETERMINATION OF DUST PARTICULATE

Samples were pre-treated by removing extraneous materials that may be present, and distil water was added to facilitate filtration. They were then evaporated over steam bath to moist residue and transferred to an oven to complete evaporation at 105°c.

The residues were cooled in a dessicator and weighed to nearest milligram. The weights were then used to calculate the dust particulate according to Warner (1976).

PRE-TREATMENT OF SAMPLE FOR TRACE METAL ANALYSIS

Each weighed residue was subjected to perchloric acid digestion after first adding 20% HNO_3 and allowing to stand for 1hr. 10ml of perchloric acid was added and heated on a hot plate to yellow colour end point. It was then dissolved with IM HCl, filtered and the filtrate made up to 150ml with deionized water. 25ml was used to analysed for each metal. Determination of trace metals was performed with a Hach Instrument, Model DR/2000, Computerised Spectrophotometer. Five metals Pb, Cr, Cu, Zn and Fe were analysed for.

RESULTS AND DISCUSSION

TABLE 2: RESULTS FOR THE PARAMETERS MEASURED FROM VARIOUS STATIONS

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	r* Values
Total Dust Cover g/m2/mo	0.036	0.762	0.871	0.398	0.653	0.182	0.545	0.617	0.327	0.254	
Fe ppm	0.08	0.70	1.1	0.31	0.91	0.09	0.93	1.83	1.3	0.40	0.62
Pb "	0.21	0.221	1.11	1.02	0.47	0.10	1.07	0.02	0.24	0.24	0.41
Cu "	0.8	0.32	0.30	0.6	1.1	0.04	2.3	2.0	2.01	0.8	0.04
Cr "	0.00	0.5	0.08	0.4	0.1	0.04	0.01	0.01	0.09	0.09	0.32
Zn "	0.34	0.1	0.01	0.01	0.9	0.71	0.67	0.67	0.99	0.06	−0.1

* Correlation coefficients of total dust cover Vs. Trace metals*

All the data computed for correlation analysis. Test for significance was done by comparing the observed mean with the TLVs using the population t-test at 0.05 level of significance.

TABLE 3:
MEAN RESULTS OF AIR CHARACTERISTICS MEASURED IN THE ENTIRE CALABAR MUNICIPALITY

CHARACTERISTICS STUDIES	RESULTS
Total dust cover $g/m^2/mo$	0.465 ± 0.2687
Fe ppm	0.662 ± 0.422
Pb "	0.469 ± 0.428
Cu "	1.037 ± 0.819
Cr "	0.144 ± 0.128
Zn "	0.48 ± 0.420

TABLE 4:
THRESHOLD LIMIT VALUES (TLVs) FOR HEAVY METALS IN THE AIR (Giddings, 1973)

Metal	TLV ($\mu g/m^3$)	mg/m^3
Pb	100-200	01 - 0.2
Fe	1000	1.0
Cu	1000	1.0
Cr	1000	1.0
Zn	1000	1.0

The results of the dust particulate and trace metals studied for each station are given in Table 2 and Fig. 3. The mean values for each air quality characteristic studied for the Municipality are given in Table 3 and represented in Fig. 2.

The level of Pb was significantly higher than the TLV (Table 4), Cu was also high but not significant ($P<0.05$) compared to its TLV. This implies that on the average Calabar air was significantly polluted with Pb as at the time of this study.

Generally, the dust particulate cover for the various location were low, and not significant ($P<0.05$) but the distribution vary widely (Fig.3). The highest level of 0.871 $g/m^2/mo$ was measured at site (3). Watt Market area, while the lowest of 0.036/$g/m^2/mo$ was recorded for Polycal (Control). These were expected and are significant ($P<0.05$). The Watt Market is in the business area of the Municipality with many and varied kinds of commercial and industrial activities. This area also has the highest level of traffic in the Municipality due to high population density and holds the terminal points for most commercial vehicles in and out of the Municipality. The high traffic concentration is bound to increase vehicles' exhaust emission which is one of the greatest sources of air particulate matters (Giddings, 1973; Berry and Norton, 1974; Seinfeld, 1975).

Polycal area on the other hand is quite remote from the CBD (Central Business District) and most major industrial and commercial activities and hence it has the lowest dust particulate matter. That explains its choice as the control point. The levels measured in other sites fell within these two extremes (Table 2). The second highest level was at Mbukpa (site 2) with 0.762$g/mg^2/mo$ because of similar conditions as in Watt Market, but only to a lesser extent. The second lowest measurement of 0.182$g/m^2/mo$ was recorded at Diamond (Site 6). Though this area was expected to record high level of air contaminants including dust cover due to cement processing plant there (Sell, 1981), but the factory had been lying dormant for long period including the time of this study, hence the low level.

On the whole, there was low level of atmospheric dust particulate cover during this study with the mean for the Municipality of 0.465$g/m^2/mo$. This is very negligible compared to National Standard of 360$g/m^2/mo$ (FEPA, 1991).

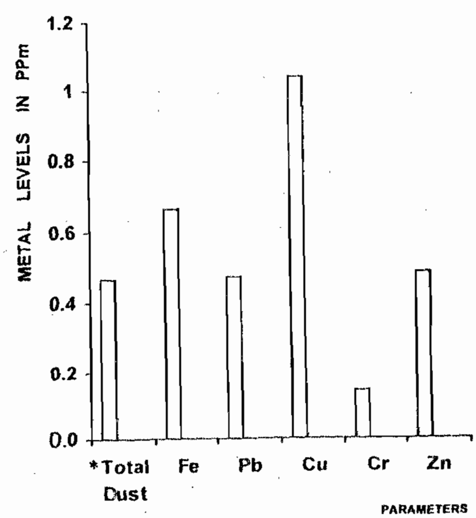

Fig 2 THE MEAN LEVELS OF AIR CHARACTERISTICS STUDIED FOR CALABAR MUNICIPALITY (* Total dust cover in $g/m^2/mo$)

The trace metal levels and distribution in the atmosphere generally followed the similar pattern as dust particulate but with wide variation between locations (Fig. 2) and they vary with dust particulate. The highest level of trace metal of 2.30 ppm was recorded for Cu at the Ports complex (Site 7). This appears realistic considering the shipping and general port activities here coupled with commercial and some light industrial activities. This area has also recorded relatively high levels of some other trace metals - Pb 1.07, Fe 0.93, Zn 0.67 ppm, These were all higher than the Municipal average (Table 3). Cr level was the lowest, being below detectable level (BDL) at the control site (Polycal).

Though the average level of the rest of the trace metals for the Municipality show high contamination, they do not indicate pollution of the air, as they were below, their TLVs, for safe air (Giddings, 1973; FEPA, 1991).

However, there is cause to worry about these levels as heavy metals could be easily biomagnified through the food chain to pollution levels in a particular ecosystem, like the aquatic or terrestrial environments (Mitchell, 1974) when they settle.

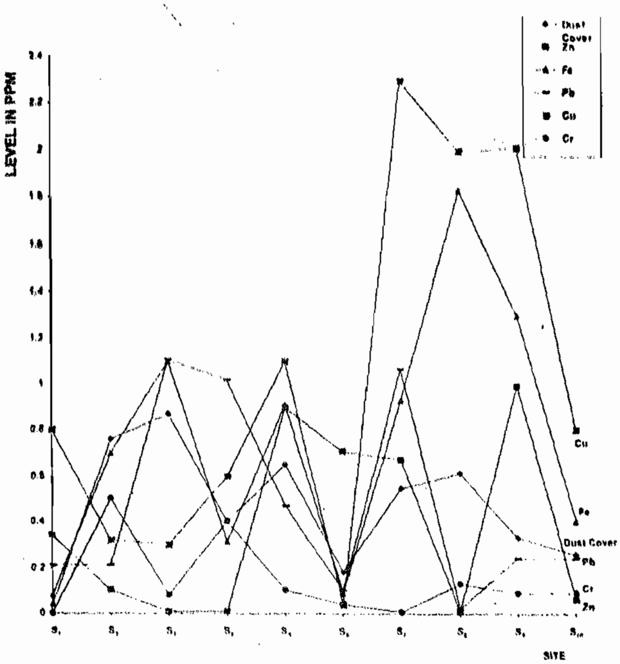

Fig. 3 THE VARIATION OF AIR QUALITY EACH PARAMETER STUDIED ACCORDING TO THE SITE

The probable causes of low level of atmospheric dust particulate and trace metals measured in this study could be attributed to several factors:

(i) Heavy rain fall in the area that is likely to wash down the particulate matter from the atmosphere (the study was done in the rainy season with average rainfall during the period of 322mm from Unical meterological station).

(ii) Relatively low level of traffic in Calabar Municipality resulting in low levels of vehicles' exhaust emissions.

(iii) Low level of industrial activities (like manufacturing, power plant) etc.

(iv) Absence or low levels of construction and agricultural activities in the area has generated low levels of particulate into the air.

CONCLUSION

Calabar Municipality has very negligible level of air particulate matter as the time of this study. Also the study showed that the Calabar air was contaminated but not polluted with most of the trace metals studied (except Pb) that was above the TLV for safe air. The low levels of air contaminants in Calabar as at the time of this study has been attributed to meteorological factors, relatively low levels of traffic, construction, industrial and agricultural activities in the area.

However, continuous air quality monitoring is recommended in view of the increasing industrialization, and in particular the activities of the proposed EPZ in the area which could adversely affect the air quality. It is also recommended that this study be carried out in the dry season to note the annual average, seasonal variation and to observe the effects of climatic factors on the level of air particulate and distribution in the Municipality.

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