The International POPs Elimination Project (IPEP)

Fostering Active and Effective Civil Society Participation in Preparations for Implementation of the Stockholm Convention

A Study on Waste Incineration Activities in Nairobi that Release Dioxin and Furan into the Environment

Environmental Liaison, Education and Action for Development (ENVILEAD)

Kenya
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About the International POPs Elimination Project

On May 1, 2004, the International POPs Elimination Network (IPEN http://www.ipen.org) began a global NGO project called the International POPs Elimination Project (IPEP) in partnership with the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Program (UNEP). The Global Environment Facility (GEF) provided core funding for the project.

IPEP has three principal objectives:

- Encourage and enable NGOs in 40 developing and transitional countries to engage in activities that provide concrete and immediate contributions to country efforts in preparing for the implementation of the Stockholm Convention;

- Enhance the skills and knowledge of NGOs to help build their capacity as effective stakeholders in the Convention implementation process;

- Help establish regional and national NGO coordination and capacity in all regions of the world in support of longer-term efforts to achieve chemical safety.

IPEP will support preparation of reports on country situation, hotspots, policy briefs, and regional activities. Three principal types of activities will be supported by IPEP: participation in the National Implementation Plan, training and awareness workshops, and public information and awareness campaigns.

For more information, please see http://www.ipen.org

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This report is available in the following languages: English

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ACRONYMS AND ABBREVIATIONS

AFD:	Agence Francaise de Développement
APCD:	Air Pollution Control Devices
BAT:	Best Available Techniques
BEP:	Best Environmental Practices
CBO:	Community Based Organization
CBS:	Central Bureau of Statistics
EMCA:	Environment Management and Coordination Act
EPR:	Extended Producer Responsibility
GAIA:	Global Anti-Incinerator Alliance/ Global Alliance for Incinerator Alternatives
GoK:	Government of Kenya
GPCR:	Gas Phase Chemical Reduction
HCB:	Hexachlorobenzene
IARC:	International Agency for Research on Cancer
IPEN:	International POPs Elimination Network
IPEP:	International POPs Elimination Project
ITDG:	Intermediate Technology Group
JICA:	Japan International Cooperation Agency
KAM:	Kenya Association of Manufacturers
KEBS:	Kenya Bureau of Standards
KEPI:	Kenya Expanded Programme on Immunization
KIPPRA:	Kenya Institute for Public Policy Research and Analysis
KNH:	Kenyatta National Hospital
LOCs:	Less Organized Countries
NIP:	National Implementation Plan
NCT:	Non Combustion Technology
NGO:	Non Governmental Organization
PCBs:	Polychlorinated Biphenyls
PCDD:	Polychlorinated dibenzo-p-dioxins
PCDF:	Polychlorinated dibenzofurans
POPs:	Persistent Organic Pollutants
PVC:	Polyvinyl Chloride
SANE:	South Africa New Economics (network)
SCWO:	Super-Critical Water Oxidation
TCDD:	2,3,7,8 - tetrachlorodibenzodioxin
TEQ:	Toxic Equivalency Quotient
TNT:	Trinitrotoluene
UNEP:	United Nations Environmental Program
U-POPs:	Unintentional Persistent Organic Pollutants
USEPA:	United States Environmental Protection Agency
WHO:	World Health Organization

EXECUTIVE SUMMARY

This report outlines the findings of a study carried out in and around the city of Nairobi, Kenya by ENVILEAD. The study was carried out between the months of January and March 2005, about the patterns of practice that are likely to release persistent organic pollutants (POPs) into the environment as part of the International POPs Elimination Project (IPEP's) initiatives.

The focus of the study was the practice of medical and municipal waste burning, which research has shown to be a potential source of unintentional POPs (U-POPs). The study's objective was to investigate the anatomy of this practice, identify the key issues involved and make recommendations for the way forward.

It was established that burning is the dominant method of waste disposal in the city, and this is done through industrial incinerators and in the open air. The main reason for this preferred method of disposal is its convenience in the absence of a functioning system of waste management (by the City Council) and in the absence of adequate legal guidelines on the disposal of solid waste by the government. This practice is however also associated with several other factors such as lack of awareness on the part of the public, economic pressures and the general paucity of administrative capacity in Less Organized Countries (LOCs).

The study was able to establish that the area around the Dandora dumpsite, the city's biggest waste burning site, is highly contaminated with POPs. This was established from the results of U-POPs levels in eggs sampled from the site in a different study. There is also a high likelihood of other sites, such as the Kenyatta National Hospital (KNH) incinerator, whose maximum temperatures range between 600°C and 700°C and has no Air Pollution control Devices (APCD), and open-air burning site and Kitengela open burning site being U-POPs hotspots.

The study came up with the following key recommendations for the way forward:

- Additional research needs to be undertaken in order to gather more detailed information regarding this pattern of practice. Among the additional research required is in the area of relationship between the socio-economic dynamics and the practice, quantification of the levels of dioxin (as well as other organic pollutants and heavy metals) emissions from the identified sites, and establishment of the impacts of the same on public health;
- The legal framework for the safe disposal of solid waste, based on Best Available Techniques (BAT) and Best Environmental Practices (BEP), should to be addressed;
- The plastics industry, as a major contributor of difficult-to-manage waste, needs to be fully engaged in the search for solutions in the city's waste management programme;
- Greater effort should be placed in the development of alternative technologies for safe waste disposal, which should be affordable and sustainable;

- A popular appreciation of the science of ecology needs to be created in the country, as a means of ensuring sustained grassroots support for environmental conservation efforts.

INTRODUCTION

Background

Just as the generation of waste involves a complex interplay of social, cultural, economic and technological processes, the proper management of waste cannot be divorced from the same processes. While it is necessary, for conceptual purposes, to view waste management as a clear and distinct category of activity in society, in practice any successful waste management strategy has to address such diverse issues as patterns of consumption, incentive systems (the economics of waste management), waste handling technology, and legal frameworks. In its broadest sense, the issue of waste management is an aspect of the search for sustainable development strategies.

This report seeks to provide an overview of the critical issues regarding the management of municipal and medical waste in Nairobi, especially in respect of the potential danger of generating unintentional POPs (U-POPs) in the process of burning such waste. The study's broader objective is to assist in the development of a comprehensive waste management strategy for the city and other urban areas in the country, in the context of the provisions of the Stockholm Convention on Persistent Organic Pollutants (POPs). Annex C of the Stockholm Convention, identifies waste incinerators, including co-incinerators of municipal, hazardous or medical waste or of sewage sludge, as source categories with high potential to release U-POPs into the environment.

Municipal and medical waste was selected for study because of its large quantity as a percentage of the total waste generated[1], and the complex nature of issues involved in the proper management of these two types of waste. Nairobi City Council (2002) admits that it is unable to manage waste effectively in the city, and of particular concern was the proliferation of informal medical facilities, some of which are located within residential areas.

The Environmental Management and Coordination Act (1999), is well placed to manage waste, including POPs-contaminated waste, it gives provisions for setting of standards, licensing of waste disposal sites and control of hazardous waste. However, lack of enforcement mechanism is the biggest challenge facing waste management in Kenya (Nairobi City Council, 2002).

[1] A report by NEMA reveals that Nairobi generates approximately 2000 tonnes of waste per day. Of this, 68% is municipal waste generated from households (East Standard 2004)

Kenya as a country is in the process of developing a National Health Care Waste Management Plan. The National AIDS Control Council has just received funds from the World Bank toward the cost of Kenya's HIV/AIDS Disaster Response Project, part of the funds are to be used in the development of a National Health Care Waste Management Plan (Daily Nation, 2005).

The lack of enforcement of the relevant environmental law, among other key factors, has led to a chaotic situation in which almost anything goes as far as the handling of waste is concerned. A recent report by KIPPRA on solid waste management in Kenya shows that only 25% of the solid waste generated daily in the city of Nairobi is currently collected (UNEP 2005).

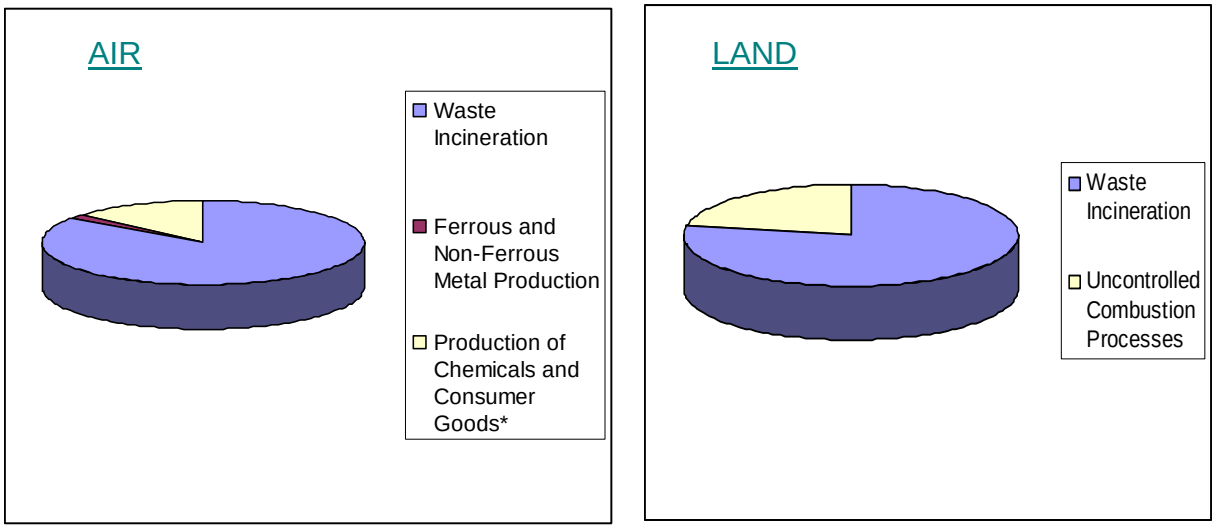
The focus of the study was waste burning, which any casual observation reveals to be the preferred waste disposal option for the Nairobi residents, which is a consequence of failure on the part of the City Council, and Government, to institute organized systems waste handling. The study looked at open air burning types and industrial incinerators.

Burning and POPs Generation

Polychlorinated dibenzo-p-dioxins (PCDD) and Polychlorinated dibenzofurans (PCDF), Hexachlorobenzene (HCB) and Polychlorinated Biphenyls (PCBs) are unintentional persistent organic pollutants (U-POPs), formed and released from thermal processes involving organic matter and chlorine as a result of incomplete combustion or chemical reactions. These U-POPs are commonly known as dioxins because of their similar structure and health effects (Tangri 2003).

These U-POPs are both of natural and anthropogenic origin. They resist photolytic, biological and chemical degradation. They are bio-accumulative, widespread geographically and are toxic to life. The concentration of U-POPs of anthropogenic origin has greatly increased over the years. Toxics Link Report (2000) identifies several potential sources of these U-POPs, among them being medical waste incineration and open burning of domestic waste.

According to USEPA estimates, municipal solid waste incineration and medical waste incineration are among the top sources of dioxins released into the air. They make up for 1,100gm TEQ/year and 477gm TEQ/year respectively (USEPA 1998). Of all source categories, combustion sources account for nearly 80% of air emissions.



Source: Kenya POPs Inventory

Fig. 1: Comparison of U-POPs emissions from different source categories in Kenya

Luscombe and Costner (2003) show how incinerators endanger public health and the environment in general. They identify the toxic pollutants in incinerator gases and residues, and enumerate the human health and environmental damage of the various chemicals in the incinerator releases. Connett (1998) shows how municipal waste incineration is a poor solution to the waste management problem. He lists the toxic emissions of incineration and shows how dioxins, furans and other by-products of combustion impact human health and the environment.

Objectives of Study

The overall goal of the study was to understand the (social, economic and technological) dynamics of the practice of waste burning in the city and to find out how this might contribute to the release of U-POPs into the environment. Other critical issues, such as the public health impact of the pattern of practice, were left for the next phase of the study.

The specific objectives of the study were:

i. to assess the extent of waste burning/incineration within Nairobi
ii. to establish the City Council of Nairobi's role in the prevalence of open burning and incineration as the preferred methods of waste disposal
iii. to identify the location of waste burning/ incineration sites in the city
iv. to find out how chlorine-containing waste (such as PVC plastics) is disposed
v. to assess the level of awareness of the general public about the adverse consequences of waste incineration

vi. to examine Government regulatory mechanisms for disposal of chlorine-containing waste
vii. to explore suitable BAT and BEP for waste management in Kenya.

Significance of Study

Article 5 of the Stockholm Convention requires parties, Kenya included[2], taking measures to reduce or eliminate releases from unintentional production of POPs. These measures include:

i. reduction of annual total releases derived from anthropogenic sources of U-POPs, with the goal of their continuing minimization and where feasible, ultimate elimination;
ii. the development of an action plan (NIP) by parties. Kenya's NIP should be ready by 25th December, 2006; and
iii. to promote BEP and incorporate BAT in the NIP.

The study's findings will be incorporated in Kenya's NIP of the Stockholm Convention with a view to assisting in the realization of the above measures.

METHODOLOGY

To achieve the objectives of this study, both primary and secondary data was used. Primary data comprised local views, perceptions and opinions related to the waste disposal sites among local community members. Various Government and other resource persons also provided valuable primary data for the study.

The state of the incinerators and dumpsites as well as the disposal methods were studied through observation by the researchers. Additional data was gathered through taking photographs of the sites and interviewing workers (where applicable) at the different sites visited.

Secondary data was obtained from both published and unpublished information on waste burning in Kenya and elsewhere in the world. Previous studies carried out on medical and municipal waste disposal at the global, regional, national and local levels were reviewed. Descriptive analysis was used to summarize the collected data.

Scope of the Study

The study was a preliminary investigation, intended to open the way for further detailed investigations of the same sites and other similar sites in the country.

[2] The convention came into force on 17th May 2004. Kenya became a party to the convention on 23rd December 2004

Preparation for the Study

Staff recruitment and training: Two research assistants were recruited and trained for fieldwork.

Stakeholders' identification: Various stakeholders were identified and approached for their views on the issue under investigation. These stakeholders included:

i. Members of public within Nairobi
ii. Health care professionals
iii. The Occupational Health Officer, Ministry of Health
iv. National Environmental Management Authority (NEMA)
v. Kenya Association of Manufacturers
vi. Major Supermarkets in town
vii. Private waste handlers
viii. City Council of Nairobi

Locations of Interest

For the study of medical waste management, researchers chose to visit a few health care institutions based in Nairobi. These were: Kenyatta National Hospital (KNH), Nairobi Hospital, Mater Hospital and Forces Memorial Hospital. For the study of municipal waste management, the researchers visited the Nairobi City Council's dump site at Dandora as well as several residential estates in Nairobi including: Jericho, Kariobangi, Huruma, Ngomongo, Baba dogo, Muthurwa, Shauri moyo, Kimathi, Buruburu, Lucky Summer and Korogocho all in Eastlands; Westlands, Kangemi, Uthiru and Kikuyu along Waiyaki Way in the West side of Nairobi, and Kitengela to the south of the city.

AREA OF STUDY

Nairobi is the largest town in Kenya and also the country's capital city. It covers an area of 696 km² and currently has a population of 2,143,254 and population density 3,079 per square kilometre (GoK, 2000).

At 1.5 ^{0} south of the equator, Nairobi is a tropical city. Its altitude of 5,000 to 6,000 feet means that the climate is temperate. Rainfall is divided between two rainy seasons: the short rains fall in November and early December, and the long rains between April and mid-June. Because it is virtually on the equator, Nairobi has a constant twelve hours of daylight per day all year round. The sun rises at 6.30 - 7.00a.m and sets again at 6.30 - 7.00 p.m.

The average day-time temperature varies only slightly throughout the year, ranging from 85°F (29°C) in the dry season to 75°F (24°C) during the rest of the year. At night, however, temperatures can drop to as low as 48°F (9°C), though rarely lower.

Founded as a last halt before the Highlands for railway engineers in the early 1900s, Nairobi, which was then just a few shacks and tracks, now covers 696 square kilometres. This figure includes 120 square kilometres of the Nairobi Game Park and all of Jomo Kenyatta International Airport. Central Nairobi barely makes up five square kilometres.

LITERATURE REVIEW

Tangri (2003), notes that despite intensive scrutiny over many years, much remains unknown about the releases of pollutants from waste-burning activities. Waste burning produces hundreds of distinct hazardous by-products of which only a handful of them have been studied thoroughly. Hundreds remain unidentified. Connett (1998) identifies some of the toxic emissions of incineration. These include: hydrogen chloride, nitric oxide, heavy metals, dioxins, furans and other U-POPs, fly ash, bottom ash, stack gas, fugitive emissions plus other residues.

Polythene bags and plastics, including PVC items, make up approximately 225 tonnes out of the 2000 tonnes of solid waste generated daily in Nairobi (KAM, 2003). This represents about 11% of total waste generated daily, while 75% comprises biodegradable waste that can be composted. The remaining percentage is made up of other recyclable materials such as textiles, metal and glass making up 2.7%, 2.6% and 2.3% respectively. Open burning of municipal waste is widely used by the residents of Nairobi, as a means of disposing solid waste.

The following facts regarding plastics were identified from literature:

- According to KAM, consumers and end users are the ones who cause environmental pollution from plastics;
- Not all plastics emanate from the local industry, some is imported;
- The plastics sector currently constitutes approximately 150 industries, and has an annual growth rate of 6%;
- Currently, there are about 70 firms that recycle plastics locally; and
- Plastics contribute 28% of all cadmium found in municipal solid waste and approximately 32% of all lead; substances that are highly toxic to humans and the environment in general.

Health Effects

Because of the persistent and bio-accumulative nature of dioxins and furans, these chemicals exist throughout the environment. Human exposure is mainly through consumption of fatty foods, such as milk. USEPA (2000) in Tangri (2003) notes that 90-95% of human exposure to dioxins is from food, particularly meat and dairy products. This is because dioxins accumulate in fats and oils[3]. Their health effects depend on a variety of factors, including the level of exposure, duration of exposure and stage of life during exposure.

Some of the probable health effects of dioxins and furans include the development of cancer, immune system suppression, reproductive and developmental complications, endocrine disruption (GAIA, 2003; Connett, 1998; Luscombe and Costner, 2003). The International Agency for Research on Cancer (IARC) has identified 2,3,7,8 – TCDD as the most toxic of all dioxin compounds.

Environmental and Socio-economic Effects

The accumulation of dioxins and furans in the environment owing to waste incineration activities can reach levels that render resources unfit for human consumption. Connett (1989), cited in Connett (2003), reports of an incident in Netherlands where 16 dairy farmers downwind of a huge incinerator in Rotterdam could not sell their milk because it contained three times higher dioxin levels than anywhere else in Netherlands.

Even low doses of dioxins are very toxic. In 1998, the WHO lowered its recommended Tolerable Daily Intake (TDI) of dioxins from 10 picograms TEQ per kilogram of bodyweight per day (pg/kg/day) to a range of 1-4 pg/kg/day (Van Leeuwen and Younes 1998). According to studies conducted in Netherlands, prenatal exposure to typical daily intake of dioxins and PCBs has effects on neurodevelopment and thyroid hormones. Deficits of up to four points in IQ and increased susceptibility to infections in 42 month old children exposed to typical daily intakes of dioxins/PCBs were observed (Patandin 1999).

Incineration produces residues that require treatment and/or disposal, most often in a landfill. Incinerator ash - either as bottom ash or fly ash – is highly toxic. Tangri (2003) observes that handling of this ash raises serious concerns because workers are often exposed to the ash, sometimes with little or no protective gear.

In India just like in Kenya, Toxic Link (2000), notes that incineration is rudimentary and most incinerators are single chambered with a smoke stack. Major reasons for dioxin emissions from such waste incinerators are:

[3] WHO (1999) points out that dioxins are highly persistent for they breakdown very slowly and have a half-life in human body of about 7 years.

- almost all of them burn mixed waste;
- due to lack of enforcement and monitoring, most of the hospitals are incinerating their plastic waste and also waste treated with chlorinated disinfectant;
- many of the incinerators still have single chambers, in spite of the fact that the installation of double (secondary) chambers is needed to eliminate volatile substances by better combustion; and
- most of the incinerators do not operate under stipulated temperature. Under the regulations, primary chambers should operate at 850º C and secondary chambers should operate at 1000º C or more.

Tangri (2003) has enumerated several problems particular to transferring incineration technology to the developing countries. These problems include:

- lack of monitoring - no ability to regularly monitor stack emissions or incinerator ash toxicity;
- lack of technical capacity to test releases - not able to conduct tests for dioxins and other pollutants;
- lack of secure landfills for ash - toxic incinerator ash dumped in, at best, an unlined pit, where it runs the risk of contaminating groundwater. Access to the ash land not controlled;
- corruption[4];
- shortage of trained personnel - necessary number of trained Manpower to manage incinerator operations;
- budgetary constraints - hinder maintenance and replacement of key incinerator functions; and
- differing physical conditions and lack of robustness of technology - where incinerator technology imported from the west is not appropriate to the Southern conditions.

Other Pollutants from Incineration

In addition to dioxins, polychlorinated biphenyls (PCBs) and Hexachlorobenzene (HCB), incinerators are sources of other halogenated organic compounds, toxic metals and greenhouse gases to name but a few[5]. Toxic metals released from incineration activities include: Mercury, Lead, Cadmium, Arsenic, Chromium, Beryllium, Antimony, and Manganese. Stanners and Bourdeau (1995), cited in Tangri (2003), give a worldwide atmospheric emissions estimate of trace metals from waste incineration; this is summarized in the Table 1 below:

[4] Where there is corruption the likelihood of installing substandard equipment for kickbacks is high.
[5] [Blumenstock et al (2000) in Tangri, (2003)].

Table 1. Worldwide atmospheric emissions of trace metals from waste incineration

Atmospheric emissions from waste incineration		
Metal	**1000 tons/year**	**% of total emission**
Antimony	0.67	19.0
Arsenic	0.31	3.0
Cadmium	0.75	9.0
Chromium	0.84	2.0
Copper	1.58	4.0
Lead	2.37	20.7
Manganese	8.26	21.0
Mercury	1.16	32.0
Nickel	0.35	0.6
Selenium	0.11	11.0
Tin	0.81	15.0
Vanadium	1.15	1.0
Zinc	5.90	4.0

Source: Stanners and Bourdeau (1995), in Tangri (2003), page 17

Public Opposition to Incineration

Waste incineration is unpopular in many countries. In the USA, for example, since 1985, over 300 trash incinerator proposals have been defeated or put on hold due to public opposition, and several large engineering firms have pulled out of the incinerator business altogether (Connett 1998). In Michigan, all but one of the 290 medical waste incinerators in the state closed down rather than attempt to meet federal emissions limits imposed in 1997 (Tangri 2003). Tangri (2003) reports that in 2001 alone, major incinerator proposals were defeated by public opposition in France, Haiti, Ireland, Poland, South Africa, Thailand, UK, Venezuela.

Even in poor countries such as Bangladesh, public opposition to incinerators has yielded changes. A proposal by an American company to build a power station which would burn trash shipped-in from New York City to Khulna in Bangladesh was defeated by public opposition (Connett 1998). In 2000, GAIA was launched. GAIA members work both against incineration and for the implementation of alternatives Tangri (2003).

Kenya Eggs Study

A study in early 2005 on egg-sampling by ENVILEAD and Arnika (under the Dioxin, PCBs and Waste Working Group of IPEN) found eggs collected around the Dandora dumpsite in Nairobi, Kenya, to have dioxin levels over 6 times higher than the EU dioxins limits for eggs. In addition, the sampled eggs

exceeded the proposed WHO limits for PCBs by more than 4-fold (Fig. 2). It is estimated that the Dandora open dumpsite handles 803,000 tons of waste per year (National inventory of POPs, 2004).

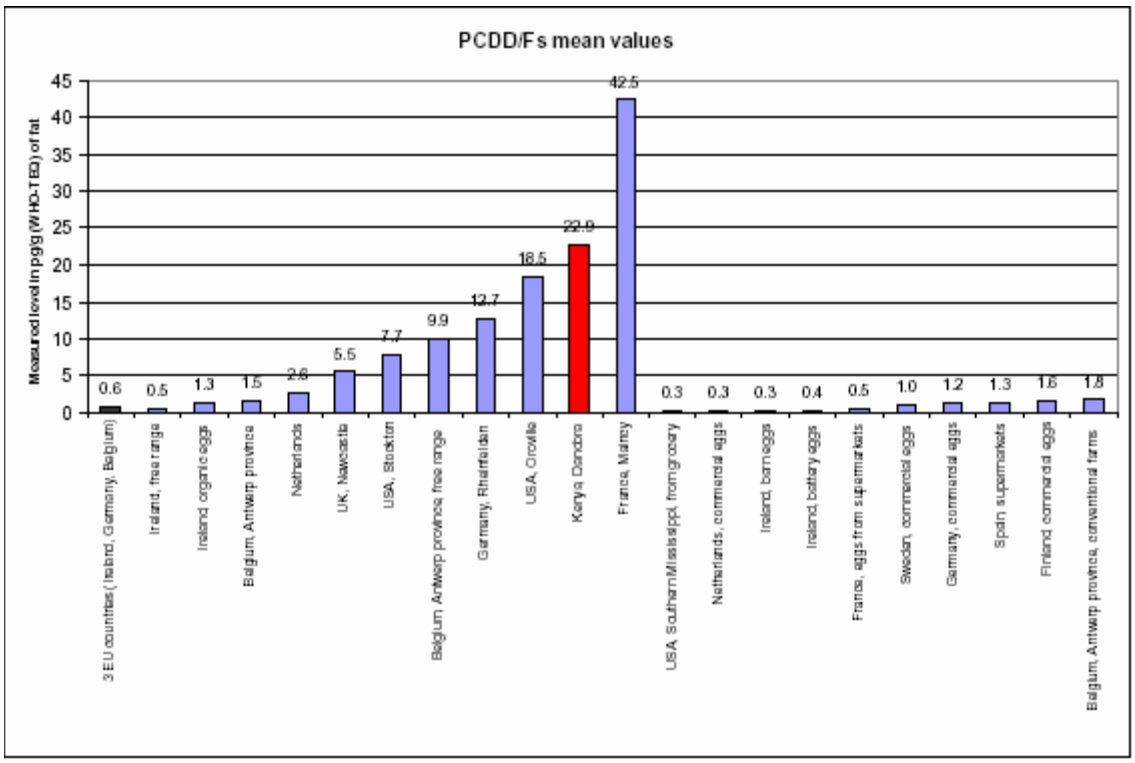


Fig. 2: Mean values (PCDD/Fs) found in Eggs Sampled from Dandora – Kenya, compared with levels in eggs from other contaminated sites in the world
Source: The Egg sampling report by ENVILEAD and ARNIKA (2005)

STUDY FINDINGS

Basic Findings

The study made several basic findings that will be important in the search for waste management solutions in Nairobi and elsewhere in the country. Among these are:

a. **The nature of consumer demand:** In the Kenyan market, where more than half the nation's population lives below the poverty line, plastic constitutes a very attractive option as the material of choice for numerous domestic, medical and industrial products. The business organizations that researchers were able to visit, such as supermarkets and plastics' manufacturers, confirmed cost attractiveness of plastic to local consumers. There is therefore a basic market-based challenge to the problem of waste management,

comprising rational economic action linking consumers, manufacturers and traders.

b. **Legal framework and administrative capacity:** Waste is a necessary outcome of any production and consumption process. But in the real world, the quantity of waste a society produces has implications on the resources the society requires for managing the same. It is therefore necessary, especially where resources for waste management are very limited, to institute measures that reduce the overall quantity of waste generated, with a special focus on products such as plastics that are especially problematic in safe disposal.

   Proper waste management requires enforcement of the existing legal provisions. The study established that Kenya has a sound legal framework (EMCA, 1999) for guiding the utilization of BEP and BAP in waste management. However, the law is not enforced to the letter. It was established that most health institutions, including KNH, do only rudimentary segregation of waste. Of the hospitals visited, only Nairobi Hospital and Mater Hospital had a thorough waste segregation system.

   The existence of suitable legal guidelines is however only one part of the requirements for a proper system of waste management. The other part has to do with administrative capacity to enforce such law. The study established that the City Council, which has the legal responsibility for managing solid waste in the city, has an alarming lack of administrative capacity for this role. For example, the Dandora dumpsite, which is supposed to be under the management of the Council, is a veritable health and ecological time-bomb for Nairobi and its environs.

General Findings

The following were the study's general findings:

I. The level of public awareness on the adverse effects of waste burning activities and U-POPs among the residents is pathetically low. A majority of the study's respondents could not link any ill-health to incineration activities and U-POPs as a major health threat;
II. All the main health institutions in Nairobi such as KNH, Nairobi Hospital, Mater Hospital, and Forces Memorial Hospital either have their own incinerators or hire the services of one. In addition however some of the institutions are involved in open air burning. For instance, the biggest hospital in Kenya (KNH) burns some of its waste mostly consisting paper, plastics, clothing etc – usually considered to be of low risk - in an open pit in front of the incinerator;

III. Open burning of municipal waste is widely used by the residents of Nairobi, as a means of disposing solid waste. In a survey of two blocks' area around Pumwani in Eastlands, Nairobi, eight small open air waste burning sites were counted, all of which had assorted plastics;
IV. The incinerator at Kenyatta National Hospital, which is situated just a few metres upwind from the residential homes of low cadre staff of the hospital and medical students' hostels, operates at temperatures between 350°C and 650°C and has no APCD. The incinerator emits noxious fumes that are carried to the homes and hostels, causing considerable distress to the residents;

Plate: Kenyatta National Hospital open dumpsite:
At the background are hospital staff quarters

V. The dioxin-rich bottom ash from incinerators around Nairobi is normally deposited at the Dandora dumpsite;
VI. The Dandora dumpsite constitutes the most prominent, and challenging, manifestation of problems arising out of the waste-burning pattern of practice in Nairobi;
VII. The level of waste recovery, reuse and recycling is grossly inadequate. For example, only 1% of plastics are recycled (KAM, 2003);
VIII. The legal framework regulating waste burning activities is sound. However, the enforcement of the law is weak; and
IX. The Nairobi City Council lacks the capacity to manage the waste generated in the city effectively;

Table 2 below shows a number of major companies in Nairobi that dump their mixed waste in Dandora dumpsite. It is therefore necessary for the private sector to be involved in the search for waste management solutions as they are major contributors of waste.

Table 2. Waste disposal methods for various major companies in Nairobi

Company/organization	Contents of waste	Estimated weight in tons/month	Method of disposal
Jomo Kenyatta International Airport (JKIA)	Mixed aircraft waste	300	Waste dumped in Dandora dumpsite
Kenya Revenue Authority staff quarters	Household/domestic waste	285	Waste dumped in Dandora dumpsite
Kenya Shell Company (Shell & B.P. House)	Commercial waste	60	Waste dumped in Dandora dumpsite
Kenya breweries	Household and commercial	200	Waste dumped in Dandora dumpsite
NAS Airport Services	Food & food packaging	350	Waste dumped in Dandora dumpsite
Swan Industries	Commercial & industrial waste	350	Waste dumped in Dandora dumpsite
Kenya Shell aviation Stations	Commercial & food waste	72	Waste dumped in Dandora dumpsite
Orbit Chemicals	Polythene sheet cuttings & plastic drums	-	• Plastics recycled • Paper & drum sold • Other waste dumped near Athi River.

Source: Kenya National Inventory of POPs (2004)

Findings on Health Effects and Exposure Pathways

The study was not able to carry out a comprehensive investigation into the health consequences of the incinerators and open air burning sites visited. There were however complaints about chest complications and serious smoke irritation for those living downwind from the KNH incinerator, as well as from those living around the Dandora dumpsite.

The main exposure pathways for any contamination from the sites visited in the study are:

- Inhalation of the pollutants-infested smoke and fly ash carried across by the wind;
- Consumption of animal products such as meat, milk and eggs from animals feeding within and around the sites;
- River water from a river flowing next to the Dandora dumpsite and serving numerous people downstream on its way to the Indian ocean; and
- Ground water reserves affected by leachate from the Dandora dumpsite.

It is worth noting that some categories of people are at higher risks of exposure to dioxins than others. These include children, infants, some workers, people

who eat fish as a main staple of their diet and people who live near dioxin release sites. CHEJ (1999) observes that these groups are likely to be exposed to at least 10 times as much dioxin as the general population.

CHALLENGES TO THE STOCKHOLM CONVENTION: RESPONSIBLE PARTIES - KENYA

POPs and Scientific Development

The existence of POPs worldwide is one of the best illustrations of the Frankenstein nature of scientific and technological development. While progress in science and technology has greatly increased humanity's power to modify its environment for its benefit in ways previously unimagined, the same progress has created threats of similar magnitude to humanity and the planet as a whole. The last century has been called an "era of chemicals", where more than 18 million chemicals were synthesized and about 100,000 of them came into commercial use (Toxics Link 2000).

It was not until the publication of Rachel Carson's book, "The Silent Spring", that the general public's attention was drawn to the dark side of the chemical revolution. The Stockholm Convention is in many respects an effort to interpret Carson's thesis into social action. The broader framework of the Stockholm Convention's objectives should be viewed as completing the loop of knowledge in chemistry, through developing the institutional capacity to control the real and potential danger of chemicals. The realization of the Stockholm Convention's mandate would be the coming of age of the chemical revolution. As Isaac Asimov put it, "The saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom."

POPs and Less Organized Countries

The above-outlined problems are relevant to Kenya and other Less Organized Countries (LOCs). In addition though, LOCs face several challenges that are unique to their special circumstances. Among these is the sheer pressure of survival priorities.

The immediacy of hunger, debilitating disease, social and economic dislocation, and other such concerns that affect large sections of society in LOCs is such that an issue like that of POPs is unlikely to find a place at the fore of the national agenda.

The psychological environment of desperate social and economic circumstances has a tendency to promote fatalism and other behavioural tendencies that are not conducive to organized long term action based on people's faith in their ability to

influence the course of their destiny. A good illustration of this is the challenge that the behaviour-change message in the HIV/Aids campaign in Africa has faced, despite the powerful and very public nature of the AIDS pandemic. Galvanizing community action for the POPs eradication campaign shall require very well thought-out strategies, and competent leadership.

In addition to the problem of priorities, LOCs face a big challenge of organizational capacity in the campaign against POPs. The low levels of organizational capacity in LOCs translate to challenges in administrative competence, financial resources, technological resources, monitoring ability and other such key requirements for an effective POPs eradication campaign.

With sufficient support there are specific organizations within LOCs that can make a real and positive difference in such a campaign. In the long run, in order for any major campaign such as that of the Stockholm Convention to be truly successful, the campaign has to be done in the context of an overall sustainable development strategy. Such a campaign would have implications going beyond specific issue of POPs.

The crippling nature of incinerator debt.
Capital costs of incinerator projects for instance, drain the resources of LOCs and increase their indebtedness through the need for foreign financing to build and maintain such facilities not forgetting continued reliance on manufactured products from other nations. Instead of allowing nations to develop new industries and reduce foreign imports, incinerators transform these resources into smoke and ash.
Analysis by a local environmental group in Miljoteknik Zychlin, Poland revealed that the debt for the US$5million proposed incineration facility would have taken the community of 14,000 residents over 100 years to repay! - Brenda Platt (2004)

For example, a successful POPs elimination campaign may need to involve fundamental changes in the agricultural sector, waste management approaches and legislation (as well as enforcement mechanisms) dealing with chemical safety in general. Such an agenda requires very considerable organizational capacity both within the public sector and civil society, which is the big challenge for LOCs.

The Environment and Economy

While the growth of science and technology has an important bearing on the dangers to the environment that the Stockholm Convention and similar other Conventions seek to counter, it is the market economy that provides the framework within which the power of science and technology can be projected into the world.

As is the case with science, measuring economic development in a one-dimensional manner, purely in terms of (monetary) returns on investment and not the overall impact of the concerned economic activity on society and the natural environment, is unsatisfactory. In economics, problems arising from the undesirable consequences of economic activity that are not captured in the pricing structure of products are called negative externalities.

Negative externalities are those situations arising from economic activity that create costs to the society that are not reflected in the balance sheets of the concerned businesses. For example, in pricing its products, a given organization may include the cost of labour, energy, marketing, finance and other such inputs but leave out the cost (borne by the society) of medical and other costs directly attributable to harmful effects of the organization's products.

POPs ought to be treated as an aspect of the problem of externalities in economic theory, and solutions sought within the framework of approaches developed in the discipline of economics to deal with this problem.

ALTERNATIVE PRACTICES

Other than incineration, landfilling and composting are alternative methods of waste disposal used in the country, although to a minimal extent. More often than not, individuals and community-based organizations (CBOs) are the ones involved in composting biodegradable waste mostly on a commercial basis. Landfilling is commonly practiced in the smaller health facilities such as District hospitals, health centers and clinics, but most of these landfills are not built to standard. Other landfills in the country are situated in Mombasa and Nakuru for municipal waste disposal, built through the assistance of Agence Francaise de Développement (AFD), a French operation that works through the government.

Alternative Technologies for Hazardous Waste Treatment

In developed countries, non-incineration technologies for hazardous waste treatment are available; these include several processes summarized by Crowe and Schade (2002) in Tangri (2003) in Table 3.

Table 3. Non-Incineration technologies for hazardous waste treatment

Technology	Process description	Potential Advantages	Current Uses
Base Catalyzed Dechlorination	Wastes reacted with alkali metal hydroxide, hydrogen and catalyst material. Results in salts, water and carbon.	Reportedly high destruction efficiencies. No dioxin formation.	Licensed in the United States, Australia, Mexico, Japan, and Spain. Potential demonstration for PCBs through United Nations project.
Biodegradation (in enclosed vessel)	Microorganisms destroy organic compounds in liquid solutions. Requires high oxygen/nitrogen input.	Low temperature, low pressure. No dioxin formation. Contained process.	Chosen for destruction of chemical weapons neutralent in the United States. Potential use on other military explosive wastes typically used for commercial wastewater treatment.
Chemical Neutralization	Waste is mixed with water and caustic solution. Typically requires secondary treatment.	Low temperature, low pressure. Contained and controlled process. No dioxin formation.	Chosen for treatment of chemical agents in the United State.
Electrochemical Oxidation (Silver II)	Wastes are exposed to nitric acid and silver nitrate treated in an electrochemical cell.	Low temperature, low pressure. High destruction efficiency. Ability to reuse/ recycle process input materials. Contained process. No dioxin formation.	Under consideration for chemical weapons disposal in the United States. Assessed for treatment of radioactive wastes.
Electrochemical Oxidation (CerOx)	Similar to above, but using cerium rather than silver nitrate.	Same as above; cerium is less hazardous than silver nitrate.	Demonstration unit at the University of Nevada, USA. Under consideration for destruction of chemical agent neutralent waste.
Gas Phase Chemical Reduction	Waste is exposed to hydrogen and high heat, resulting in methane and hydrogen chloride.	Contained, controlled system. Potential for reprocessing by-products. High destruction efficiency	Used commercially in Australia and Japan for PCBs and other hazardous waste contaminated materials. Currently under consideration for chemical weapons destruction in the United States. Potential demonstration for PCB destruction through United Nations project.
Solvated Electron Technology	Sodium metal and ammonia used to reduce hazardous wastes to salts and hydrocarbon compounds.	Reported high destruction efficiencies.	Commercially available in the United States for treatment of PCBs.
Supercritical Water Oxidation	Waste is dissolved at high temperature and pressure and treated with oxygen or hydrogen peroxide.	Contained, controlled system. Potential for reprocessing by-products. High destruction efficiencies.	Under consideration for chemical weapons destruction in the United States. Assessed for use on radioactive wastes in the United States.
Wet Air Oxidation	Liquid waste is oxidized and hydrolyzed in water at moderate temperature	Contained, controlled system. No dioxin formation.	Vendor claims 300 systems worldwide, for treatment of hazardous sludges and wastewater

Source: Crowe and Schade (2002) in Tangri 2003, page 62

From the study, we found out that none of the above stated technologies is used in Kenya**.**

RECOMMENDATIONS

The study proposes the following measures:

I. Additional studies should be undertaken to acquire additional and more detailed information about the waste burning and incineration and its consequences in Kenya. This includes analysis and quantification of U-POPs in biotic and abiotic systems and their impact on public health;

II. In line with Article 10 of the Stockholm Convention, Public information, awareness and education on U-POPs should be carried out, for a well informed citizenry will make a big contribution on efforts geared towards elimination/ and reduction of the U-POPs. Proper education and training in waste management must be offered to all stakeholders in a way best suites their respective circumstances and builds their understanding and changes their behaviour accordingly;

III. Subsidiary legislation addressing waste incineration should be enacted under the Environmental Management and Coordination Act (1999). This should guard against indiscriminate burning of waste;

IV. A buy-back scheme for used plastics should be instituted. This should not be difficult to do because the plastics industry is willing to manage waste sites in all major population areas where the manufacturers will buy plastic waste from the general public. Such collection centres would be set up and fully funded by the same manufacturers (KAM, 2003);

V. A national campaign, financed by the plastics industry should be launched, giving the public exact details of where to take their plastic waste for recycling. Supermarket chains should also be encouraged to allocate bins in their branches where customers can bring back plastic carrier bags and other items for recycling;

VI. A zero waste program should be introduced immediately and eventually developed into policy. It has been tried and tested in other countries and it is rapidly gaining acceptance the world over. Within the zero waste program, there should be a rigorous national campaign lobbying for an end to open burning and incineration of waste and in particular waste that contains PVC;

VII. Waste segregation at source should be the standard practice in all households and medical facilities. The current waste management practice in which waste materials are all mixed together as they are generated, collected, transported and finally disposed of should be stopped. If proper segregation is achieved through training, clear standards, and tough enforcement, then resources can be turned to the

management of the small portion of the waste stream needing special treatment[6];

VIII. A policy of Extended Producer Responsibility (EPR) should be put in place. The basic concept of EPR is that firms must take responsibility for their products over their entire life cycles (Tangri 2003). This is in harmony with the "Polluter Pays" principle of the Stockholm Convention;

IX. Statutory regulations to force manufacturers to use at least 15% recycled plastics in their non-food products should be imposed. In this way demand for plastic waste will be created therefore leaving little if anything for disposal. Since to install capacity for recycling is expensive however, the plastics' industry should be given tax incentives for the exercise;

X. Cleaner production based on a circular vision of the economy should be encouraged. Cleaner production aims at eliminating toxic wastes and inputs by designing products and manufacturing processes in harmony with natural ecological cycles (Tangri 2003);

XI. Product bans ought to be made for certain categories of manufactures. Products and packaging that create waste problems (non-recyclable or hazardous- such as polyvinyl chloride - PVC) for the society should not be allowed to enter into the economy. Bans are appropriate for materials that are problematic at every stage of their lifecycles (Ryder 2000 in Tangri 2003);

XII. Infrastructure for the safe disposal and recycling of hazardous materials and municipal solid waste should be developed. Approximately 50% of all waste is organic, and can therefore be composted. Another large segment of the remainder can be recycled, leaving only a small portion to be disposed. The remaining portion can then be disposed through sanitary landfills, sewage treatment plants, and other technologies.

To ensure continuity and clarity in the proposed recommendations, clear plans and policies on management and disposal of waste should be developed. This should be followed by integrating them into routine workers' training, continuing education and evaluation processes for systems and personnel. Involvement of all stakeholders including public interest NGOs and other civil society in developing and implementing a waste management scheme is necessary for successful implementation of the Stockholm Convention.

[6] Platt and Seldman (2000), show how comprehensive waste composting, reuse and recycling programmes generate ten times as many jobs per tonne of municipal waste as do incinerators.

CONCLUSION

The burning of waste as a method of waste disposal in Nairobi clearly constitutes a pattern of practice which contributes to the release of U-POPs into the environment. As suggested by the term “pattern”, this practice is a complex process involving economic factors, people’s attitudes, governance issues and other such components. It is a matter requiring detailed study and much creative effort to address satisfactorily.

In its broader context, the issue of waste management is an aspect of the challenge of sustainable development. Inability to deal with waste in such a way as it does not harm people or the environment is an indication of an ecologically unsustainable system of social organization. The challenge of sustainable development is to design an economic and technological system that is in harmony with ecological principles.

The current dominant system of economic and technological organization in the world is powerful and in many respects very successful. It is however not a sustainable system and in fact constitutes a veritable danger to the survival of life in the planet. There is need to review some of the system’s most basic organizational principles, as a way out of the dangerous trajectory it has set for humanity.

The poorly formed social structures and systems in LOCs, especially in sub-Saharan Africa, may ironically make the best hope for the development of fresh, ecologically sustainable development approaches. LOCs have the opportunity to build their houses with the special benefit of a wealth of knowledge of the successes, and follies, of the past. LOCs should proceed to build their societies with energy and enthusiasm, but with the clear understanding that humanity cannot stand outside, or above, the ecological order that sustains all other life in the planet.

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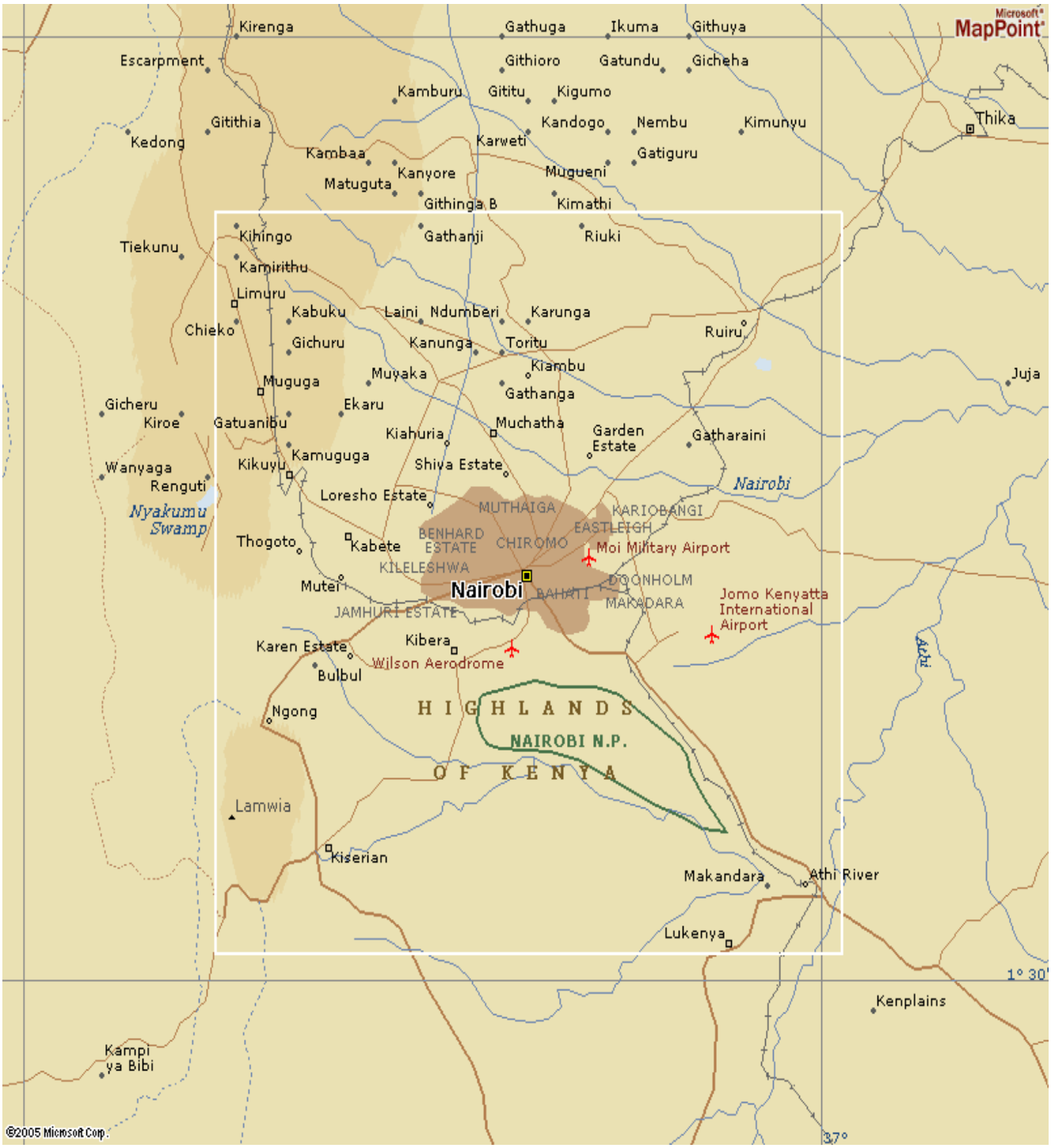
ANNEX 1: MAPS

1. Map of Kenya

Note Nairobi's position and the other major towns (the red dots) which could have similar environmental challenges.

2. Map of Nairobi



The brown patch at the center of White square is the heart of Nairobi. Note the Nairobi River, which joins the Athi River on the way to the Indian Ocean.

ANNEX 2: PLATES

1. Dandora dumpsite

This is the Western edge of the Dandora dumpsite. The houses in the foreground are part of the Korogocho slums. In the background is lucky-summer estate. The dumpsite is surrounded by densely populated residential quarters.

2. Kitengela Town Dump

Notice the persons in the way of the smoke. These are scavengers at the site who work in this environment on a daily basis.

3. Waste content of the dumpsites

Typical contents of dumpsites around Nairobi. Notice the high proportion of plastics.

4. Medical Waste awaiting incineration (KNH)

The maximum temperature of the hospital's incinerator on the right is 700ºC

5. The Nairobi river (foreground) flowing past the Dandora Dumpsite

Note the mountain of burnt ashes in the background