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MINISTRY OF ENVIRONMENT AND MINERAL RESOURCES

INVENTORY OF MERCURY RELEASES IN KENYA

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ACRONYM

GDP	Gross Domestic Product
Hg	Mercury
KRA	Kenya Revenue Authority
N	No
THg	Total Mercury
UNEP	United Nations Environment Program
VCM	Vinyl Chloride Monomer
Y	Yes

Contents

Acknowledgements **3**

ACRONYM **4**

1.0 Executive summary **8**

2.0 Mercury release source types present in Kenya **12**
2.1.1 Mercury problem 13
2.1.2 Mercury releases in general. **Error! Bookmark not defined.**
2.2 Sources of releases to the environment 14

3.0 Summary of Mercury inputs to society **17**
3.1.1 Energy consumption and Fuel Production 17
3.1.2 Primary metal production 17
3.1.3 Other materials production 17
3.1.4 Production with mercury 18
3.1.5 Production of recycled metals. 18
3.1.6 Waste 18
3.1.7 General Consumption of mercury in products, as metal mercury and as mercury containing substances. 19
3.2 Cemeteries and crematoria 19

4.0 Summary of Mercury Releases **21**

5.0 DATA AND INVENTORY ON ENERGY CONSUMPTION AND FUEL PRODUCTION. **28**
5.1 Data Description 28
5.1.1 Coal combustion 29
5.1.2 Combustion of petroleum coke and heavy oil 29
5.1.3 Combustion/use of diesel, gasoil, petroleum kerosene 29
5.1.4 Use of raw or pre-cleaned natural gas. 30
5.1.5 Fuel production: 30
5.1.6 Oil extraction 30
5.2 Background calculations and approximations 31
5.2.1 Releases 33
5.3 Data gaps and Priorities for potential follow up. 35

6.0 DOMESTIC PRODUCTION OF METALS AND RAW MATERIALS 36
6.1 Data description 36
6.1.1 Primary metal Production 36
6.1.2 Other materials Production 38
6.2 Background calculations and approximations. 39
6.3 Data gaps and priorities for potential follow-up 42

7.0 DATA AND INVENTORY ON DOMESTIC PRODUCTION AND PROCESSING WITH INTENTIONAL MERCURY USES 43
7.1 Data description 43
7.2 Data Description 45
7.2.1 Chlor Alkali Production 45
7.2.2 Skin Lightening Creams 45
7.2.3 Background Calculations and approximations 45

8.0 DATA AND INVENTORY ON WASTE HANDLING AND RECYCLING 49
8.1 Data Description 49
8.1.1 Production of recycled ferrous metals (Iron and steel) 49
8.1.2 Waste incineration 49
8.1.3 Landfills 49
8.1.4 Wastewater and sludge 50
8.1.5 Production of recycled mercury ("secondary production") 50
8.1.6 Medical Waste Incineration 50
8.1.7 Uncontrolled Domestic Waste Burning**Error! Bookmark not defined.**
8.1.8 Landfills and Waste Dumps. 51
8.1.9 Sewage Treatment. 52
8.1.10 Data gaps and priorities for potential follow up 52
8.2 Releases 52

9.0 DATA AND INVENTORY ON GENERAL CONSUMPTION OF MERCURY IN PRODUCTS, AS METAL MERCURY AND AS MERCURY CONTAINING SUBSTANCES 54
9.1 Data description 54
9.1.1 Dental Almagams 54
9.1.2 Thermometers 54
9.1.3 Switches 54
9.1.4 Batteries 55
9.1.5 Light sources with mercury 55
9.1.6 Electrical and electronics 55
9.1.7 Dental mercury-amalgam fillings 55
9.1.8 Laboratory chemicals and equipment 56
9.2 Data gaps and priorities for potential follow up 57
9.3 Data gaps and priorities for follow up 57

9.3.1 Background calculations and approximations 59

10.0 Inventory on crematoria and cemeteries 62
10.1 Data description 62
10.2 Background calculations and approximations 64
10.3 Data gaps and priorities for potential follow up 64

11.0 List of major data gaps 65
11.1.1 Data Sources 65

12.0 Conclusion: 66
Recommendations: 67
12.1.1 67

References 68

Tables:
Table 2.1. Mercury release sources…… 8
Table 2.2 Miscellaneous potential mercury sources 9
Table 3.1 Summary Mercury inputs 13
Table 3.2 Description of the type of results 16
Table 3.3 Total summary releases
Table 4.1 Energy consumption and fuel products
Table 4.2 Use of Diesel, petroleum, kerosene 23
Table 4.3 Refined petroleum products 24
Table 5.1 Aluminium production 28
Table 5.2 National Cement production 30
Table 5.3 Paper Factories in Kenya 30
Table 6.1 Domestic production and processing with Mercury uses 32
Table 6.2 Production and consumption of batteries in Kenya 34
Table 7.1 General waste management
Table 7.2 Production of recycled ferrous metals 42
Table 7.3 Waste generation levels at selected hospitals in Nairobi 43
Table 7.4 Production for international sources
Table 9.1 Production from cemetery and crematoria

Figures

Fig 1 Source category estimated Hg input Kg/Hg 5
Fig 2 Share of petroleum consumption by fuel category 22
Fig 3 Estimated Hg input from Energy 23
Fig 4 Releases attributed to energy 26
Fig 5 Gold Ore
Fig 6 Production with international mercury uses
Fig 7 Recycling Waste in a dump 38
Fig 8 Open burning of waste
Fig 9. Nakuru Waste dumpsite
Fig 10 Emissions from international uses of mercury
Fig 11 Emissions for international uses of mercury

1.0 Executive summary

Mercury and its compounds are highly toxic to humans especially to the developing nervous system. They are also harmful to ecosystems and wildlife populations. Releases to the environment and products have raised global concern and that is why the 24th session of the UNEP Governing Council decided that further international action was required to reduce the risks posed by mercury to human health and the environment. This action is to address atmospheric emission; releases to land, water, soil find environmentally sound solutions for waste containing mercury, reducing its demand in products, supply, and storage, rehabilitation of contaminated sites and to increase pollution knowledge through inventories , research and monitoring nationally. Currently, the discussions on the internationally biding legal instrument are going on and countries need to carry out an inventory of mercury production, import, use and releases to be able to assess how future actions will affect them

This inventory is prepared by an interministerial team under the Ministry of Environment and Mineral Resources as part of the preparations for national actions to address the growing emissions of mercury, in November 2011 as part of the preparations for Kenya's participation in the negotiations for a legally bidding mechanism for mercury emission. Action is required to focus of reasons of emission, identify the key sources of the emissions and take the appropriate control measures.

This mercury release inventory was made with the use of the "Toolkit for identification and quantification of mercury releases" made available by the United Nations Environment Programme's Chemicals division (UNEP Chemicals)[1]..

It was developed on the Toolkits Inventory Level 1 which is based on mass balances for each mercury release source type. Inventory Level 1 works with pre-determined factors used in the calculation of mercury inputs to society and releases, the so-called default input factors and default output distribution factors. These factors were derived from data on mercury inputs and releases from such mercury source types from available literature and other relevant data sources such as research and policy documents. The Toolkit is still being refined to remove gaps. For the following mercury source subcategories, input and releases estimates were made:

- Coal combustion in large power plants
- Combustion of petroleum
- Fuel production
- Metals and raw materials
- Domestic Production and processing with intentional mercury uses
- Waste handling and recycling
- General consumption of mercury in products as metal mercury and mercury containing substance, and
- Crematoria and cemeteries

The individual mercury release sub-categories contributing with the highest mercury inputs were;

[1] The Toolkit is available at UNEP Chemicals' website: http://www.unep.org/hazardoussubstances/Mercury/MercuryPublications/GuidanceTrainingMaterialoolkits/ Mercury Toolkit/ tabid/4566/language/en-US/Default.aspx

Table 1.1 Executive Summaries

Source category	Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y					
		Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Coal combustion and other coal use	24.3	21.9	0.0	0.0	0.0	2.4	0.0
Other fossil fuel and biomass combustion	1,197.2	1,197.2	0.0	0.0	0.0	0.0	0.0
Oil and gas production	4,479.9	1,120.0	44.8	0.0	0.0	672.0	0.0
Primary metal production (excl. gold production by amalgamation)	50.5	5.1	0.0	15.2	15.2	0.0	15.2
Gold extraction with mercury amalgamation	2,110.0	1,266.0	422.0	422.0	0.0	0.0	0.0
Other materials production	1,292.8	790.1	0.0	0.0	251.4	251.4	0.0
Chlor-alkali production with mercury-cells	12.6	2.5	0.3	4.8	1.3	0.0	3.8
Other production of chemicals and polymers	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Production of products with mercury content	3,010.0	25.1	15.1	301.0	0.0	301.0	30.1
Use and disposal of dental amalgam fillings	5,700.0	114.0	1,892.4	0.0	205.2	1,094.4	1,094.4
Use and disposal of other products	8,046.5	1,870.9	746.9	2,284.8	0.0	2,497.9	646.0
Production of recycled metals	1.1	0.4	0.0	0.4	0.0	0.4	0.0
Waste incineration and open waste burning*1	11,094.0	11,079.6	0.0	0.0	0.0	0.0	14.4
Waste deposition*1	-	-	-	-	-	-	-
Informal dumping of general waste *1*2	20,000.0	2,000.0	2,000.0	16,000.0	-	-	-
Waste water system/treatment *3	52.5	0.0	47.3	0.0	0.0	5.3	0.0
Crematoria and cemeteries	752.5	2.5	0.0	750.0	0.0	0.0	0.0
TOTALS	**29,790.0**	**19,500.0**	**5,120.0**	**3,780.0**	**470.0**	**4,820.0**	**1,800.0**

i. The treatment and disposal of waste represented substantial flows of mercury. Informal and open burning of general waste

ii. Use and disposal of other products

iii. Other materials production; primarily cement production.

Detailed presentation of mercury inputs and releases for all mercury release source types present in the country are shown in the following report sections.

Fig 1 shows the major sources that have input to mercury levels.

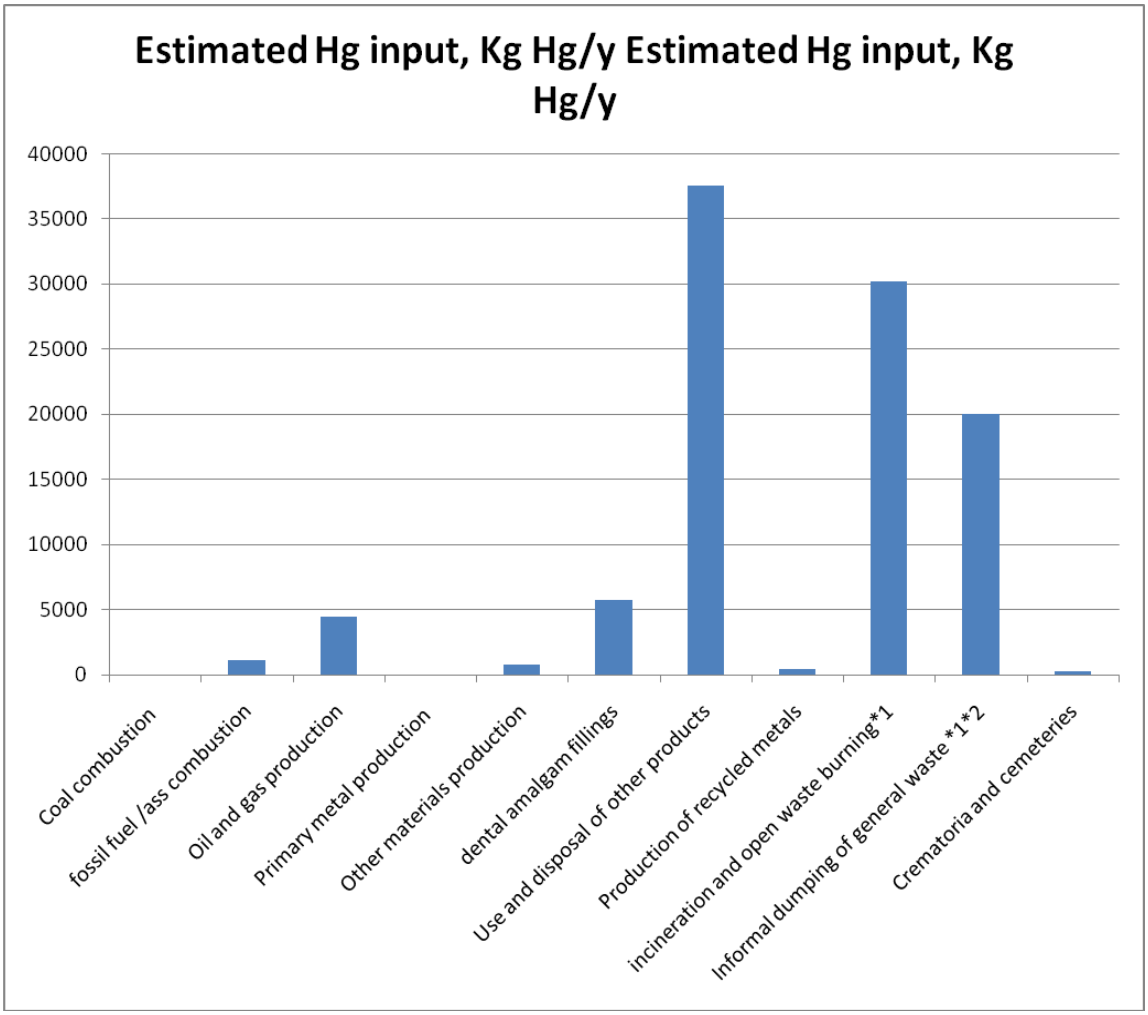


Fig 1.Contribution of various sources to Hg input

Data gaps

This report has drawn on opinions of others and data from the available local and Kenya and international literature on mercury-containing materials and devices. In addition, it, and mercury emissions from various natural and anthropogenic processes. The information has been accepted as provided and has not been independently checked. The data has been used in good faith but it could contain errors. Major data gaps were for example Availability of recent data on coal combustion was not accurate because it is not documented; accu-

rate figures for other emission source types because no requirement found to keep that data. For waste water treatment it is not accurate because few are analysed and documented and there is under estimation for crematoria and cemeteries because no data and information available as none are documented.

In conclusion, the inventory objective progress in the near future is to achieve a full comprehensive inventory on mercury and its releases is a high necessity in order to avoid the aforementioned gaps and having a true estimation for mercury releases in Kenya Its recommendations such as capacity building of relevant bodies in Kenya to enable them to collect data and information on mercury through development of legislation to regulate the circulation of mercury and its compounds: import, circulation, transport, storage, disposal for contaminated lands is vitally important

2.0 Mercury release source types present in Kenya

Background

Mercury is recognized as a toxic and persistent element. It is documented that it has serious impacts on human health and environment. When released it is transported globally in the atmosphere and is as such a global problem. To reduce the risk from anthropogenic mercury releases to human health and the environment the UNEP Governing council decided in 2009 to develop a global legally binding convention on mercury. Information on releases of mercury is important to inform the national policy-making towards the current negotiations, to identify priority mercury sources in the countries and to provide a baseline for national mercury management. National inventories are also important in supporting the verification of global mercury release inventories.

2.1.1.1 Objective of inventory

The objective of the inventory is to develop an inventory of mercury use and release and create an associated follow-up action plan and build capacity in MEMR on mercury management while establishing the mercury use and release inventory and to assist the Government in establishing priorities for mercury actions in their country. MEMR will provide feedback to UNEP on the usability of the toolkit.

2.1.1.2 The chemistry of mercury

Mercury is a metal with atomic number 80.

Mercury generally exists as elemental mercury (Hg (0) or Hg^0), monovalent mercury (Hg (I)), divalent mercury (Hg (II) or Hg^{2+}) and mono methylmercury (CH_3-Hg^+, commonly called methylmercury ($MeHg^+$)).

Mercury in its compound form with other elements may appear as either monovalent or divalent mercury. Many inorganic and organic compounds of mercury can be formed from Hg (II). Mercury also forms organ metallic compounds by covalent bonding directly with carbon. These organ metallic compounds are stable, though some are readily broken down by living organisms (Japan Public Health Association 2001). Elemental (Metallic) mercury is a dense, silvery-white, shiny metal and normally liquid at normal temperature and pressure. It has a relative molecular mass of 200.59, a melting point of -38.87°C, a boiling point of 356.72°C, and a density of 13.534 g/cm^3 at 25°C (WHO 2003). Elemental mercury is the most volatile form of mercury. It has a vapour pressure of 0.3 Pa at 25°C and transforms into the vapour phase at room temperatures (WHO 2003). In particularly, if elemental mercury is not enclosed, elemental mercury evaporates and forms mercury vapours which dissolve only slightly in water (56 µg/litre at 25°C) (WHO 2003).

Mercury vapours are colourless and odourless (WHO 2003). The higher the temperature, the more vapours are released from liquid elemental mercury (UNEP 2002). Elemental mercury is used to extract gold from ore at the amalgamation process of artisanal and small scale gold mining in a lot of countries, and mercury vapour is released into the atmosphere when the amalgam is burned (Spiegel 2006). There have been random studies of mercury problem in Kenya.

2.1.2 The Mercury problem in Kenya

Like many other countries, Kenya faces environmental issues on importation of obsolete technologies that use mercury that use mercury, unregulated importation of toxic and hazardous chemicals and inappropriate technologies that use mercury. As the world community identifies risks posed by chemicals and technologies, Kenya should do the same . It should as well as ensure that technologies and practices being discarded by others are sold cheaply to Kenya. The mercury problem in Kenya has not been evaluated adequately because of lack of supporting data and information. As of now Kenya has oes not have adequate data on its production, supply; import, export and use of mercury. It also does not have reliable estimates of the quantities releases or discharged into the environment.

Because of international requirements, Kenya is progressing towards the phase out of mercury based processes and equipment[2]. There is however demand from users for accurate cost effective alternate technologies and a road map for final disposal of discarded equipment such as fluorescent tubes, thermometers r and sphygmomanometers. This inventory will help identify those activities where elemental Hg is released in the environment; assess the per capita Hg usage so that emissions can be better understood. There are benefits, for example, the government of Delhi has required phase out by 2009 health care products using mercury.

Mercury in environment Mercury is a persistent, mobile and bio accumulative element in the environment and retained in organisms. Because mercury is an element it is ultimately persistent; it cannot be converted to a non-mercury compound. Mercury in the aquatic environment is changed to various forms, mainly methyl mercury methylated from mercury. Once mercury enters into the environment, mercury permanently exists in the environment by changing its chemical forms depending on the environment shows the mercury species and transformations in the environment. The release of mercury to the environment can be grouped into four categories:

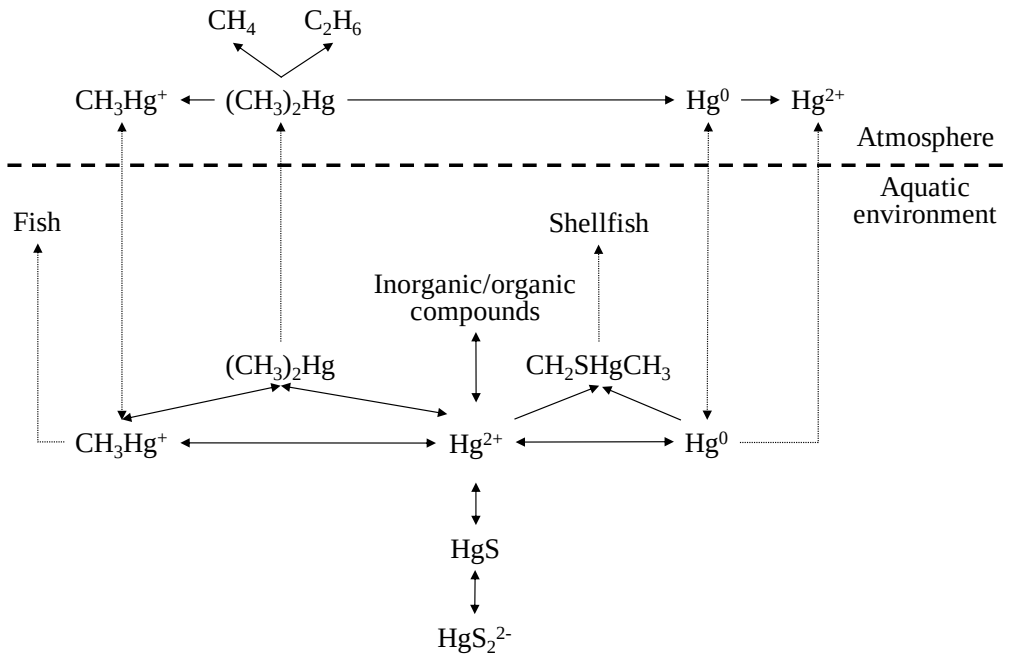
i. Natural sources

ii. Current anthropogenic releases from mobilisation of mercury impurities in raw material

iii. Current anthropogenic releases resulting from mercury used intentionally in products and processes due to releases during manufacturing , disposal and incineration

iv. Remobilisation of historic anthropogenic releasers previously deposited in soil, sediments water bodies, landfills and tailings due to land use and anthropogenic perturbations.

[2] Sessional Paper on environment and development sites various problematic chemicals of which mercury is one



v.

Figure 2-1 Dynamics of mercury in the environment (Beijer 1979)

Mercury in the atmosphere is broadly divided into gas form and particulate form. Most of mercury in the general atmosphere is in gas form (95% or more). Gaseous mercury includes mercury vapour, inorganic compounds (chlorides and oxides), and alkyl mercury (primarily methyl mercury (Japan Public Health Association 2001).

2.2 Sources of releases to the environment

The Toolkit has summarised the key sources.

Table 2-1 shows sources and chemicals intermediaries which mercury release sources are identified as present and absent, respectively, in Kenya. Only the source types which are positively identified as present are included in the quantitative assessment. It should be noted however, that the presumably minor mercury release source types shown in Table 2-2 were not included in the detailed source identification and quantification work. In deciding whether they are present or not, research and reports were used. Stakeholders were consulted. Most data and verification is however needed in order to qualify. For where there is a Table 2.2 show those sources not included in the inventory but could or could not be in Kenya. Those that definitely are, are indicated by a Yes (Y) and those definitely no are indicated by a No (N). Those not very sure are indicated with a question mark (?)

Table 2-1 Identification of mercury release sources in the country; sources present (Y), absent (N), and possible but not positively identified (?).

Source category	**Source present?**
	Y/N/?
Energy consumption	
Coal combustion in large power plants	N
Other coal uses	Y
Combustion/use of diesel, gasoil, petroleum, kerosene	Y
Biomass fired power and heat production	Y
Charcoal combustion	Y
Fuel production	
Oil extraction	N
Oil refining	Y
Extraction and processing of natural gas	N
Primary metal production	
Gold extraction by methods other than mercury amalgamation	Y
Alumina production from bauxite (aluminium production)	N
Primary ferrous metal production (iron, steel production)	N
Gold extraction with mercury amalgamation - without use of retort	Y
Other materials production	
Cement production	Y
Pulp and paper production	Y
Production of chemicals and polymers	
Chlor-alkali production with mercury-cells	Y
Production of products with mercury content	
Manometers and gauges with mercury	N
Biocides and pesticides with mercury	N
Paints with mercury	Y
Skin lightening creams and soaps with mercury chemicals	Y
Use and disposal of products with mercury content	
Dental amalgam fillings ("silver" fillings)	Y
Thermometers	Y
Electrical switches and relays with mercury	Y
Light sources with mercury	Y
Batteries with mercury	Y
Polyurethane (PU, PUR) produced with mercury catalyst	Y
Paints with mercury preservatives	Y
Skin lightening creams and soaps with mercury chemicals	Y
Medical blood pressure gauges (mercury sphygmomanometers)	Y
Other manometers and gauges with mercury	Y
Laboratory chemicals	Y
Other laboratory and medical equipment with mercury	Y
Production of recycled of metals	
Production of recycled mercury ("secondary production")	Y
Production of recycled ferrous metals (iron and steel)	
Waste incineration	
Incineration of municipal/general waste	N
Incineration of hazardous waste	Y
Incineration of medical waste	Y
Sewage sludge incineration	N
Open fire waste burning (on landfills and informally)	Y
Waste deposition/land filling and waste water treatment	
Controlled landfills/deposits	Y
Informal dumping of general waste *1	Y
Waste water system/treatment	Y
Crematoria and cemeteries	
Crematoria	Y
Cemeteries	Y

Table 2-2 Miscellaneous potential mercury sources not included in the quantitative inventory; with preliminary indication of possible presence in the country.

Source category	Source present?
	Y/N/?
Geothermal power production	Y
Production of other recycled metals	Y
Production of lime	Y
Production of light weight aggregates (burnt clay nuts for building purposes)	Y
Chloride and sodium hydroxide produced from mercury-cell technology	N
Polyurethane production with mercury catalysts	?
Seed dressing with mercury chemicals	?
Infra red detection semiconductors	?
Bougie tubes and Cantor tubes (medical)	?
Educational uses	Y
Gyroscopes with mercury	Y
Vacuum pumps with mercury	Y
Mercury used in religious rituals (amulets and other uses)	?
Mercury used in traditional medicines (Ayurveda and others) and homeopathic medicine	?
Use of mercury as a refrigerant in certain cooling systems	?
Light houses (leveling bearings in marine navigation lights)	?
Mercury in large bearings of rotating mechanic parts in for example older waste water treatment plants	?
Tanning	?
Pigments	?
Products for browning and etching steel	?
Certain color photograph paper types	?
Recoil softeners in rifles	?
Explosives (mercury-fulminate)	?
Fireworks	?
Executive toys	?

Table2.2. shows a lack of information on areas suspected to have mercury emissions and more research and monitoring will need to be done for geothermal power production; production of other recycled metals; production of lime; seed dressing with mercury chemicals; educational uses; use of mercury as refrigerant in certain cooling systems and pigments to confirm their presence or absence.

3.0 Summary of Mercury inputs to society

Mercury inputs to society should be understood as the mercury amounts made available for potential releases through economic activity in the country. This includes mercury intentionally used in products such as thermometers, blood pressure gauges, fluorescent light bulbs, etc. It also includes mercury mobilised via extraction and use of raw materials which contains mercury in trace concentrations. The following source sub-categories made the largest contributions to mercury inputs to society. They are use and disposal of dental amalgam fillings, use and disposal of other products, oil refining and other fossil fuel and biomass combustion. Waste incineration and open burning and informal dumping of general waste constitute large flows of mercury through society. The mercury in waste originates from mercury containing products and materials.

The emissions source categories being energy consumption; fuel production; primary metal production; other materials production; production of products with mercury content; use and disposal of products with mercury content; production of recycled metals ;waste incineration and waste deposition/land filling ; waste water treatment crematoria and cemeteries.

An overview of mercury inputs to society in Kenya is given in Table 3.1 below.

3.1.1 Energy consumption and Fuel Production

In the energy consumption and fuel production, estimated Mercury input in kilograms of mercury per year is largely from oil refining mainly are spread national through power generation, agriculture and manufacturing though there is a higher concentration in Mombasa through three major Power stations Kipevu I and Kipevu II as well as the Kenya Petroleum Oil Refinery. This is followed by combustion of diesel, gas oil, petroleum and kerosene with 653. Biomass fuel many products used daily in Kenya contains mercury. Total of 5701 kg of mercury per year y is from this source the bulk being from gas and oil production.

3.1.2 Primary metal production

There is little primary metal production which can release mercury in Kenya except for gold which is also not very high. Average reported production is 500 kg and other sources total 1000 kg (KNBS 2009). There has been a steady production of unwrought gold but for all the years the production is usually not high averaging 10kg. These sources produced 2160.5.3 kgHg /year the bulk being from gold of mercury amalgams through zones which have high artisanal mining such as Migori and Kakamega.

3.1.3 Other materials production

The key ones are cement and pulp and paper production. Lime is also produced but is not inventoried here. This source produced 129.2.8 kg Hg per year.

3.1.4 Production with mercury

There is no volatile carbon materials(VCM) production with mercury catalyst or acetaldehyde production with mercury catalyst. There is no production of mercury thermometers as most are imported from India and China where electrical switches, light sources with mercury (fluorescent, compact etc.) come from. There is no production but import of manometers and gauges with mercury and biocides and pesticides and pesticides with mercury. Those have not been quantified. There is some suspected production of chloralkali production with mercury cells, batteries with mercury using mercuric chloride, paints with mercury and skin lightening creams and soaps with mercury chemicals. It produced 3010 kg Hg per year.

3.1.5 Production of recycled metals

There is no production of recycled mercury but there is some production of recycled ferrous metals from metal scrap. This source produces minimal 1.1 kg mercury per year which can be regarded as negligible. However the informal which recycles also most all scrap metal has not been quantified.

3.1.6 Waste

There is no incineration of municipality waste or sewage sludge although some proposal has been made to start energy facilities that will burn waste but there are private facilities that provide the following services;

- Incineration of hazardous waste as per regulations issued by National Environment Management Authority.
- Incineration of medical waste combined with other waste.
- Open burning of waste on landfills and in factories and housing estates informally is the most dominant volume reduction methods for waste(NIP, 2007).
- Controlled land filling deposits in Nairobi and industries is present. Sanitary landfills are under construction in the towns of Nakuru, Mombasa, and Kisumu(JICA Report, 2011).
- Informal dumping of general waste, which was the most predominant, and
- Wastewater system and treatment generate solid waste as sludge which is sometimes collected and used as fertiliser.

This in total produces 31,000 kgHg per year.

3.1.7 General Consumption of mercury in products, as metal mercury and as mercury containing substances.

This category includes use and disposal of products with mercury content including dental amalgams, thermometers and electrical switches and relays with mercury. Light sources with mercury such as batteries with mercury and medical blood pressure gauges and laboratory chemicals for research and analytical work.

Skin-lighteners are sold as creams, lotions and soaps. Hundreds if not thousands of them are available in the global market. Those that use mercury as an active ingredient often contain from 2 to 10 percent mercury by weight. Products tested in a variety of countries in Africa, Asia and Latin America and North America have contained from 660 to 57,000 parts per million (ppm) mercury.[2] Unfortunately, the most effective ingredients, which include mercury compounds and hydroquinone, are also the cheapest, and that induces many manufacturers to use them in products, despite their well documented toxic hazards. Skin lighteners are heavily marketed to women, with the message that they hold a key to beauty.

Other products that are important to Kenya is dental amalgams which produces 5,700 kg of Hg per year.

3.2 Cemeteries and crematoria

There are crematoriums in most major towns but predominantly in Nairobi, Kisumu and Mombasa and extensive use of cemeteries in all towns and rural areas. Every urban human settlement usually has a designated cemetery which releases 752.5 kg of mercury per year.

Table 3.1 **INVENTORY LEVEL 1 - SUMMARY OF MERCURY INPUTS AND RELEASES**

INVENTORY LEVEL 1 - EXECUTIVE SUMMARY

Source category	Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y					
		Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Coal combustion and other coal use	24.3	21.9	0.0	0.0	0.0	2.4	0.0
Other fossil fuel and biomass combustion	1,197.2	1,197.2	0.0	0.0	0.0	0.0	0.0
Oil and gas production	4,479.9	1,120.0	44.8	0.0	0.0	672.0	0.0
Primary metal production (excl. gold production by amalgamation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gold extraction with mercury amalgamation	2,110.0	1,266.0	422.0	422.0	0.0	0.0	0.0
Other materials production	949.0	583.8	0.0	0.0	182.6	182.6	0.0
Chlor-alkali production with mercury-cells	12.6	2.5	0.3	4.8	1.3	0.0	3.8
Other production of chemicals and polymers	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Production of products with mercury content	3,010.0	25.1	15.1	301.0	0.0	301.0	30.1
Use and disposal of dental amalgam fillings	5,700.0	114.0	1,892.4	0.0	205.2	1,094.4	1,094.4
Use and disposal of other products	8,046.5	1,870.9	746.9	2,284.8	0.0	2,497.9	646.0
Production of recycled metals	1.1	0.4	0.0	0.4	0.0	0.4	0.0
Waste incineration and open waste burning*1	11,094.0	11,079.6	0.0	0.0	0.0	0.0	14.4
Waste deposition*1	-	-	-	-	-	-	-
Informal dumping of general waste *1*2	20,000.0	2,000.0	2,000.0	16,000.0	-	-	-
Waste water system/treatment *3	52.5	0.0	47.3	0.0	0.0	5.3	0.0
Crematoria and cemeteries	752.5	2.5	0.0	750.0	0.0	0.0	0.0
TOTALS	**29,390.0**	**19,280.0**	**5,120.0**	**3,760.0**	**390.0**	**4,760.0**	**1,790.0**

Notes:

4.0 Summary of Mercury Releases

The fate of mercury releases to the environment and types of releases to each receiving environmental medium are largely to air both for point sources and also diffuse sources from which release may be spread locally, regionally and globally with air masses, water currents and food products. Discharges to aquatic environment from point and diffuse sources from which mercury will then be dispersed to rivers and to the marine environment, freshwater aquatic ecosystems and land /soil terrestrial ecosystem to general surface and grounds water. It is at this point that human being become vulnerable through water, food and products.

In Kenya, there has not been a systematic monitoring of mercury emissions or its presence in the environment. This inventory is the most systematic there has been done so far. The total amount of mercury emissions annually for Kenya in 2012, have been estimated using the 2011 UNEP Mercury toolkit to be detailed in Table 4.1. These are largely anthropogenic sources. The natural emissions have not been quantified for lack of data which means that some of the UNEP categories could not be estimated. These include geothermal emissions which are significant emission levels in Kenya but are included in the UNEP Toolkit with no emission factors. More work will need to be done on this.

In the Table 4-1 below, a summary of mercury releases from all source categories present is given. The key mercury releases here are releases to air (the atmosphere), to water (marine and freshwater bodies, including via waste water systems), to land, to general waste, and to sectors specific waste..

Table 4-1 below shows more detailed description and definition of the output pathways.

The following source sub-categories made the largest contributions to mercury releases to the atmosphere.

i. Use and disposal of mercury products Incineration and open burning of waste
ii. Informal burning of general waste
iii. Dental amalgam fillings
iv. Oil and gas products

Table 4-1 Summary of estimated mercury releases

Source category	Estimated Hg releases, standard estimates, Kg Hg/y					
	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Energy consumption						
Coal combustion in large power plants	-	-	-	-	-	-
Other coal uses	21.9	0.0	0.0	0.0	2.4	0.0
Combustion/use of petroleum coke and heavy oil	-	-	-	-	-	-
Combustion/use of diesel, gasoil, petroleum, kero-sene	653.4	0.0	0.0	0.0	0.0	0.0
Use of raw or pre-cleaned natural gas	-	-	-	-	-	-
Use of pipeline gas (consumer quality)	-	-	-	-	-	-
Biomass fired power and heat production	345.4	0.0	0.0	0.0	0.0	0.0
Charcoal combustion	120.0	0.0	0.0	0.0	0.0	0.0
Fuel production						
Oil extraction	-	-	-	-	-	-
Oil refining	1,120.0	44.8	0.0	0.0	672.0	0.0
Extraction and processing of natural gas	0.0	0.0	0.0	0.0	0.0	0.0
Primary metal production						
Production of lead from concentrates	5.1	0.0	15.2	15.2	0.0	15.2
Gold extraction by methods other than mercury amalgamation	0.0	0.0	0.0	0.0	0.0	0.0
Gold extraction with mercury amalgamation - without use of retort	1.2	0.4	0.4	0.0	0.0	0.0
Other materials production						
Cement production	466.9	0.0	0.0	155.6	155.6	0.0
Pulp and paper production	36.0	0.0	0.0	0.0	0.0	0.0
Production of chemicals						
Production of products with mercury content						

Use and disposal of products with mercury content						
Dental amalgam fillings ("silver" fillings)	114.0	1,892.4	0.0	205.2	1,094.4	1,094.4
Thermometers	36.3	54.5	36.3	0.0	54.5	0.0
Electrical switches and relays with mercury	1,596.0	0.0	2,128.0	0.0	1,596.0	0.0
Light sources with mercury	16.9	0.0	16.9	0.0	22.5	0.0
Batteries with mercury	244.3	0.0	244.3	0.0	488.5	0.0
Paints with mercury preservatives	119.6	6.5	0.0	0.0	3.9	0.0
Skin lightening creams and soaps with mercury chemicals	0.0	2,850.0	150.0	0.0	0.0	0.0
Other manometers and gauges with mercury	38.0	57.0	38.0	0.0	57.0	0.0
Laboratory chemicals	0.0	125.4	0.0	0.0	125.4	129.2
Other laboratory and medical equipment with mercury	0.0	501.6	0.0	0.0	501.6	516.8
Production of recycled of metals						
Production of recycled mercury ("secondary production")	-	-	-	-	-	-
Production of recycled ferrous metals (iron and steel)	138.3	0.0	142.5	0.0	138.3	0.0
Waste incineration						
Incineration of municipal/general waste	-	-	-	-	-	-
Incineration of hazardous waste	64.8	0.0	0.0	0.0	0.0	7.2
Incineration of medical waste	64.8	0.0	0.0	0.0	0.0	7.2
Sewage sludge incineration	-	-	-	-	-	-
Open fire waste burning (on landfills and informally)	30,000.0	0.0	0.0	0.0	0.0	0.0
Waste deposition/land filling and waste water treatment						
Controlled landfills/deposits	-	-	-	-	-	-
Informal dumping of general waste *1	2,000.0	2,000.0	16,000.0	-	-	-
Waste water system/treatment *2	0.0	47.3	0.0	0.0	5.3	0.0
Crematoria and cemeteries						
Crematoria	15.0	0.0	0.0	-	0.0	0.0
Cemeteries	0.0	0.0	750.0	-	0.0	0.0
TOTAL of quantified releases	**37,220.0**	**7,530.0**	**3,520.0**	**380.0**	**4,920.0**	**1,770.0**

Table 4-2 below provides general descriptions and definitions of the output pathways to air, water, land, by product and impurities, general waste and sector specific waste treatment.

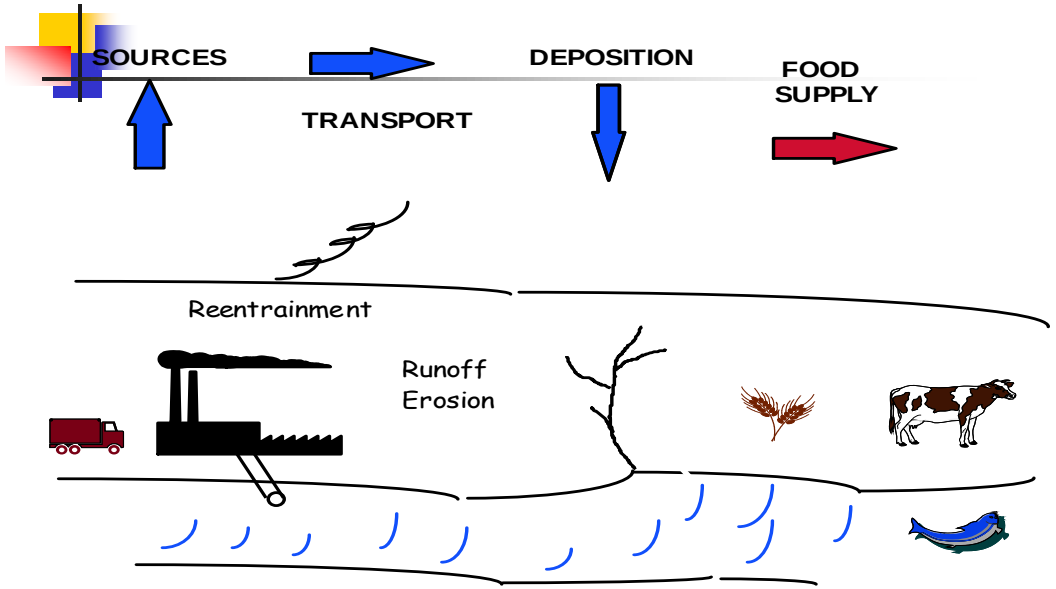
Table 4-2 Description of the types of results

Calculation result type	**Description**
Estimated Hg input, Kg Hg/y	The standard estimate of the amount of mercury entering this source category with input materials.,
Air 37,220	Mercury emissions to the atmosphere from point sources and diffuse sources from which mercury may be spread locally or over long distances with air masses; for example from: • Point sources such as metal smelter, waste incineration; • Diffuse sources as small scale gold mining, informally burned waste with fluorescent lamps, batteries, thermometers..
Water 7530	Mercury releases to aquatic environments and to waste water systems: Point sources and diffuse sources from which mercury will be spread to marine environments (Indian oceans), and freshwaters (rivers, lakes, etc.). for example releases from: • Wet flue cleaning systems from coal fired power plants; • Industry, households, etc. to aquatic environments; • Surface run-off and leachate from mercury contaminated soil and waste dumps

Calculation result type	Description
Land 3520	Mercury releases to soil, the terrestrial environment: General soil and ground water. For example releases from: • Uncollected waste products dumped or buried informally • Local un-confined releases from industry such as on site hazardous waste storage/burial • Spreading of sewage sludge with mercury content on agricultural land (sludge used as fertilizer) • Application on land, seeds or seedlings of pesticides with mercury compounds
By-products and impurities 380	By-products that contain mercury, which are sent back into the market and cannot be directly allocated to environmental releases, for example:. • Chlorine and sodium hydroxide produced with mercury-based chlor-alkali technology; with mercury trace concentrations • Metal mercury or calomel as by-product from non-ferrous metal mining (high mercury concentrations)
General waste 4920	General waste: Also called municipal waste. Typically household and institution waste where the waste undergoes a general treatment, such as incineration, land filling or informal dumping. The mercury sources to waste are consumer products with intentional mercury content (batteries, thermometers, fluorescent tubes, etc.) as well as high volume waste like printed paper, plastic, etc., with small trace concentrations of mercury.
Sector specific waste treatment /disposal	Waste from industry and consumers which is collected and treated in separate systems, and in some cases recycled; for example. • Hazardous industrial waste with high mercury content which is deposited in dedicated, safe sites • Hazardous consumer waste with mercury content, mainly separately collected and safely treated batteries, thermometers, mercury switches, lost teeth with amalgam fillings etc.

With respect to the effects of mercury on the environment most concern has been expressed globally over the accumulation of anthropogenic mercury form diffuse sources in aquatic ecosystems. Even in Kenya, relatively more work has addressed this media because of suspected bioaccumulation and bio magnifications of mercury which result in adverse effects on the aquatic animals and associated wildlife. The main concern being possible causes of increased dietary intakes of mercury in the human population due to the high concentrations of methyl mercury in fish.

The most studied (relatively) is releases to water work on mercury has been done in Lake Victoria[3] wher patterns in total mercy in water, soil and sediment cores were determined. Water THg concentrations range from 0.7 to 5.8 mg/l. Scientists have suggested that the THg in Lake Victoria are primarily atmospheric with some erosion inputs. Studies have also been done on Mercury in head hair. This is common way of randomly sampling presence of THg in human environment.



[3] The water quality standards of Kenya, the Kenya Standard KS 05-459 has standard of 0.001 m/l

Fig 4.1 Sources and Pathways to Human Exposures. Sources: UNEP Basel Convention training Pack www.basel.int

5.0 DATA AND INVENTORY ON ENERGY CONSUMPTION AND FUEL PRODUCTION

Energy consumption and production covers use of fossil fuels and plan matter mainly biomass for production of electricity heat and light.

Globally, energy consumption and fuel production is a major source of mercury emission. In energy consumption, coal use, combustion of petroleum products, biomass and charcoal use that are the major sources. Heating and cooking in residential households with biomass is common practice in Kenya. Over 74% of the people in the rural areas rely on biomass energy for cooking and heating. Wood fuel provides the bulk of total primary energy (about 70%) and meets 93% of the rural household energy requirements). Agricultural and forest wastes are also used as fuel (Beijer Institute, 2003). For natural gas, livestock (cattle, sheep, goats, donkeys) waste produces substantial quantities of methane, in most areas with high potential for agriculture, especially where farmers practice zero grazing. Unfortunately, in this inventory, methane production could not be quantified. In many urban areas, sawdust is used as fuel and so are plastics. In all these cases, 90% of the combustion takes place on the traditional 3 stone fireplace designs and not the conventional *jiko*

Fossil fuels and biomass naturally contain trace concentrations of mercury which is released when fuel is burnt into the air. Some big facilities have air pollution control systems from which releases it into water systems can occur. During extraction, refining and treatment of oil, some of the mercury in the fuel may be released to the environment. The source categories which are present in Kenya are summarised in Table 4.1.

5.1 Data Description

The annual production shown in column 3 is likely to change once more data and information becomes available. The major energy sources are firewood(,68.3%), paraffin(13.2%),electricity(o.6%), gas LPG9(3.5%),charcoal(13.3%), biomass residue(0.3%)[4].

The most reliable data o is available from the Kenya National Bureau of Statistic. Other sources like inventories, research paper, surveys.

[4]Kenya Integrated Household Budget survey 2005/06, Kenya Bureau of Statistics

5.1.1 Coal combustion

Kenya does not produce coal though it will soon start in the Mwingi County. Coal is also not widely used in other uses except for cement production where it is predominantly used as fuel. Therefore, the consumption of coal in cement factories is taken as the only major input estimated at 900,000 tons per annum (Yager, 2011). Other uses are not considered as important though they exist but are not quantified. Further work is required to collect data on their use of coal.

5.1.1.1 Other Coal Uses

No other coal uses were identified

5.1.2 Combustion of petroleum coke and heavy oil

Heavy oil is used in industries and power generation plant. 1,740,211 tons were used in 2010.

5.1.3 Combustion/use of diesel, gasoil, petroleum kerosene

Diesel is used in vehicles, agriculture, emergency power generating sets and other miscellaneous uses. However the major use is in fired power plants. . The consumption for different sectors of petroleum is detailed in Table 5.1. The total demand of petroleum products grew from 3,610,800 in 2009 to 3,760,700 tonnes in 2010 (KNBS 2011

Table5.1 Use of Diesel, Petroleum and Kerosene

Type	%	Quantity
Fuel Oil	33.0	590,944
Liquefied petroleum gas	2.7	59,773
Motor spirit (premium)	12.2	105542,856
Kerosene	7.8	374,945
Light Diesel	36.4	118,799,200.
Total		225,367,718

5.1.4 Use of raw or pre-cleaned natural gas.

Liquefied petroleum gas is extensively used in homes, factories and institutions. In addition a few industries such as Agrochemicals Foods in Muhoroni (ACF)generate their own natural gas from molasses. Sugar factories also produce natural gas now and then but it is not consistent and no data is available.

5.1.4.1 Biomass fired power and heat production.

Biomass is used in industries and household energy requirement. For boilers normally the type in use is wood. For this inventory, this subcategory refers to the combustion of biomass for power and/or heat, including wood burning (small branches, bark, sawdust, woodchips, peat and agricultural waste such as straw and citrus pellets, among others (UNEP, 2003)). Biomass-fired power factories distributed nationally.

Wood burning is also carried out at the residential, commercial and institutional level especially schools which rely predominantly on firewood for cooking. Parameters considered for estimating "Biomass fired power and heat production" take into account the total image for the combined uses. Estimated emissions from wood fuels are based on information on the production of wood provided by Kenya Forest Service. In most cases, the biomass is burned jointly (co-burning) with fossil fuel and sometimes when wood supply is plenty, without any addition of fossil fuels. This practice is found across Kenya in small, continuously operated steam boilers for drying. The use of wood boilers is increasing in the Kenya Tea Development Authority(KTDA) factories.

5.1.4.2 Charcoal combustion

Charcoal on the other hand was reported to supply 82% of urban household energy with a per capita annual consumption of 152 kg, while for rural households; it contributed 34% with a per capita consumption of 156 kg. As for the case of wood fuel, restaurants and kiosks consumed the highest estimated at 0.43 million tonnes per year. This reflects the importance of fuel wood and charcoal in supplying energy and creating employment. This is the data used derivation of the charcoal amounts used to calculate mercury inputs from charcoal.

5.1.5 Fuel production

5.1.5.1 Oil extraction

There is no oil extraction in Kenya.

5.1.5.2 Oil Refining

During the year 2011, the refinery processed a total of 1,742,146 metric tons of crude oil.

The quantity of crude oil imported was all from the United Arab Emirates (UAE)[5].

5.2

5.3 Background calculations and approximations

Data for petroleum was readily available in the KNBS but for biomass and heat production approximations have been made as follows:

In the year 2010[6], fuel wood supplied 89% of rural energy with a per capita annual consumption of 741 kg and 7% urban household energy with a per capita annual consumption of 691 kg. For the cottage industry, the consumption has been estimated at 1.3 million tonnes[7]. Data gaps and priorities for potential follow up. Assuming 80% of population is in rural areas and a per capita consumption of 741 kg. For urban populations 20% of populations

Rural 40% X 0.8 X 741 X 365 =

Urban 40 X 10^6 X 0.2 X 17 X 741 X 365 =	86,548,800
Cottage industry +	45,000,000
Total Estimate +	131,000,000
Charcoal 40 X 10^6 X 0.8 X 0.34 X 152 =	1,653,760 tons

(Source :KIPPRA, 2010).

[5]PIEA

[6]Biomass Energy Use In Kenya ,Prepared for International Institute for Environment and Development (IIED) by ,Practical Action, Eastern Africa Office ,P.O. Box 39493-00623 Nairobi, Kenya ,tameezan.gathui@practicalaction.or.ke ,October, 2010

[7]

Source category	Activity rate		Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y		
Energy consumption	Annual consumption/production	Unit	Standard estimate	Air	Water	Land
Coal combustion in large power plants	0	t coal combusted/y	-	-	-	-
Other coal uses	90,000	t coal used/y	24	21.9	0.0	0.0
Combustion/use of petroleum coke and heavy oil	0	t oil product combusted/y	-	-	-	-
Combustion/use of diesel, gasoil, petroleum, kerosene	118,799,200	t oil product combusted/y	653	653.4	0.0	0.0
Use of raw or precleaned natural gas	0	Nm3 gas/y	-	-	-	-
Use of pipeline gas (consumer quality)	0	Nm3 gas/y	-	-	-	-
Biomass fired power and heat production	11,512,000	t biomass combusted/y (dry weight)	345	345.4	0.0	0.0
Charcoal combustion	1,000,000	t charcoal combusted/y	120	120.0	0.0	0.0
			465			
Fuel production						
Oil extraction	0	t crude oil produced/y	-	-	-	-
Oil refining	81,452,900	t oil refined/y	4,480	1,120.0	44.8	0.0
Extraction and processing of natural gas	0	Nm3 gas/y	0	0.0	0.0	0.0

For energy sector the total Hg inputs are as in Table 1.

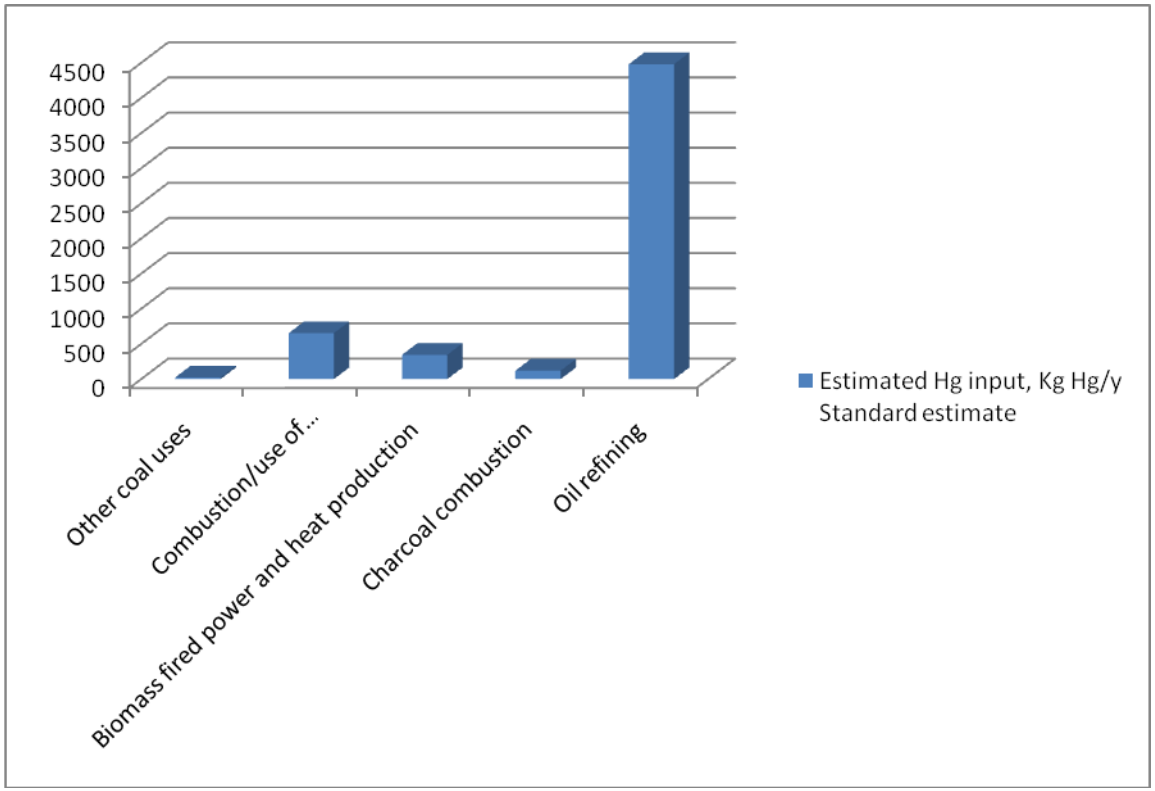


Fig.3 **Estimated Hg input, Kg Hg/y Standard estimate**

5.3.1 Releases

The release for energy sector is in Fig 1. In the energy subcategory, the largest input is from oil refining with 4,489 kg hg/year followed by the combustion and use of petroleum coke and heavy oil with an estimated Hg input of 653 kg hg/year. Though biomass input is important, it is not so signif-

icant comparatively. The important thing to note for energy release is that nearly all are to air which means improvement in technology of combustion might reduce mercury emissions.

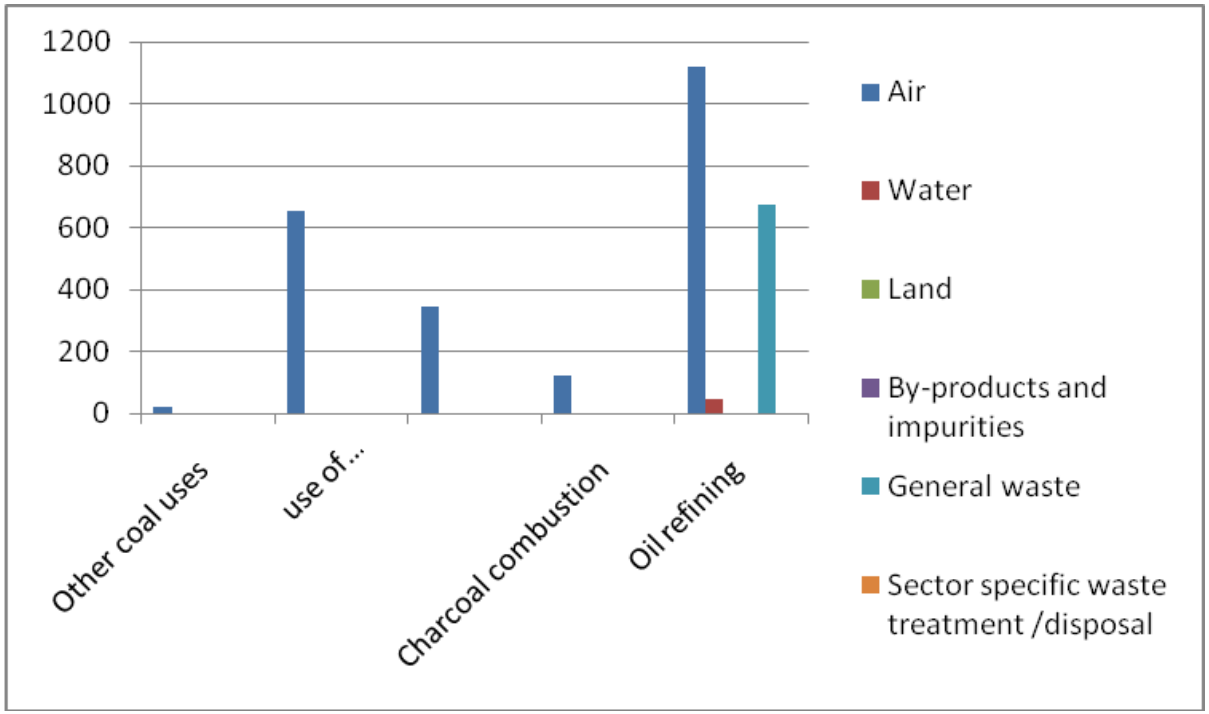


Fig 4. Releases attributed to energy.

Besides oil reefing charcoal combustion and other uses of coal are the key important emission sources.

5.4 Data gaps and Priorities for potential follow up.

Major gaps exit for other uses of coal and in biomass combustion. Charcoal also have a high degree of uncertainty but have very high potential for improvement.

6.0 DOMESTIC PRODUCTION OF METALS AND RAW MATERIALS

6.1 Data description

6.1.1 Primary metal Production

Primary metal production includes extraction and processing of mercury, zinc, copper, lead, aluminium and other non ferrous metals. It also includes gold and silver extraction by processes including the mercury amalgamation process. The following sources of mercury contained in the UNEP tool kit are not present in Kenya:

- Mercury primary extraction and initial processing
- Production of zinc concentrates
- Alumina production from bauxite
- Primary ferrous metal production (iron, steel production.)

For Kenya this broad category include two areas namely:

- Production of lead from concentrates which happens intermittently
- Gold extraction by methods other than mercury amalgamation, and
- Gold extraction with mercury amalgamation without use of retort

6.1.2 Production of Lead from Concentrates

In Kenya, there used to be lead production from lead concentrates by Associated Battery Manufacturing but this has been taken over fully by recycled batteries[8]. Lead ore was mined from Kinango in the Coast Province. However, currently most of the lead is from recycled batteries.

[8] T.Yager: The Mineral Industry of Kenya, 2009

Lead is used mainly in motor vehicle and solar battery lead acid production by Chloride (K) Ltd in Nairobi industrial area. Lately, lead ore has become less attractive and as lead is being recycled from the old batteries. Kenya's old battery lead smelter is managed by Chloride (K) Ltd and located in Athi River. It requires about 500 tonnes of scrap batteries in a month. At the moment the smelter is only getting 300 tonnes i.e. 3600 tonnes per annum. Previously the company used to be overwhelmed by the supply of scrap batteries with Nairobi alone contributing 120 tonnes per month. Demand for scrap batteries has shot up in the face of unavailability of new lead in the market. The high demand for lead has led to the birth of a few other informal smelters in Nairobi's
Kariobangi area. There is also large export of battery scrap lead to China.

6.1.3 Aluminium

There is no manufacturing of aluminium from bauxite, but there is extension recovery of aluminium from waste. However there is extensive use of aluminium.

6.1.4 Gold

Mercury is sometimes used around the world intentionally for recovering gold from the crushed ore or alluvial deposits. This can contribute to mercury emissions. In Kenya, there has not been systematic way of collecting data on this aspect. An alternative is use of cyanide which has much higher efficiencies (90% of gold recovered compared with 45% using the mercury amalgam process). The use of mercury amalgam occurs in Kenya for small scale artisanal or hobby gold mining.

6.1.4.1 Historical background of gold mining

Between 1952 and 1966 gold production in Western Kenya oscillated between 10,000 and 12,000 ounces a year, largely recovered as a byproduct. Production increased again to a level of 35,000 ounces when new discoveries happened in Migori. The rest of Kenya's gold production is from Turkana and West Pokot districts. In South Western Kenya, gold mining is mainly artisanal. It occurs in all districts in the Lake Victoria Basin (Migori, Kuria, Trans-Mara, Homabay, Kisumu, Bondo, Siaya, Vihiga, Kakamega, Busia and Nandi). Some larger mining companies are in this area although their activity is currently rather limited.

6.1.4.2 Risk to Water Systems

Many rivers crossing gold bearing areas carry gold nuggets and flakes in their alluvium. This gold is recovered by panning or on rudimentary sluices made of cloth (see figure 2). Mercury is often used to amalgamate the fine gold dust from the pan concentrate. Panning is done directly in the river. Alluvial mining takes place mainly during the dry season, when low water levels allow miners to access the river live-bed sediments. This has the effect to increase the concentration of mercury because of the smaller volumes of water. Gold exports 1,055 kg accounted from exports.[9] Data and inventory on domestic production and processing with intentional mercury use.

Fig 5.Gold ore

6.1.4.3 Artisanal Gold Mining

Artisanal gold miners typically target near-surface, small-volume, high-grade gold deposits. These are sulphide-poor quartz veins in which oxidation has released the gold and concentrated it along faults or close to the water table. The veins are typically dark in colour, and have a cavernous and rusty appearance due to the oxidation of sulphides. Gold flakes and nuggets are present in voids and joints, often in a visible form.

The ore is taken out of the mine as broken fragments in pans or basins. It is then crushed with a hammer on a millstone. This is done either in an open space close to mine site, or in designated workshops. The milled ore is sieved and the oversize re-crushed. After the amalgam is recovered from the pan concentrates, the amalgam is pressed in a cloth sieve to recover excess mercury. In some cases tailings from this first processing can be reprocessed on a rudimentary sluice.

6.1.5 Other materials Production

6.1.5.1 Cement Production

The UNEP Toolkit (2011) refers to other minerals with mercury impurities such as
Cement production, pulp and paper production, burnt lime production. Cement, pulp and paper and burnt lime as sources of mercury emissions are all produced in Kenya. However, this inventory does not include burnt lime because it was not included in the level 1 of the Toolkit. There

[9] Kenya Production of mineral commodities, 2009 Minerals Yearbook

are three cement plants whose combined production capacity is 1.87 million tonnes per year. They are East Portland Cement Co Ltd in Athi River, Bamburi Portland Cement Co Ltd, and Kaloleni Cement Company in Kaloleni. The main raw materials for cement production are limestone, pozzuolana and gypsum which are available in adequate quantities in various parts of Kenya especially in the Athi Plains and also plenty in the North-Eastern Province. In addition there is one clinker grinding plant with a combined production capacity of about 1 million tonnes/year.

6.1.5.2 Pulp and Paper Production

Pulp and Paper manufacturing is a source of mercury emissions, from trace level of mercury in the wood raw material, in fuels used for energy production and in the chemicals applied in the processes (UNEP, 2005) A particular contributor to the manufacture of chlorine and caustic soda using the mercury cell chlor-alkali process. It has been reported that chlor-alkali process is no longer used in Kenya and elemental chlorine is no longer used for bleaching pulp and paper. However, because the alternative technologies applied have not been indicated as completely phased out, the emission estimates have been made and 60 ton estimate has been made.

6.2 Background calculations and approximations.

6.2.1 Aluminium

There only major source of aluminium, is from secondary productions from the following sources. Primary alumina production from bauxite is thus not present in Kenya.

Table 6.1 Aluminium Production

Enterprise	**Tons per annum**
Booth Manufacturing Ltd	4000
Aluminium Enterprises	1200
Crystal Industries Ltd	1000
Narcol Aluminium Rolling	1000
Aluminium Extrudes	800
Total	**8000**

Source: MEMR :POPs inventory 2006

6.2.2 Cement

All the plants engage cement kilns for cement manufacture by dry process.

Table 5.1: Production of cement in Kenya.

Table 6.2. National Cement production levels

Name of the Company	Production(tonnes/annum)
East African Portland Cement company (EAPCC)	1,200,000
Bamburi Portland Cement Company (BPCC)	1,800,000
Rhino Cement Co limited	500,000
Athi River Mining	650,000
Others	420,000
Total	4,570,000

Source: (Yager 2010)

The total production of cement is 4,570,000 tons per year.

Table 6.1 Domestic Production of Metals and Raw materials

Source category	Source present?	Activity rate		Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y						
	Y/N/?	Annual consumption/production	Unit	Standard estimate	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal	Cat. no.
Primary metal production											
Production of lead from concentrates	y	0	t concentrate used/y	0	0.0	0.0	0.0	0.0	0.0	0.0	5.2.5
Gold extraction with mercury amalgamation - without use of retort	Y	1,055	kg gold produced/y	2,110	1,266.0	422.0	422.0	0.0	0.0	0.0	5.2.2
Gold extraction with mercury amalgamation - with use of retorts	N	0	kg gold produced/y	-	-	-	-	-	-	-	5.2.2
Other materials production											
Cement production	Y	3,320,000	t cement produced/y	913	547.8	0.0	0.0	182.6	182.6	0.0	5.3.1
Pulp and paper production	Y	1,200,000	t biomass used in production/y	36	36.0	0.0	0.0	0.0	0.0	0.0	5.3.2

6.3 Data gaps and priorities for potential follow-up

The key gaps exist in knowing the quantities of gold produced by either system because it is still small scale.

6.3.1.1 Release of mercury to air

Heating of the amalgam in open air with a torch or on a fire allows the recovery of more-or less pure gold. Gold from reef often has a high silver content. The tailings of several old mines have been partly reprocessed by artisanal miners, mostly by sluicing and panning the tailings. This has been done, for example, at the Macalder mine near Migori and at the Sakwa mine near Rongo. The presence of recoverable gold in these tailings is due to the fact that typical gold extraction processes used by mining company cannot recover 100% of the gold present in the ore. However over a few tens of years, bio-chemical processes within the tailing dump (break down of sulphides and acidification notably) will slowly free the remaining gold. .

6.3.1.2 Release to water

Most of the rivers in the gold beams region ultimately drain into Lakes Victoria, Turkana. These lakes are important for fish production which is not only an important source of dietary fish but is also a source of 4% of Kenya's gross domestic gross product (GDP).

7.0 DATA AND INVENTORY ON DOMESTIC PRODUCTION AND PROCESSING WITH INTENTIONAL MERCURY USES

7.1 Data description

Consumer products with intentional mercury use' is a very broad category and the destination of the releases (air, water or land) depends on a variety of variables such as the product usage, useful life, life cycle, and other aspects. Thus, emissions in this category depend on the kind of product, the production process, its handling during use and its final disposal as waste. Emissions are also estimated by taking into account input and output distribution factors.

This includes production of chemicals and production of products with mercury. Those likely to be present in Kenya include:

- Light sources with mercury fluorescent compact tubes
- Batteries
- Paints and
- cosmetics

Mercury has been used in the past in a variety of industrial processes including chlor-alkali production, vinyl chloride monomer products and acetaldehyde production (UNEP). Use of chlor-alkali process has already been discussed as part of pulp and per process. Although there is extensive use of Polyvinyl chloride (PVC), the granules come imported into Kenya. It was not possible to know the level of mercury in this category. Lamps, thermometers and switches are all imported.

Domestic production and processing with intentional mercury use is not contributing significant input but this is likely to change when data is clear on chlor-alkali light sources, batteries, pains and skin lightening creams and soaps with mercury chemicals which have been controlled by the Kenya Bureau of Standards.

Table 7.1 Details the inputs and mercury releases from this category.

Table 6.1 . Domestic Production and processing with Intentional Mercury uses.

DOMESTIC PRODUCTION AND PROCESSING WITH INTENTIONAL MERCURY USE

Source category	Source present?	Activity rate		Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y						
Production of chemicals	**Y/N/?**	Annual consumption/production	Unit	estimate	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal	Cat. no.
Chlor-alkali production with mercury-cells	y	60	t Cl2 produced/y	13	2.5	0.3	4.8	1.3	0.0	3.8	5.4.1
Production of products with mercury content											
Light sources with mercury (fluorescent, compact, others: see guideline)	y	10	kg mercury used for production/y	10	0.1	0.1	1.0	0.0	1.0	0.1	5.5.3
Batteries with mercury	y	1,000	kg mercury used for production/y	1,000	5.0	5.0	100.0	0.0	100.0	10.0	5.5.4
Paints with mercury	y	1,000	kg mercury used for production/y	1,000	10.0	5.0	100.0	0.0	100.0	10.0	5.5.6
Skin lightening creams and soaps with mercury chemicals	y	1,000	kg mercury used for production/y	1,000	10.0	5.0	100.0	0.0	100.0	10.0	5.5.7

7.2 Data Description

7.2.1 Chlor Alkali Production

Chlor- alkali data is from past reports in Webuye Pulp and Paper Mills. Paper and paper Products Manufacturing Industries.

7.2.2 Skin Lightening Creams

From Asia to Africa, millions of Dark skinned women seek solutions to make their skin lighter in colour. Many are willing to take enormous health risks in the form of creams injection pore pills in pursuit of this version of beauty. The Kenya law is clear on the use of some bleaching products. According to a posting on banned cosmetics on the Kenya of Standards website, products with mercury as banned.

Skin lightening creams are in use in general though no one dares admit using them[10]
A study carried out by iLima Kenya for the International POPs Elimination Network (IPEN) found16% of skin lightening products has mercury. However, on the positive end, products containing mercury are often well labelled. 76% consumers are aware of the fact that some skin lightening products can contain mercury and 96% are aware that mercury is toxic. Key sources of mercury in products are skin lightening creams, batteries, thermometers used in homes and hospitals, blood pressure meters used in hospitals and medical practices.
Although mercury free alternatives for all these goods are available, and although the toxicity of mercury is widely acknowledged, products containing mercury are still regularly sold and used.

7.2.3 Background Calculations and approximations

Under the methodology supplied in the Toolkit, Hg emissions associated with the use of mercury-containing products are calculated by multiplying the consumption of a given product or activity rate by "input factors" that correspond to the quantity of mercury estimated in each product. These values are then multiplied by "distribution factors" corresponding to estimated percentages that would be released to the air, water, land, as waste, etc. The values for input and output distribution factors are obtained from the study conducted using the best available information, which includes information from manufacturer's specifications, country of origin and/or values given in the Toolkit.For this subcategory it was necessary to use historical data for products that have entered the country, as the useful life, use and disposal of these means that the mercury they contain will not necessarily be released during the same year they enter the country.

7.2.3.1 Batteries with mercury

Kenyans purchase nearly 240 million dry-cell batteries every year to power radios, toys, cellular phones, watches, laptop computers, and portable power tools. Of these about 150 million pieces (PCs) are produced locally and another 50 million PCs are illegally imported into the country. The illegal imports are often counterfeits and/or substandard and do not last as long as the genuine brands. Consequently, there are more often discarded or dumped and accumulate in the environment where they become a source of pollution to the soils and waters.

[10] The standard Magazine of the Saturday Nation of 9th June, 2012

Eveready East Africa Ltd plant based in Nakuru and is one of the largest battery factories in Africa with a capacity of over 200 million *pakapower* batteries annually and a workforce of about 250 people. Since its beginning it has been affiliated with Eveready Battery Company, USA, which has existed for over 110 years. We are proud of this linkage as it gives a history of firsts for the portable power industry such as alkaline battery, a size lithium battery. EVEREADY'S main brands include EVEREADY, Energizer and Schick which are recognized world over for their distinct quality Dry-cell batteries include alkaline and carbon zinc (9-volt, D, C, AA, AAA), mercuric oxide (button, some cylindrical and rectangular), silver-oxide and zinc-air (button), and lithium (9-volt, C, AA, coin, button, rechargeable batteries

Table 7.2 Production and Consumption of Batteries in Kenya

Sources	**Quantities per annum**
Produced	150 million pieces
Smuggled	50 million pieces
Imported	40 million pieces
Total Consumed	240 million pieces

Source: Eveready Batteries Kenya Limited (2006)

The inventory instead took into account batteries inside the packages of other imported products, such as electronic devices and games, etc., a large number of which enter with batteries included. In this regard, the present study considers batteries identified that contain mercury in their components include:

- Alkaline manganese batteries for intensely used devices such as walkmans, photographic cameras and games, remote controls, etc.
- Zinc air batteries, which are appropriate for hearing aids for the deaf, pacemakers and photographic equipment.
- Mercury oxide batteries for hearing aids, pacemakers and photography
- Silver oxide batteries for watches, calculators and photographic cameras

To estimate batteries disposed of in 2009, a useful life of less than one year was assumed and therefore no historical cumulative values were taken into account, except for mercury-zinc cells, which were assigned a useful life of two years. There has also been tremendous increase in the imports. An annual growth of 20% from 2006 is estimated.

The input factors suggested in the Toolkit for different kinds of batteries was used, making it necessary to transform the activity rate unit. It is estimated that the total is 1tonne. Because of the numerous diverse sources of batteries and almost total lack of standardization of imported products, the Kenya Bureau of Standards (KEBS) has issued a ban on importation and sale of substandard dry cell batteries http://www.kebs.org/index.php issue on 17th June 2009.

7.2.3.2 Paints

The Kenyan paints companies offer a wide range of products to suit each individual need and taste. One can get all varieties of plastic paint, acrylic paint, primers, emulsions, latex paints

and many others in a wide spectrum of colours to choose from. Selection of paint goes far beyond just the matching or desired colour.

Paint companies offer a wide range of paints, pigments; coatings and varnishes . In the past few years, the paints industry in Kenya has been thriving on an upbeat construction and growing economy. As a result of a construction boom in the country, the Kenyan market for paints and coatings continue to maintain a relentless upward march.

The Paints and Coatings Industry in Kenya produces between 55-60 million litres per annum.[11] Some metals have over the years been outlawed in paint preparation and the entire Dura coat range is free from compounds such as; lead mercury, cadmium and chromium. While green paints are Low VOC, it is considered virtually impossible to have Zero VOC levels as some of the pigments in paint contain solvents. The leading paint manufacturers and painting companies in Kenya include Sadolin Paints, Basco Paints and Crown Berger. Each company manufactures its own specialized product – with some also offering professional paint services and training. They indicated they don't use mercury.

This category was not addressed because data was not available. However, since mercury has been used as a preservative in various pharmaceutical products such as vaccines, eye drops, nasal solutions, antiseptics, gynecological drugs, herbal medicines and other products, it was suspected present. It was not possible to quantify this subcategory, but some mercury containing products sold in were identified as potential areas for inventory taking.
In order to take into consideration of use of leaded paint from the informal sector it is estimated that 1 tonne or 1000 kg are used.

7.2.3.3 Thermometers.

Mercury thermometers have been used traditionally to measure temperaturewith the main ones identified as those used in medical, environmental, wine industry, food preparation, and industrial applications. Parameters taken into account for estimating emissions from "Thermometers with mercury. "There are medical thermometers and environmental thermometers. There was no distinction made. No thermometer are made in Kenya,

7.2.3.4 Fluorescent Bulbs

Mercury is used in small quantities for different kinds of discharge lamps. The most common examples are fluorescent tubes and compact fluorescent lamps (CFL), notably metal halide, mercury vapor, high-pressure sodium, and neon lamps. Kenya does not produce lamps with mercury, and its activity level is therefore obtained through use and disposal of lamps produced elsewhere. Parameters taken into account for estimating.

7.2.3.5 Creams and soaps

Mercury has been used in creams and soaps to promote clear skin and as a preservative in some eye makeup and makeup remover. Mercury releases may occur during production, use and disposal of these products. Several studies have been undertaken with a view to controlling.

[11] Press Release by Dura coat Paints on 19th April, 2011 on launching the first seies of green pains in East and Central Africa

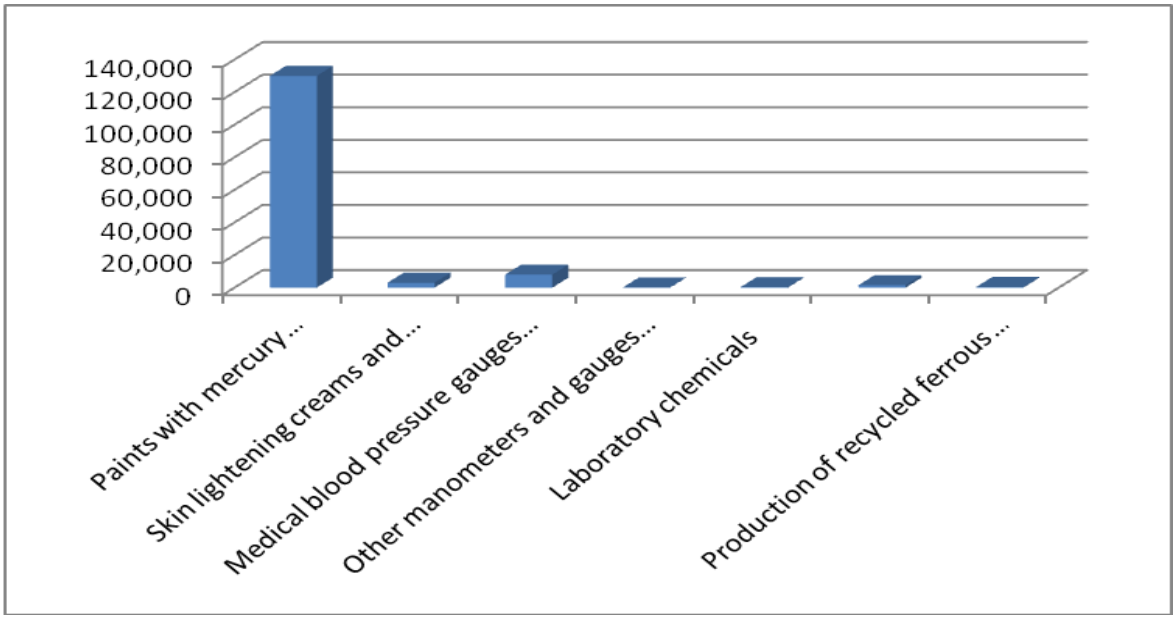


Fig 6: Input of mercury with intentional mercury use.

8.0 DATA AND INVENTORY ON WASTE HANDLING AND RECYCLING

8.1 Data Description

Increase in the populations of countries worldwide accompanied by their ever increasing demand for manufactured products has lead to an increase in production of waste. Kenya is no exception. The population in the country has increased from 8.6 million in 1963 to a current population of approximately 38 million. Of this, 21 million (70%) live in rural areas. Of the 9 million (30%) who live in the urban centers, 5.4 million (60%) live in informal settlements and engage in informal sector employment characterized by small streams of highly toxic and hazardous wastes. The rate of population growth in these informal settlements is currently 8%. They dispose the waste primarily through recycling[12].This section addresses the areas of production of recycled metals, waste incineration waste deposition and land filling, and waste water treatment

8.1.1 Production of recycled ferrous metals (Iron and steel)

Iron and steel are produced from scrap metal using various high temperature processes. Mercury may be present in recycled metals/materials as a result of the presence of natural mercury impurities in the original materials as well as presence of mercury contamination originating from anthropogenic use of mercury. (E.g. mercury switches in cars undergoing iron/steel recycling).

8.1.2 Waste incineration

High temperature hazardous waste incineration is allowed when a facility undergoes an environmental impact assessment. Quantifying mercury containing products in either controlled or uncontrolled landfills is particularly difficult.

8.1.3 Open Burning of waste

There is extensive use of incinerators in industries and hospitals. Kenya is party to the Stockholm Convention on Persistent Organic Pollutants. It has been making effort to comply with best available techniques and best environmental practices to dispose most of its waste. There are two approaches, cessation of open burning of waste and promotion of best incineration technologies that do not generate dioxins and furans.

8.1.4 Landfills

Waste deposition, sanitary landfills and waste water treatment represent the most critical pathways for mercury to enter the environment. The so called landfills in Kenya are just dumps receiving large quantity of mercury containing products, particularly from domestic household and institutional waste[13].

[12] Source: Position Paper on the Nairobi Rivers Rehabilitation and Restoration Programme www.evironment.go.ke

[13] Source :MEMR.Kenya UPOS Inventory(2006)

8.1.5 Wastewater and sludge

It was estimated that approximately 245,761,289 m^3 are discharged annually without undergoing any treatment. The majority of this would occur in environments with minimal industrial activity.

8.1.6 Production of recycled mercury ("secondary production")

Main producers of medical waste are shown in Table 7.2.

8.1.7 Medical Waste Incineration

The total waste generate is either recycled, left to rot, collected for dumping, or burnt in the open Medical waste disposal is regulated strictly by local medical authorities and the hospitals authorities. Most facilities dispose incineration within the hospital or facility. In one of two, cases, the larger centralized medical waste incineration facilities operate for eight hours a day, five days a week. The mode of operation involves manually feeding the waste into the incinerators followed by manual removal and disposal of residues. Kenyatta National Hospital, generating the highest quantity of waste, works for 16hrs a day. The next best Nairobi Hospital works only for 8 hours. In Kenyatta hospital, there is capacity to handle a higher volume if the two incinerators on site were to operate simultaneously. Currently, only one single incinerator is operated at a given time.

Waste generation from Hospitals/medical Services

		Annual Waste Production		
Region (Province)	Number of Beds & Cots	Waste Generated @ 0.41 kg/p/d & 70% occupancy rate (kg)	75% assigned class 1- waste Generated	25% assigned class 2 – waste generated Tons
Nairobi	5011	524,927.305	393,695.48	131,231.83
Coast	7998	837,830.49	628,372.87	209,457.62
Eastern	7822	819,393.61	614,545.21	204,848.4
North Eastern	1914	200,501.07	150,375.80	50,125.27
Central	8314	870,933.07	653,199.80	217,733.27
Rift Valley	12832	1,344,216.16	1,008,162.12	336,054.04
Nyanza	12545	1,314,151.48	985,613.61	328,537.81
Western	6971	730,247.11	5,476,685.33	182,561.78
Total	**63407**	**6,642,200.29**	**4,981,650.21**	**1,660,550.07**

The total quantity of waste generated was determined as follows:

District Hospitals	=	41 @ 110 kg each =	110 x 41 =	4,510
Provincial Hospitals	=	8 @ 110 kg each =	110 x 8 =	880
Private Hospitals	=	Nairobi, Mombasa, Kisumu	=	1,156.30
Clinics & Nursing Homes		400 @ 5 kg each	=	2,000
Total				8,000

It was found that the above estimate could not account for all the waste generated. In order to be comprehensive, the criteria recommended by World Health Organisation (WHO) was used to determine the approximate quantities of waste generated. There are 77 District, 8 Provincial and about 7 private hospitals with a bed capacity equivalent to the provincial hospitals. The waste from these hospitals is disposed through combustors of varying degrees of technology. The incinerators in the latter hospitals can be rated as low technology while those for the district hospitals can be classified as uncontrolled combustion, with no air pollution control system. The amount of medical waste is extrapolated from the bed occupancy rate of 70% with a per capita waste generation of 0.41kg/patient/day. Table 13 below indicates the extrapolated waste totals.

Uncontrolled domestic waste burning include instances where waste is burned with no pollution controls and therefore includes burning in the open in piles, barrels or in home fires. The burning of waste in landfills is considered separately. The generation of solid waste varies with different types of houses as well as different socio economic groups. The average waste generated per capita per day is 0.72kg. A per capita production of 0.8 kg is estimated for urban areas and 0.3 kg for local population. Approximately 20% of Kenya's population lives in urban areas. The total waste generated is calculated here below;

Population of Kenya = 40,000,000
For urban population 20% = 8,000,000
Waste generated = 8,000,000x0.8x0.001x365
= 1,752,000 tons/annum
For rural population is 80% = 24,000,000
Waste generated = 32,000,000x0.3x0.001x365 = 2,628,000tons p .annum
Total waste generated = 4,380,000
Waste in incineration = 25% x4380,0001,190 t.a.

Waste burnt in the open 50% = 0.5x 4,380,000
= 2,190,000t/a

Fig 8. Open burning of waste Picture by FN Kihumba during a clean-up campaign I Kawangware in Nairobi.

8.1.8 Landfills and Waste Dumps.

The wastes that end up in landfills and waste dumps come from both households, institutions and industries, though some agricultural waste is generated and commercial sources. The inventory indicated that many of the facilities generating both hazardous and non hazardous waste use open burning as the mode of waste disposal. In the City of Nairobi for example, the City Council employees after sweeping will often burn them. Households also practice open burning although in a majority of cases especially in the rural areas, composting is done. There is no sanitary land filling in Kenya and nearly all local authorities use dumping as a method of disposal which is often followed by open burning. While this waste disposal organised by the authorities is not informal, it has very similar characteristics as the landfills do not offer any protection against further spreading of the waste into the environment with water run-through or via evaporation. Calculations on waste amounts were considered under open burning. Waste which is dumped is 1,300,000 tons

The actual mercury concentrations in household waste in Kenya are not known; default factors from the Toolkit were used. As these default factors primarily build on data from developed countries, the mercury emissions calculated may perhaps be overestimated (though substitution of mercury-added products may be more advanced in developing countries today).

Fig 9.Nakuru Waste dump

8.1.9 Sewage Treatment

Generally people are served by main sewer, septic tanks and pit latrines.
For purposes of the inventory, only main sewer treatment was considered. It involves the conventional activated sludge process and oxidation ditches. There are no separate sewage lines for industrial and domestic. The sewage treatment works treat mixed effluent, industrial and domestic. There are 142 gazetted urban centres. Of these, only 30 % have sewerage systems. The systems are available in few selected towns and cities as follows. In addition, the Export Processing Zone landfills extensive amounts of waste water from households, institutions and industries.

Urban centres with sewerage systems oxidation in Nairobi, Narok, Kericho, Thika, Kakamega, Eldoret and Nyeri. Conventional plants are in Mombasa, Nakuru and Limuru. There are treatment plants that can be considered as major facilities in category although they may not be connected to other external sewerage systems. Some of the key facilities are Athi River Export processing zone, Pan African Paper Mills, sugar factories, leather factories, textile factories, paper factories, sisal factories, slaughter houses.

8.1.10 Data gaps and priorities for potential follow up

Incineration and technology assessment is based on EIAs and Open burning is an estimation of waste generated, collected, recycled, biodegraded and then assumed burnt. In future better estimation will be done using the EIAs of Nakuru, Kisumu, Nairobi and Mombasa. Face to face interviews with town clerk.

8.2 Releases

General waste management set up is the most important sources of mercury emissions to all the three media. Open burning of waste on landfills and informally disposed waste contribute to a mercury input of 30,000 kg Hg/y followed by controlled landfills with 20,000kg Hg/y. The source of this input is from waste products which are disposed without sorting them first in an environmentally sound manner. Importantly so is that largely emissions are to air as shown in Fig

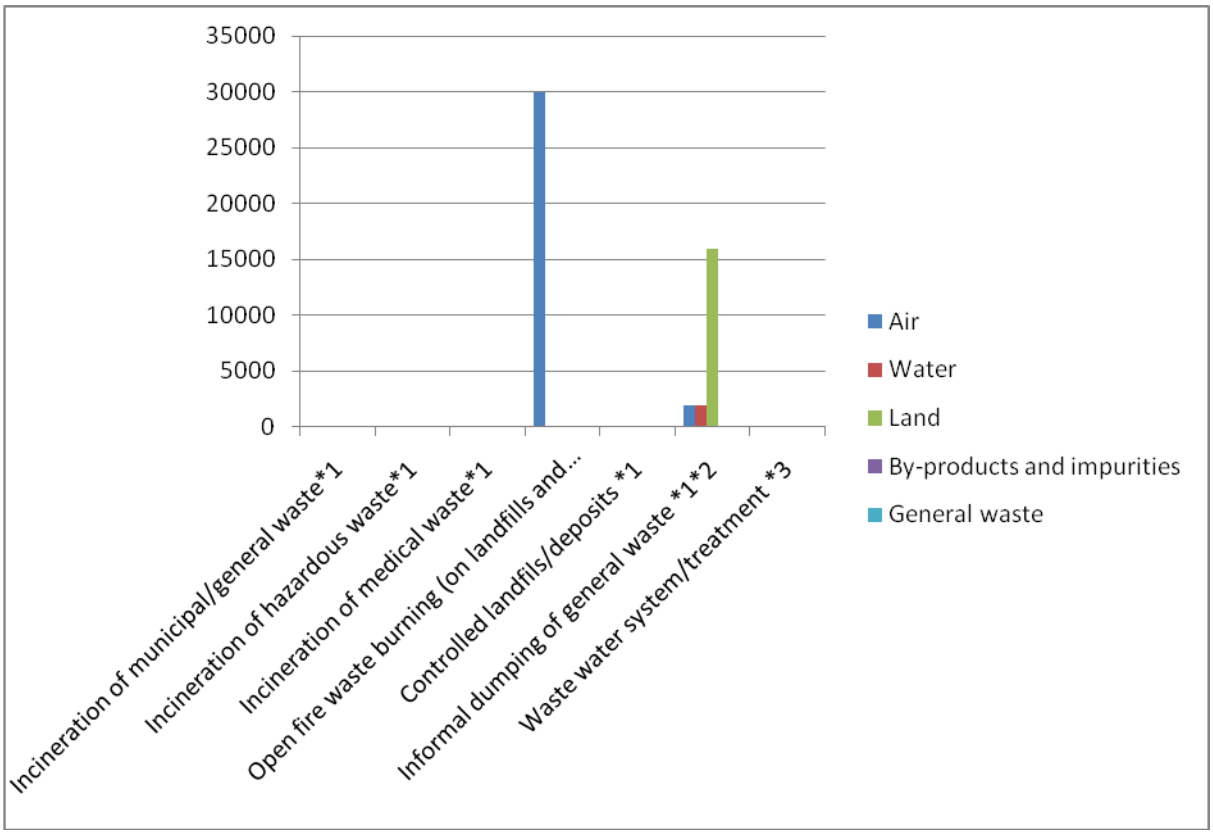


Fig 10. Emissions from intentional uses of mercury

9.0 DATA AND INVENTORY ON GENERAL CONSUMPTION OF MERCURY IN PRODUCTS, AS METAL MERCURY AND AS MERCURY CONTAINING SUBSTANCES

Data description

9.1.1 Dental Amalgams

The population of dentists in Kenya is approximately 953 which amount to a dentist-population ratio of 1: 41,973. The dentists are distributed between private and public sector with the majority being in urban areas. The Ministry of Medical Services has 120 public hospitals which provide dental services to the public. According to the ministry's annual report of 2009/2010 and 2010/2011 6,402 and 5,168 dental amalgam fillings were done annually respectively [1.] This data can be used to compute the approximate estimates of mercury input using the 0.8g per filling from the UNEP toolkit level 2 and using the National/overview approach.

With regard to the number of fillings done by dentists in private clinics in Kenya two studies have been done. In one study involving 68 dentists in Nairobi, it was reported that 50% use dental amalgam and a total of 1,029 fillings of all filling materials were executed per week (Ganatra et al 2009)[3]. On the other hand in a more recent study among 77 dentists, 76% of them reported amalgam as the first choice filling material. In the same study 1,320 fillings of all filling materials were done in a week (Ndonga et al 2011)[4]. Overall, the total numbers of fillings that are done by dentists are very small and cannot be extrapolated from a small sample due to unique factors that prevail.

9.1.2 Thermometers

Due to lack of data, the number of quantity of mercury thermometers in circulation in Kenyan households, institutions, hospitals, could not be quantified. Data on net import of thermometers have however been obtained, and the data have been used to estimate mercury amounts in products reaching the waste stream, see below. It was noted also that in many hospitals, mercury containing chemical thermometers have been replaced with digital ones. It is thus expected that the proportion of those in circulation currently will be broken each year releasing mercury into the environment within households and to landfills through disposal of remains. This cannot be quantified on the available data though known to be present especially in small clinic and dispensaries.

Net import data were derived from the UN Comrade database.

9.1.3 Switches

Mercury is a component in many electric switches such as displacement/plunger. More work will need to be done for these equipments and an assessment done on the quantities of mercury contained in any one switch. Electrical switches are produces in Kenya but also extensively imported. The mercury input and releases via switches was quantified using default factors in the Toolkit based on population.

9.1.4 Batteries

The main producers of batteries are Duracell and Eveready. However batteries for watches cameras, cell phones are largely imported. After use they are dumped. The high and middle income groups usually dispose waste with 0.09% made of batteries while low income groups generate 0.07% of solid waste being batteries, giving an average of 0.08% of solid waste as batteries. There is therefore in Kenya an estimated 1 ton of batteries in Nairobi or 730tonnes of batteries[14] in Kenya. The waste amounts of mercury from batteries were however calculated using estimates of battery consumption in combination with defaults factors from the Toolkit based on the waste fate scenario "less than two thirds (67%) of the waste is collected and treated under public control" (the same applies for all products).

9.1.5 Light sources with mercury

Mercury containing lamps include linear fluorescent tubes (LFL), compact fluorescent (CFL), high pressure mercury vapor lamps, high pressure sodium lamps and metal halide camps. The latter three are grouped as high intensity discharge (HID) lamps. The New Zealand average mercury concentrations were used were 12mg Hg/Lamp for fluorescent tube (4ft); the 4mg Hg/lamp for fluorescent tube (2ft) and the 50 mg/lamp for each of the other lamps. These give a guide to what is being used in Kenya as there are e no reliable figures for fluorescent tubes imported into Kenya. In 2011 the Kenya Government announced that it would like to change the energy inefficient incandescent bulbs with the energy saving ones. A total estimate of 1million 4ft tubes and 2million 4ft tubes was made. 500,000 energy saving bulbs were estimated. This figures need to document through systematic documentation of the bulbs which are imported. It is noted that few are recycled. All the rest go into landfills.

9.1.6 Electrical and electronics

There was a lot of interest indicated to include e-waste in this inventory because mercury is a trace compound in electrical and electronic waste streams where it is used in thermostats, sensors, relays, switching equipment and the LCDs displays (including TVs and computer monitors). It is estimated that the average mercury content in computer parts to be roughly 0.002%. LCD TVS are increasing replacing the cathode ray tube. LCD TVs and computer monitors are potential source of mercury in electrical and electronic waste (besides batteries, switches and fluorescent lamps). LCD TV can contain as much as 150 mg of mercury in the backlights given the relatively recent introduction of LCD monitors, it is expected few monitors are being disposed of to a land fill. In an average, TV or computer LCD monitor contain 100 mg mercury. 10,000 monitors would have to be scrapped to equate to 1kg of mercury each year which suggest the size of the problem.

In this inventory, mercury in electronics was quantified along with switches, as described above.

9.1.7 Dental mercury-amalgam fillings

[14] Study done in 2009 by Japan International Cooperation Agency with the Ministry of Local Government Draft Report (July 2010) Volume 3 Supporting Report

The data available to quantify the mercury burden contributed to the environment is at its best scanty. It is crucial to be able to quantify the total percentage of dental amalgam waste to be able to succinctly approximate the amount of waste mercury residue contributed by dentists in Kenya. Moreover, it is important to note that dental amalgam is packaged in capsules whose weight corresponds to the size of cavities to be filled to minimize waste. In countries where the waste amalgam has been quantified it has been estimated approximately 30% of the amalgam prepared in dental offices (0.6 g per capsule) are wasted Flavia et al 2008[2] Of this only a small amount would be discharged to water system.

Mercury-amalgam fillings consist of an alloy or mercury, silver, copper and tin (with usual mercury content of 44 to 51% by weight). Mercury is released into the air and water and as waste during the production, use and disposal of amalgam fillings. These types of fillings are used widely in the public health sector.

The results indicate average monthly applications of 20,000 amalgam fillings for the 200 chairs providing dental care, with a total mercury consumption of 11.7 kg. This indicates a total yearly use of around 281 kg of mercury, considering that 57% of all dental offices in the public health care system in responded to this survey. Nevertheless, this sector represents only a segment of the sector, as there are many dentists operating in private practice in, making it difficult to quantify this value using only the information provided.

- Mercury releases can occur at different stages of the life cycle of dental amalgam: during dental filling and/or replacement from old ones, at the end of life (cremation or burial), and during progressive deterioration of amalgam fillings in people's mouth due to chewing and hot beverages (EU, BIOS report, 2012).

- Depending upon the number of amalgam fillings and other factors, the estimated average daily absorption of mercury vapor from dental fillings varies between 3 and 17 μg mercury (UNEP, WHO 2008).

- Mercury releases to the environment:

A survey[15] was applied among 20 private dental institutions as with the private health care facilities, little information was forthcoming in part because of their inability to supply such information and in part due to the time constraints of the study.
The activity rate suggested by the Toolkit is based on the number of inhabitants that, for the purpose of this study, corresponds to the population in 2009 for the assessed part of the cycle: "Dental preparations and procedures at dental offices. "No past statistics were applied, as the category of cemeteries and crematoria were considered as of 2005, which would cover mercury releases from fillings from previous years. Twenty private health care facilities in Nairobi were surveyed in a limited fashion, given the limited amount of time available for the study and the fact that most private facilities do not give out information readily. When this report was made no information was available on this survey. The thermometers that could be quantified were medical and environmental.

9.1.8 Laboratory chemicals and equipment

Mercury is used in laboratory instruments, reagents, preservatives and catalysts. Part of the Hg contained in these instruments is released to the air, mainly through ventilation systems; however, mercury is also released through wastewater and through general waste disposal. Through the

[15] iLima Study

KRA the study was able to determine that 4 Kg of mercury was imported as a chemical product but for what purposes it was not indicated for laboratory use into by a local lab. The output factor applied was that suggested in the Toolkit, with a distribution of 30% to water, 30% to general waste and 40% to sector-specific treatment. The entry of chemical products containing mercury for lab use was also identified but was not quantified because of the complexity of the compounds involved.

9.2 Data gaps and priorities for potential follow up

i. Legal requirement for data on mercury in products is necessary.

ii. For paints, manufacturers use trade names and often do not indicate level of mercury. Better estimation methods are necessary.

iii. Skin lightening products are from different countries which themselves do not publicise mercury level is still shrouded in secrecy. Legal requirement for mercury data is necessary.

9.3 Data gaps and priorities for follow up

The inventory process has confronted difficulties in collecting data from the Customs: there are many materials and equipment has been imported and they might have some content of mercury and they cannot be defined by the Customs through official records.

- Dental amalgam fillings consist of an alloy typically of mercury, silver, copper and tin (mercury content 44 to 50% by weight). The use of the term "Mercury amalgam" is redundant since an "amalgam" is an alloy of mercury with other metals. Very small amounts of mercury may be released during placement of fillings or removal of dental amalgam. It is estimated that only 0.1% of ALL mercury released into the environment comes from dental sources(Adegbembo, Watson and Lugowski. 2002) [16]
- Finally the instruments used to evaluate the Hg are not clear in the inventory document.
- Data about mercuric thermometers other than medical are not available.
- Information about the medical equipment and pharmaceuticals with mercury needs more investigation, for cosmetics and related products.

Paints

- We need more investigation and analyzing to assure that the mercury existing in these materials.
- The concerned bodies do not have a data base on mercury and its compounds.
- A lack of information from the private sector.
- The inventory did not cover hospitals in the public and private sectors.

For fluorescent lights

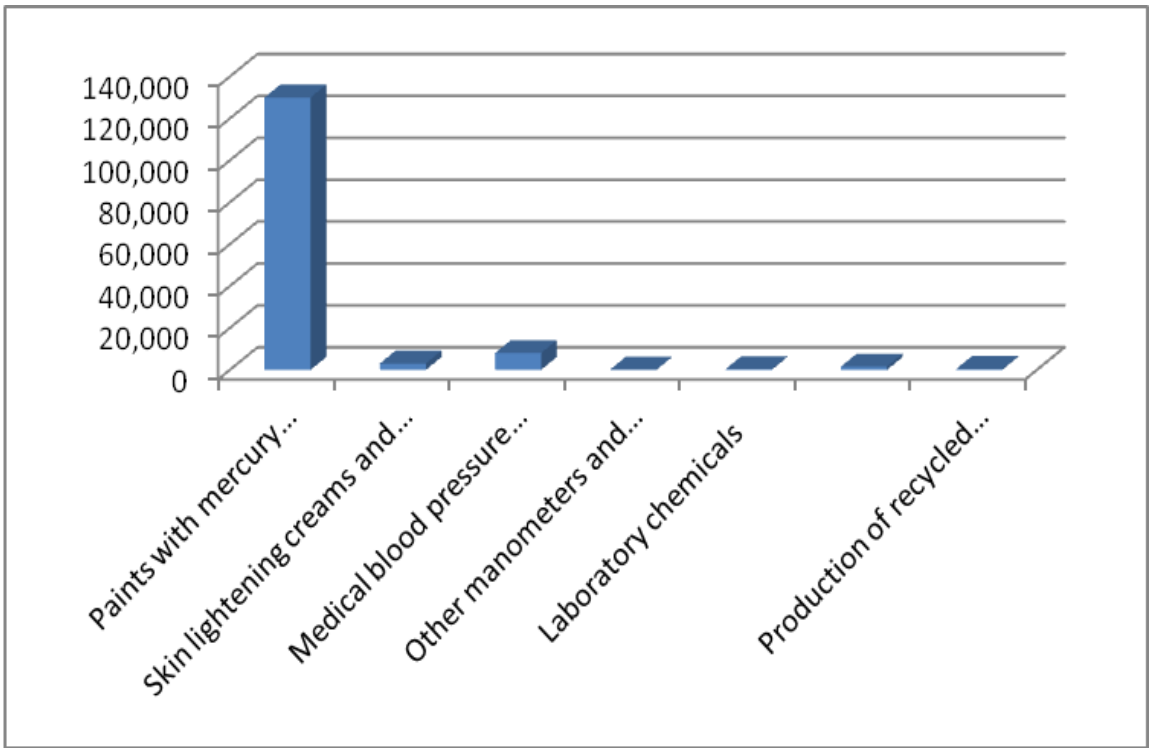
- In our calculations we have taken in our consideration the estimated amount of the florescent lamps which are used and disposed per year, is about 2,500,000 piece/year

with consideration of the estimated number of families in Kenya and the lamps life time (from 5-10 years according to the toolkit paragraph n. 832 page n. 76).

- We have no official records clarify the estimated annual discarded lamps number.
- More investigation is needed to collect data about other kinds of imported light sources with mercury.
- More investigation needed to estimate the annual discarded lamps number during the next comprehensive inventory.

GENERAL CONSUMPTION OF MERCURY IN PRODUCTS, AS METAL MERCURY AND AS MERCURY CONTAINING SUBSTANCES										
Source category	Source present?	Activity rate		input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y					
	Y/N/?	Annual consump-tion/popul ation	Unit	Standard estimate	Air	Water	La nd	By-products and impuri-ties	General waste	Sector specific waste treatment /disposal
Use and disposal of products with mercury con-tent										
Dental amalgam fillings ("silver" fillings)	***Y***			***5,700***	***114.0***	***1,89 2.4***	***0. 0***	***205.2***	***1,094.4***	***1,094.4***
Preparations of fillings at dentist clinics		38,000,00 0	number of inhabit-ants		114.0	798. 0	0. 0	0.0	684.0	684.0
Use - from fillings already in the mouth		38,000,00 0	number of inhabit-ants		0.0	68.4	0. 0	0.0	0.0	0.0
Disposal (lost and extracted teeth)		38,000,00 0	number of inhabit-ants		0.0	1,02 6.0	0. 0	205.2	410.4	410.4
Thermometers	***Y***	***2,000***		***13***	***2.6***	***3.9***	***2. 6***	***0.0***	***3.9***	***0.0***
Medical Hg thermometers	Y	1,000	items sold/y	1						
Electrical switches and relays with mercury	Y	38,000,00 0	number of inhabit-ants	5,320	1,596. 0	0.0	2, 12 8. 0	0.0	1,596.0	0.0
Light sources with mercury	***Y***	*3,500,000*	items sold/y	***56***	***16.9***	***0.0***	***16 .9***	***0.0***	***22.5***	***0.0***
Fluorescent tubes (double end)	Y	1,000,000	items sold/y	25						
Compact fluorescent lamp (CFL single end)	Y	2,000,000	items sold/y	20						
Other Hg containing light sources (see guideline)	Y	500,000	items sold/y	11						
Batteries with mercury	***Y***	***3***	***t batteries sold/y***	***327***	***81.8***	***0.0***	***81 .8***	***0.0***	***163.6***	***0.0***

Mercury oxide (button cells and other sizes); also called mercury-zinc cells	Y	1	t batteries sold/y	320						
Other button cells (zinc-air, alkaline button cells, silver-oxide)	Y	1	t batteries sold/y	7						
Paints with mercury preservatives	y	50	t paint sold/y	130	119.6	6.5	0.0	0.0	3.9	0.0
Skin lightening creams and soaps with mercury chemicals	Y	1	t cream or soap sold/y	30	0.0	28.5	1.5	0.0	0.0	0.0
Medical blood pressure gauges (mercury sphygmomanometers)	Y	1,000	items sold/y	80	16.0	24.0	16.0	0.0	24.0	0.0
Other manometers and gauges with mercury	Y	38,000,000	number of inhabitants	190	38.0	57.0	38.0	0.0	57.0	0.0
Laboratory chemicals	Y	38,000,000	number of inhabitants	380	0.0	125.4	0.0	0.0	125.4	129.2
Other laboratory and medical equipment with mercury	Y	38,000,000	number of inhabitants	1,520	0.0	501.6	0.0	0.0	501.6	516.8


140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Paints with mercury...
Skin lightening creams and...
Medical blood pressure...
Other manometers and...
Laboratory chemicals
Production of recycled...

10.0 Inventory on crematoria and cemeteries

Data description

At the time of death, a body is transferred to their cremation facility. Depending on the wishes of the deceased or the family, items such as jewellery like chains, rings are removed before the process begins.

When it is time for the cremation, the body is placed in a cremation container, and then into the cremation chamber. The cremation container/casket containing the body is then placed in the cremation chamber. The cremation chamber, sometimes referred to as the retort, is lined with fire resistant bricks on the walls and ceiling. The floor is made from a special masonry compound formulated specifically to withstand extremely high temperatures.

Once the body is in, the chamber door, which is about a half a foot thick, is closed either by hand or in some cases a switch as many of the newer models have automated doors. Others are computerised. The crematory operator then starts the machine which normally goes through a warm up cycle before the main burning begins. After the machine is warmed up, the main burner ignites starting the process of incinerating the body. The burners within a cremator are fuelled by either natural gas or propane.

This process, takes about two to three hours, although it could take a bit longer. Once the body is placed inside, the temperature is increased substantially until it is between 1800°F - 2000°F depending on the body weight of the body. Once the cremation procedure is complete, the cremated remains are removed from the chamber. Any foreign material, such as metal from bridgework or prosthetic devices, are removed and discarded.

Once the process has taken place, the body has been reduced to a fraction of its original weight. What we commonly call “ashes” is technically called “cremains,” meaning simply cremated remains. Cremains are essentially what are left of the bones of the body. The cremains are carefully examined to identify larger pieces of bone and to remove any artificial joints or dental fillings which remained in the body.

As noted earlier, mercury is used as a major component of dental amalgam. Amalgam filling constitutes the main concentration of mercury in the human body although mercury is also present in human tissues (UNEP 2009). Mercury emissions will occur to the atmosphere during cremation and mercury can be released to the soil at the cemetery.

Source category	Activity rate		Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y					
Crematoria and cemeteries	Annual numbers dead	Unit	Standard estimate	Air	Water	Land	By-products and impu-rities	General waste	Sector specific waste treatment /disposal
Crematoria	6,000	corpses cremated/y	15	15.0	0.0	0.0	-	0.0	0.0
Cemeteries	300,000	corpses bur-ied/y	750	0.0	0.0	750.0	-	0.0	0.0

10.2 Background calculations and approximations

Burial is the predominant method in Kenya, but a few crematoria exist in the major cities. There are five crematoria. 3 in Nairobi, in Kisumu and four in Mombasa. There are two busy ones.

10.3 Data gaps and priorities for potential follow up

Based upon the official death rate in Kenya for 2009, (KNBS 2009) and estimated ratio of cremation to burial 10/100, it is estimated that ... corpses were cremated in 2009. Assuming an emission rate of 4g Hg/corpse and based on the WHO (1991) estimate of the average number of fillings in an average person, provides a mercury emission rate of 0/0001kg hg/year form crematoria's.

11.0 List of major data gaps

Information on the use of mercury, and natural and anthropogenic fate and transport of mercury, in Kenya is incomplete. Accordingly, the inventory of emissions has gaps which, where possible, have been filled using overseas data, but in other cases must remain as gaps. The limitations of, and gaps in the data have been identified throughout the report.

11.1.1 Data Sources

In general, where there has been a choice in calculating estimates, Kenya data has been preferred over overseas data, and official statistics or government reports preferred over other sources. Where there has been a range of such things as emission factors, mercury contents, and the like, middle values have been chosen for the calculations. Where UNEP Toolkit default emission factors have had to be used it is expected that these values will result in conservative (high) estimates.

The lack of reliable data may have resulted in over or under-estimates of particular types of emission sources, and of the natural and anthropogenic totals. While the major sources of natural and anthropogenic emissions are thought to have been accounted for, given the lack of reliable data for some sources it is not possible to estimate the likely error in the estimates.

12.0 Conclusion

The national preliminary inventory is a significant step ahead for achieving mercury and its compounds sound management, and as a result of this preliminary inventory we have obtained estimations about mercury releases into various media.

- As for the intentional or unintentional used mercury and its releases estimations, which we have calculated, they have been made in accordance with the toolkit default input factors and default output distribution factors, consequently, the mercury input and output results are default also.

- Having reviewed the calculations results according to the toolkit default input factors of mercury and our industries reality and the nature of the used raw materials in these industries it is important for Kenya to work more on the interpretation of the inventory so that it cab,

- We also mention that this report has been prepared in accordance with the methodology proposed in the Mercury Inventory Toolkit issued by the chemicals unit in the United Nations Environment Program, which is still considered as a tentative toolkit, where our national inventory project is considered as a pilot project to help test this toolkit, and submitting notes and recommendations for future development.

- Therefore, the results of mercury amount calculations and estimating the amount of emissions which we have made based on this primary toolkit seemingly are not to the expectation of some stakeholders as not be realistic for some of the emission sources e.g. dental amalgams.

- As for the thermometers and pressure gauges, lamps and other products containing mercury in a closed form, it is very difficult to quantify and thus calculate the amount of mercury. Estimating the amount of mercury emitted from these products depends on determining the quantity of the broken products, and therefore, the results obtained do not reflect the reality of emissions where there is no mechanism to determine the percentage of devices which break in the year or for several years.

- The results show that some of the default input factors, particularly concerning of the wastes category, where these default input factors are high values, consequently, they will give us.

1. In conclusion, the inventory progress in the near future to achieve a full comprehensive inventory on mercury and its releases is a high necessity in order to avoid the aforementioned gaps and having a true estimation for mercury releases in Kenya. For example. In the case of dental amalgams The Ministry of health, Kenya Dental Association, School of Dental Science, Medical Practitioners and Dentists Board prefer the phase- down approach on the use of dental amalgam and hence support the WHO and FDI stand on dental amalgam. There is evidence that 50 and 76% of the dentists select dental amalgam as their first choice of filling material. In addition, the dental schools in Kenya use dental

amalgam filling material for training dentists. “Phasing out” dental amalgam would adversely affect dental education in Kenya as the cost of dental amalgam is user friendly to the financial constraints experienced in these institutions. They also support enhanced continuous development program on Dental waste management for dental fraternity.

2. The cost of fillings is already prohibitively high for the average Kenyan patient. A sudden phase-out of dental amalgam which is the cheapest filling material available would lock out a sizeable number of Kenyans encouraging the shift to extractions which is already high.

12.1.1 Recommendations:

- Completion of a full comprehensive inventory.
- Capacity building of relevant bodies in Kenya through more follow-up in areas with question marks.
- Development of legislation to regulate the circulation of mercury and its compounds: import, circulation, transport, storage, disposal.
- Pilot projects for specific sector

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[Give full reference to all data sources in your report:

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Appendix 1 - Inventory Level 1 calculation spreadsheets