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ASSESSMENT OF DIOXIN EMISSIONS FROM OPEN BURNING OF MUNICIPAL WASTE IN KANO METROPOLIS

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Abstract

The assessment involved field visits, Inventory and monitoring, that identified and quantified sources of dioxin emissions from Dumpsite in Kano metropolis. In Kano city open burning of municipal solid wastes serves as the most common methodology for waste volume reduction and management. Dioxin is a persistent, bioaccumulative, and toxic family of compounds that presents significant human health risks through direct exposure and diet. The largest continuing source of dioxin to the environment is open burning of residential waste, commonly in dumpsites and backyards. In Kano metropolis One hundred and six (106) dumpsites were identified, which are divided into designated, non-designated and other sites of significant interest (covering backyard, vacant plots, open dumpsites, abattoir sites, markets, etc). The study showed that a total of 866,394 tons of waste was generated per year and 50% of this waste was burned and released 279TEQ/year of dioxin into the environment which is very dangerous to the community and the entire world. This required an urgent legislation to stop the menace.

Key word: *Assessment, Dioxin, Emission, Waste, Burning*

INTRODUCTION

Persistent Organic pollutants (POPs) are chemicals that are highly toxic, resist degradation, bio-accumulates and transported through air, water and migratory species across international boundaries.The unintentional release of persistent organic pollutants is an undesired effect of the open burning of municipal solid waste. The POPs chemicals of concern

are: polychlorinated dibenzo-p-dioxins and dibenzo-furans (PCDD and PCDF), hexachlorobenzene (HCB); and polychlorinated biphenyls (PCB). The Stockholm Convention on Persistent Organic Pollutants (POPs) includes in its objectives the minimization of unintentional releases of polychlorinated dibenzo-dioxins and dibenzofurans (PCDD/PCDF) and other known POPs to the environment (IPEN, 2005). Development and implementation of policies to achieve this aim requires accurate National Inventories of releases of PCDD/PCDF (UNDP, 2010). To support this objective, the Conference of Parties (COP) established a process to review and update the UNEP Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases (UNEP, 2010).

Persistent organic pollutants (POPs) are organic compounds, often halogenated that to a varying degree, resist photolytic, biological and chemical degradation, and are semi-volatile. They are lipophilic leading to their bioaccumulation and bio-magnification in fatty tissues of living organisms; their properties of persistence (the length of time the compound will remain in the environment before being broken down or degraded into other and less hazardous substances) and, semi-volatility (that property of their physico-chemical characteristics that permit these compounds to occur either in the vapour phase or adsorbed on atmospheric particles, thereby facilitating their long range transport through the atmosphere), coupled with other characteristics have resulted in their capacity for long distance transport and thus, the presence of POPs compounds all over the world, even in regions where they have never been produced or used (UNEP Chemicals ,2010). POPs are represented by two important subgroups - the polycyclic aromatic hydrocarbons and some halogenated hydrocarbons. The halogenated hydrocarbons include several organochlorines which, historically, have proven to be most resistant to degradation and which have had wide production, use and release characteristics. These chlorinated derivatives are generally the most persistent of all the halogenated hydrocarbons. Studies have implicated POPs in endocrine disruption, reproductive and immune dysfunction, neuro-behavioural disorders and, cancer and tumour induction. Some POPs have also been implicated in reduced immunity in infants and children and the concomitant increase in infection, and developmental abnormalities (IPCS, 1996).

Significance of the Study

The importance of dioxin assessment to the people of Kano metropolis cannot be over emphasized. Therefore conducting a research of this nature on such an important area is necessary. Such a research will among other things, provide information on nature and quantity of dioxin releases as a result of open burning of municipal waste and subsequent health hazard to the surrounding communities. Finally the research will provide comprehensive data on the dioxin emission and offer recommendations on technically feasible and practical methods to tackle dioxin emission into the environment.

Limitations of the Study

- Dioxin analysis is Costly (2000 – 3000 US$ per measurement of air emissions)
- Requires competent (certified) institutions/laboratories – where are the nearest competent institution to take out samples (Nigeria?) and to do the analysis (Netherlands?)
- Always to be preferred when possible – dioxin formation is very site-specific and variations on formation and emissions can be extreme.
- Do environmental legislation/approvals allow the Government to demand companies to carry out such measurements? – For the time being, no?

Description of the Study Area

Kano City

Kano city has a population of about 2.8 million as at 2006 population census and a projected population of 3,388,975 for 2012 (NPC,2012). Kano State is located in the semi-arid savannah belt of Nigeria. It covers an area extending between latitudes 120° 40'E and 100° 30'N and longitude 70° 40'E and 90° 30'N. Bauchi, Kaduna, Katsina and Jigawa States border it. The city of Kano lies near where the Kano and Challawa rivers flowing from the southwest converge to form the Hadejia River (UNDP, 2010).

Map of Kano State indicating the various LGAs (UNDP, 2010)

Physical Characteristics

Climate: As with other parts of Nigeria, the state experiences two seasonal patterns: wet and dry seasons. The wet season starts in May and ends in October while the dry season starts from November and ends in April. Mean annual rainfall ranges from over 1,000mm in the

south to a little less than 800mm in the north. Mean temperature ranges from 26°C to 33°C.

Geology: The major geologic formations of Kano include crystalline igneous, metamorphic rocks and granite. The relief range from heights of 500meters for lower plains to 1000meters above sea level for higher ones (Holferder, 1978).

Soil: The soil types are classified into three main groups; the ferruginous tropical soils; the reddish brown soils and hydromorphic soils, which are found in poorly, drained sites. The state soil is chemically poor with 80-90% sand, and 2-4% clay contents (Holferder, 1978).

Water Resources: The major rivers are Kano, Challawa, Watari, Jatau, Dudurun and Gaya. These rivers flow into the Hadejia River, which empties into the Lake Chad. Kano also has 25 lakes and dams, which provide potable water to towns and villages (Holferder, 1978).

Biological/ Natural Resources

Flora: The dominant natural vegetations are the Guinea savannah and the Sahel savannah. These vegetations have been heavily degraded by human activities e.g. bush burning, clearing for farming, clearing for buildings and infrastructures, etc (Holferder, 1978).

Fauna: The major animals include: cattle, sheep, goats and livestock. Pastoral farming is dominant in the state (Holferder, 1978).

Socio-Economics

Population/Demography: Based on the 2006 population census, Kano State has 9.3 million inhabitants with an almost equal distribution of male (51%) and female (49%). 75% of the population live in the rural areas. The state has 44 local Government areas and covers 20,131 km^2. Kano metropolis consists of Kano Municipal, Fagge, Dala, Gwale, Tarauni, Nassarawa, Ungogo and Kumbotso, and based on the 2006 Census, Kano municipality has a total population of 2,828,861 people (NPC, 2012).

Livelihood: About 75% of the rural population derives its livelihood from agriculture. Kano State is the main producer of groundnut in Nigeria. Other important crops are cotton, guinea-corn, maize, cowpeas and varieties of vegetables (NPC, 2012).

Materials and Methods

The UNEP toolkit for monitoring UPOPs releases from open burning of Municipal waste was adopted. The UNEP Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases is designed to cover at a minimum, all source categories and processes that are listed in Annex 1, Part II and III of the Stockholm Convention and that are known to release PCDD/PCDF (UNEP Chemicals, 2005). The toolkit can be used where there are no measured data available or where national measured data and emission factors have not been generated.

The major aims of the Toolkit are:

- To be comprehensive, easy to read, follow and apply;
- To approach the subject in a logical and pragmatic manner;
- To group and present the classes and emission factors on a reasonable and practical basis;
- To enable the establishment of internationally comparable inventories (UNEP Chemicals, 2005).

The basic aim of the Toolkit is to enable an estimate of average annual release to each vector (air, water, land, products, and residues) for each process identified.
UNEP's Standardized Toolkit groups the dioxin sources into ten broad categories. The Toolkit categories the main release vectors (air, water, land, product and residue)

UPOPs emission can be calculated using the equation below:
Source strength (Dioxin emission per year) =Emission Factor x Activity Rate {PCDD/PCDF released per year}

To quantify the source strength, release rates must be determined as annual mass flow rates of PCDD/PCDF expressed in grams TEQ (Toxic Equivalent) of PCDD and PCDF released per year. The Stockholm Convention requires using established Toxic Equivalent Factors (TEQ).

Annual releases for all vectors are calculated as follows:

Source Strength (PCDD/PCDF released per year) = Σ Emission Factor x Activity Rate

The volume of waste in (m^3) is then converted by a given factor to obtain the amount of waste generated in Kano City in tons.

To convert the volume of wastes from cubic meter to ton, multiply the volume obtained by a factor of **0.353** (Unit converter.org) Weight of wastes (tonnes) = Volume × 0.353

The PCDD/PCDF emission is expressed in grams TEQ per year
Activity rate = the amount of product produced in tonnes or litre per year
Emission factors are provided in the Toolkit for each sub-category

Based on recent studies, it was recommended by the UPOPs expert committee to use new emission factors; this is as established in the 2010 edition of the UNEP Toolkit. The new emission factors for open burning of domestic waste in the toolkit are 40µg TEQ/ton for

release to air, 1µg TEQ/ton for release to land and 600µg TEQ/ton (as against the old figures of 300, 600 and 600 old) for release to residue (UNEP,2010).

The study entailed visits to designated waste dump sites in Kano City to evaluate the quantities. Roadside and backyard dumps were also identified and evaluated.

Methodology used for Calculating Source Strength of UPOPs Emission from Municipal Solid Waste generated in Kano City

The following calculation was used:

To calculate the volume of waste at a dumpsite:

Volume of waste (m^3) = Length x breadth x height

L=Length of the heap
B=breadth of heap
H=height of the heap

Results and Discussion

Site Visits- Physical Inspection in Kano City

In Kano metropolis One hundred and six (106) dumpsites were identified, which are divided into designated, non-designated and other sites of significant interest (covering backyard, vacant plots, open dumpsites, abattoir sites, markets, etc).

Calculation of the dioxin & furan emissions from the identified dumpsites in Kano metropolis

Dioxins Emission = Activity rate × Emission factor		
(µg TEQ/ton)	**(t/a)**	**(µg TEQ/ton)**

The calculation of dioxin and furan emission into air, land is based on the new UNEP Toolkit emission factors of 40 µg TEQ/ton to air, and 1 µg TEQ/ton to land, while emission into residue is based on the old figure of 600 µg TEQ/ton of waste burned.

The Nigeria NIP for the Stockholm Convention estimated that 50% of the wastes in dumpsites are disposed of by burning.

TABLE 1: Dioxin and furan emission from open burning of municipal waste at dumpsites in Kano metropolis

Type of Waste Dump	Weight waste	50% of	Annual Release in g TEQ/a			
			Air	Land	Residue	Total
Designated dumpsite	755,341	377,671	15.1	0.4	226.6	242.1
Non-Designated dumpsite	106,390	53,195	2.1	0.05	32	34
Other sites (uncollected waste)	4,663	-	0.2	0.005	2.8	3.0
Total	866,394		17.4	0.45	261	279

Results of dioxin and furan emission from open burning of municipal waste at dumpsites in Kano metropolis are shown in table 1.

Calculation of the dioxin & furan emissions from waste generated in Kano metropolis (based on per capita waste generation)

Amount of waste generation per capita = 0.56kg/person/day (Ogwueleka, 2009)
= 0.00056 ton/day
Estimated Population for Kano metropolis in 2012 =3,388,975
Thus the waste generated by the population per annum = 692,706.5 tons/a= **693,000t/a**

Nabegu (2010) established that waste pickers recover about 10% of wastes generated in Kano metropolis; however, field observations showed that about 30% of recyclable wastes were collected prior to disposal. The recovered waste goes to various small and large recycling facilities located in the city.

As established above, the waste generated by the population per annum is 692,707t/a. Only 70% of the waste generated (i.e.484, 895 ton) is available for disposal.

Out of the 484,895tons of waste remaining, 60% is collected by Refuse Management and sanitation Board for disposal at dumpsite (Kabir, 2012). The dioxin and furan emissions from municipal solid waste generated in Kano metropolis can be calculated based on the per capita waste generation, as shown in table 2.

TABLE 2 UPOPS Emission to air, land and residue from waste generated in Kano metropolis (based on per capita waste generation)

	Weight of waste	Annual Release in g TEQ/a			
		Air	Land	Residue	Total
Collected waste	290,937	11.6	0.3	175	187
Uncollected waste	193,958	7.5	0.2	116	124
Total	484,436	19	0.5	291	311

A comparison of the calculated UPOPs emissions based on waste burnt at the waste dumps in Kano metropolis and that based on waste the per capita waste generations as deduced from the study by Nabegu in 2010 shows a very close correlation of the values.

Conclusion

Findings from field studies in Kano metropolis revealed indiscriminate 'Open Burning' practices. It was obvious that the members of the communities were unaware of the deleterious side effects of open burning of waste. There was an absence of a systematic waste management strategy in the state. The study showed that a total of 866,394 tons of waste was generated per year and 50% of this waste was burned and released 279TEQ/year of dioxin into the environment which is very dangerous to the community and the entire world. This required an urgent legislation to stop the menace.

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