Environmental Pollution and Impacts on Public Health:

Implications of the Dandora Municipal Dumping Site in Nairobi, Kenya

Report Summary

Based on a study by Njoroge G. Kimani in cooperation with
United Nations Environment Programme and the St. John Catholic Church, Korogocho

UNEP

Urban Environment Unit
United Nations Environment Programme (UNEP)
P.O. Box 30552, Nairobi - KENYA.
Telephone: +254-20-7624184, Fax: +254-20-7624249
Email: urban.environment@unep.org
web: http://www.unep.org/urban_environment

UNEP

Photo: UNEP

UNEP
promotes
environmentally sound practices
globally and in its own activities.
This publication is printed on paper from
sustainable forests including recycled fibre. The
paper is chlorine free, and the inks vegetable-
based. Our distribution policy aims to reduce
UNEP's carbon footprint.

1. Introduction

Over the last three decades there has been increasing global concern over the public health impacts attributed to environmental pollution, in particular, the global burden of disease. The World Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution. Most of these environment-related diseases are however not easily detected and may be acquired during childhood and manifested later in adulthood.

Improper management of solid waste is one of the main causes of environmental pollution and degradation in many cities, especially in developing countries. Many of these cities lack solid waste regulations and proper disposal facilities, including for harmful waste. Such waste may be infectious, toxic or radioactive.

Municipal waste dumping sites are designated places set aside for waste disposal. Depending on a city's level of waste management, such waste may be dumped in an uncontrolled manner, segregated for recycling purposes, or simply burnt. Poor waste management poses a great challenge to the well-being of city residents, particularly those living adjacent the dumpsites due to the potential of the waste to pollute water, food sources, land, air and vegetation. The poor disposal and handling of waste thus leads to environmental degradation, destruction of the ecosystem and poses great risks to public health.

2. About the Study

To emphasize the link between environmental pollution and public health in an urban setting, United Nations Environment Programme (UNEP) commissioned a pilot study of the Dandora municipal waste dumping site in Nairobi, Kenya. Environmental samples (soil and water) were analyzed to determine the content and concentrations of various pollutants (heavy metals, polychlorinated biphenyls and pesticides) that are known to affect human health. Soil samples from the dumpsite were compared to samples taken from another site - Waithaka, which is a peri-urban residential area on the outskirts of Nairobi.

Photo: UNEP

A medical camp was set up at the St. John Informal School that is located next to the dumpsite. A total of 328 children and adolescents living and schooling adjacent the dumpsite were examined and treated for various ailments. Of these, 40 were referred for further laboratory tests that entailed blood and urine sampling to assess the impact of exposure to environmental pollutants from the dumpsite on human health.

Photo: UNEP

The flow chart below shows the link between the environmental pollutants from the dumpsite and public health impacts on the adjacent communities. This link is further explained in this report.

Flow Chart of the Public Health Effects brought about by Environmental Pollution emanating from Dandora Waste Dumping Site

DANDORA WASTE DUMPING SITE

- Industrial Waste e.g., falloff or unused chemicals and raw materials, expired products and substandard goods
- Agricultural Waste e.g., pesticides (herbicides and fungicides)
- Hospital Waste e.g., packaging materials and containers, used syringes and sharps, biological waste and pharmaceuticals

ENVIRONMENTAL POLLUTANTS

- Heavy Metals e.g., lead, mercury, cadmium, arsenic, chromium, zinc, nickel and copper
- Persistent Organic Pollutants e.g., aldrin, dieldrin, dichlorodiphenyl-trichloroethane (DDT), endrin, heptachlor, toxaphene, chlordane, hexachlorobenzene, mirex (organochlorines, organophosphates, carbamates) and polychlorinated biphenyls (PCBs)

ROUTES OF EXPOSURE

These toxicants can be found in air, water and soil and could find their way into the human body through:

- Inhalation – movement of air from the external environment through the airways during breathing
- Ingestion – the consumption of a substance by an organism either man or animals
- Absorption – the movement and uptake of substances into cells or across tissues such as skin by way of diffusion or osmosis

PUBLIC HEALTH EFFECTS

- Skin Disorders – Fungal infection, allergic dermatitis, pruritis and skin cancer
- Respiratory Abnormalities – bacterial upper respiratory tract infections (pharyngitis, laryngitis and rhinitis), chronic bronchitis and asthma
- Abdominal and Intestinal Problems – bacterial enteritis, helminthiasis, amoebiasis, liver cancer, kidney and renal failure
- Dental Disorders – dental carries and dental pain
- Ear Infections – otitis media and bacterial infections
- Skeletal Muscular Systems – back pain
- Central Nervous System – impairment of neurological development, peripheral nerve damage and headaches
- Eye Infections – allergic conjunctivitis, bacterial eye infections
- Blood Disorders – Iron deficiency anaemia
- Others – malaria, chicken pox, septic wounds and congenital abnormalities, cardiovascular diseases and lung cancer

3. The Dandora Municipal Waste Dumping Site

The Dandora Municipal Waste Dumping Site, located to the East of Nairobi, is the main dumping site for most of the solid waste from Nairobi area. The site is about 8 kilometers away from the city centre and occupies about 30 acres of land. Surrounding the dump are the Kariobangi North and Korogocho informal settlements and the residential estates of Dandora and Babadogo. Over 2,000 tonnes of waste generated and collected from various locations in Nairobi and its environs are deposited on a daily basis into the dumpsite and what initially was to be refilling of an old quarry has given rise to a big mountain of garbage. Dumping at the site is unrestricted and industrial, agricultural, domestic and medical wastes (including used syringes) are seen strewn all over the dumping site.

The Nairobi River also passes beside the dumpsite. Some of the waste from the dump ends up into the River thus extending environmental and health risks to the communities living within the vicinity as well as those living downstream who could be using the water for domestic and agricultural purposes like irrigation.

Photo: UNEP

4. Environmental Pollution and Impacts of Exposure

Heavy metals are metallic elements that are present in both natural and contaminated environments. In natural environments, they occur at low concentrations. However at high concentrations as is the case in contaminated environments, they result in public health impacts. The elements that are of concern include lead, mercury, cadmium, arsenic, chromium, zinc, nickel and copper. Heavy metals may be released into the environment from metal smelting and refining industries, scrap metal, plastic and rubber industries, various consumer products and from burning of waste containing these elements. On release to the air, the elements travel for large distances and are deposited onto the soil, vegetation and water depending on their density. Once deposited, these metals are not degraded and persist in the environment for many years poisoning humans through inhalation, ingestion and skin absorbtion. Acute exposure leads to nausea, anorexia, vomiting, gastrointestinal abnormalities and dermatitis.

Table 1 below shows the sources, risk levels and health effects from exposure to these heavy metals.

Table 1: Toxic heavy metals with established health effects

Heavy Metal	Sources of Environ mental exposure	Minimum Risk level	Chronic exposure toxicity effects
Lead	Industrial, vehicular emissions, paints and burning of plastics, papers, etc.	Blood lead levels below 10 µg/dl of blood*	Impairment of neu-rological develop-ment, suppression of the haematological system and kidney failure
Mercury	Electronics, plastic waste, pesticides, pharmaceutical and dental waste	Below 10 µg/dl of blood* Oral exposure of 4mg/kg/day**	Gastro-intestinal disorders, respiratory tract irritation, renal failure and neuro-toxicity
Cadmium	Electronics, plastics, batteries and contami-nated water	Below 1 µg/dl of blood*	Irritation of the lungs and gastrointestinal tract, kidney damage, abnormalities of the skeletal system and cancer of the lungs and prostate

µg/dl*: micrograms per decilitre of blood
mg/kg**: milligrams per kilogram

On the other hand, persistent organic pollutants are long-lasting non-biodegradable organic compounds that accumulate in the food chain, especially fish and livestock, and pose serious health risks to humans. They dissolve poorly in water and are readily stored in fatty tissue hence may be passed to infants through breast milk. These chemicals include: aldrin, dieldrin, dichlorodiphenyl-trichloroethane (DDT), endrin, heptachlor, toxaphene, chlordane, hexachlorobenzene, mirex, pesticides and polychlorinated biphenyls (PCBs) all of which are to be phased out and/or eliminated under the international environmental agreements.

5. The Study Findings

5.1 Environmental Evaluation

The concentration of lead (Pb) in the soil samples ranged from 50-590 ppm. 42% of the samples had levels above 400 ppm and only one sample had Pb levels at 50 ppm (reference standard in the Netherlands and Taiwan), with the rest above 60 ppm. Samples from within the waste dump manifested a value of 13,500 ppm and this is a clear indication that the dumpsite is the major source of high lead levels found in the surrounding environment. Mean concentrations of lead in soil samples from the dumpsite were over seven times more than those found in Waithaka.

For mercury (Hg), samples collected from the waste dump exhibited a value of 46.7 ppm while those collected along the river bank registered a value of 18.6 ppm. Both of these values greatly exceeded the WHO acceptable exposure level of 2 ppm. The rest of the samples were inconclusive due to the fact that the analytical method used was only capable of detecting high levels of mercury (15 ppm and above).

Mean concentrations of cadmium (Cd) in the soil samples adjacent to the site were eight times higher than those prescribed by the Dutch and Taiwanese authorities (5 ppm). High concentrations were found in both surface and sub-surface soil levels. Waithaka soil samples had copper (Cu) concentrations that were below the detection limit of 15 ppm (EDXRF System) while concentrations from the Dandora dumping site greatly exceeded the prescribed standard values as well as the natural range and registered between 7 and 80 ppm. Mean chromium (Cr) concentrations were slightly above the critical standard soil levels hence had no major negative impact on the environment. Zinc (Zn) concentrations from Dandora soils were four times greater than those from Waithaka and these values exceeded the recommended standard levels as well.

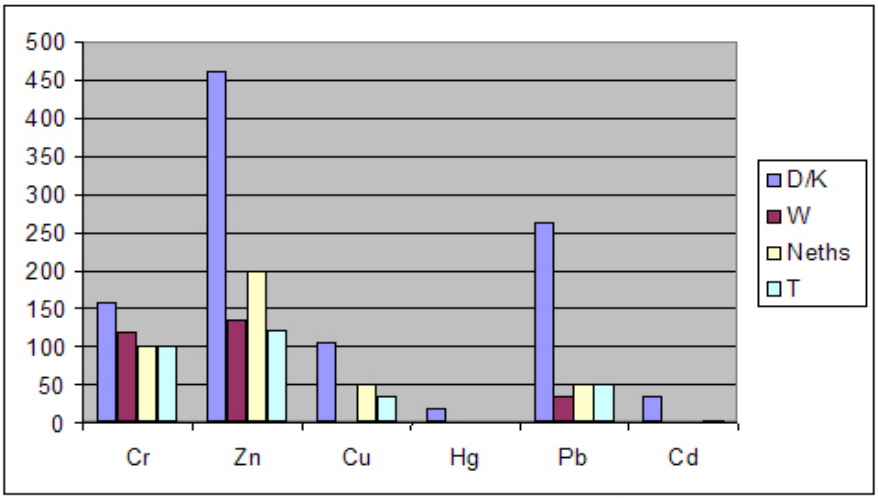
Table 2 and Figure 1 below show the mean elemental concentrations of the soil samples found adjacent to the dumpsite, within the dumpsite site and from Waithaka area as compared to the Netherlands and Taiwan standards.

Table 2: Mean elemental concentrations of soil samples from Dandora and Waithaka (ppm-parts per million, conc. - concentration)

Elements	Mean elemental conc. of soil samples adjacent to the dumpsite (ppm)	Mean elemental conc. of the soil samples from within the dumpsite (ppm)	Mean elemental conc. of Waithaka soil samples (ppm)	Reference Values in Neths. Soil Standards	Reference Values in Taiwan Soil Standards
K	20758	19100	7835	-	-
Ca	14558	77000	4300	-	-
Ti	5433	6100	5650	-	-
Cr	157	689	118	100*/250**	100[a]/400[b]
Mn	4366	3500	2400	-	-
Fe	45800	84800	57100	-	-
Cu	105	507	BDL	50*/100**	120[a]/200[b]
Zn	462	2100	133	200*/500**	35[a]/500[b]
Hg	18.6	46.7	BDL	0.5*/2**	0.29[a]/2[b]
Pb	264	13500	34.5	50*/150**	50[a]/500[b]
Cd	40	1058	-	1*/5**	2[a]/5[b]

BDL: Below Detection Limit
*: Tentative soil quality standards for the (Neths.) Netherlands
**: Reference value for good soil quality
a: Taiwan's standard values to assess soil quality
b: The upper limit of the background concentration

Figure 1: Heavy metal concentrations in the study's soil samples and soil standards



D/K= Dandora/Korogocho, W= Waithaka, Neths= Netherlands, T= Taiwan

For the water samples, total dissolved solids (TDS – Mn and Fe) as well as copper concentrations were detected from the pool (old quarry) adjacent to the river in low quantities (2.81, 0.52 and 0.009 mg/l respectively). Copper concentrations in water samples were well below the prescribed WHO and Dutch standards.

None of the polychlorinated biphenyls (PCBs) were detected in the samples as PCBs dissolve poorly in water and the river flow was rapid. However, their presence in the environment cannot be ruled out due to the manifestation of clinical abnormalities e.g., irritation of the nose and lungs, gastrointestinal discomfort, depression, fatigue and skin ailments among the children.

Photo: UNEP

5.2 Impacts on Public Health

From the environmental evaluation conducted, it was determined that the dumpsite exposes the residents around it to unacceptable levels of environmental pollutants with adverse health impacts. A high number of children and adolescents living around the dumping site had illnesses related to the respiratory, gastrointestinal and dermatological systems such as upper respiratory tract infections, chronic bronchitis, asthma, fungal infections, allergic and unspecified dermatitis/pruritis – inflammation and itchiness of the skin.

Table 3 below summarizes the health results of the 328 children aged 2-18 years examined.

Table 3: Impacts on Public Health and Systems Affected

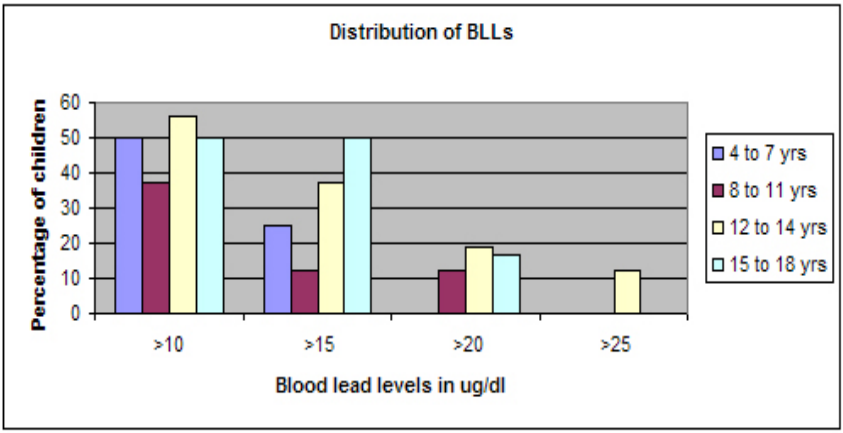
System affected	No. of children affected	% with disorders
Dermatological (skin disorders)	48	14.5
Respiratory	154	46.9
Gastroenteritis (GE) (abdominal and intestinal problems)	59	17.9
Dental disorders	31	9.5
Oto (affecting the hearing system)	15	4.6
Skeletal /muscular systems	8	2.4
Central nervous system	7	2.13
Eye infections	32	9.8
Blood (anaemia)	1	0.3
Others*	21	6.4
Normal	26	7.9

Others*: malaria, chicken pox, septic wounds, congenital abnormalities, cardiovascular diseases and lung cancer

The high levels of lead in the soil samples analyzed are negatively impacting on the communities living near the dumpsite which is evidenced as well by the fact that half of the children examined had blood lead levels equal to or exceeding the internationally accepted toxic levels (10 µg/dl of blood). This in turn led to clinical symptoms such as headaches, chest pains and muscular weakness being manifested in the children. Previous studies have established the percentage of children with high blood lead levels (above 10 µg/dl of blood) in Waithaka, Kariobangi North and Babadogo to be 5.8%, 10% and 15.2% respectively. These levels are far much less than those found in children living in Dandora/Korogocho.

Figure 2 below shows the distribution of the blood lead levels by age.

Figure 2: Blood Lead Levels in Children Living within the Environs of the Dumpsite



Blood samples collected from the children also indicated a significantly high level of certain enzymes that collectively with other parameters or individually result in cellular damage in the body or the presence of a disease process affecting the liver. High levels of creatinine (breakdown product of creatine phosphate in muscle usually produced at a fairly constant rate by the body depending on muscle mass) in some children examined indicated the need of closer follow-up in order to determine the onset of renal disfunction.

Blood investigations confirmed that 50% of the children had low haemoglobin levels while 30% had size and staining abnormalities (microcytosis) of their red blood cells (iron deficiency anaemia – IDA), a condition brought about by heavy metal intoxication. Further, the blood film studies indicated that 52.5% of the children had marked eosinophilia (increase in the number of white blood cells mostly associated with allergic reactions) a condition that could lead to chronic rhinitis (irritation of the nasal cavity), asthma, allergic conjunctivitis and dermatitis.

Photo: UNEP

6. Conclusion

This pilot study has linked environmental pollution to public health. Soil samples analyzed from locations adjacent and within the dumpsite show high levels of heavy metals emanating from the site in particular lead, mercury, cadmium, copper and chromium. At the same time, a medical evaluation of the children and adolescents living and schooling near the dumpsite indicates a high incidence of diseases that are associated with high exposure levels to these metal pollutants. For example, about 50% of children examined who live and school near the dumpsite had respiratory ailments and blood lead levels equal to or exceeding internationally accepted toxic levels (10 µg/dl of blood), while 30% had size and staining abnormalities of their red blood cells, confirming high exposure to heavy metal poisoning.

Photo: UNEP