MERCURY ASSESSMENT for the PHILIPPINES

Using UNEP InventoryToolkit

Dr. Genandrialine L. Peralta, Consultant
Ms. Elvira Pausing, EMB Project Manager

APRIL 2008

Draft Mercury Inventory Assessment for the Philippines Using UNEP Toolkit
Environmental Management Bureau, April 28, 2008

This report should be read in conjunction with the UNEP toolkit Excel file for the Philippines which provides detailed data and calculations. The following narrative report is preliminary and will be refined after further stakeholder consultation. The independent local consultant for this UNEP-EMB project is Dr. Genandrialine L. Peralta, Professor, Department of Chemical Engineering and Coordinator of Environmental Engineering Graduate Program, University of the Philippines, Diliman. The Project Manager is Ms. Elvira Pausing, senior environmental management specialist of the Environmental Management Bureau, Department of Environment and Natural Resources, Philippines. Comments and additional inputs will be appreciated.

1.0 Introduction

Mercury is ubiquitous that is found in our environment on land, water, and especially air. There are numerous researches and publications on mercury and its compounds and their chemistry, toxicology, exposure and risk evaluations to human health, impacts on the environment, and sources and cycling to the global environment are now known more than before.

A global assessment report, spearheaded by the United Nations Environment Programme (UNEP), was prepared on mercury and mercury compounds with the objective to promote environmentally sound management and a contribution to increase awareness and understanding among the many decision makers of the major issues related to mercury and its compounds (UNEP 2002).

Some countries, such as the United States, Canada, and Mexico, have done their report on atmospheric mercury emissions from anthropogenic sources. For the US, an inventory as well as assessment evaluation of exposure, risks, and control technologies and costs were done (US EPA 1997). Risk management pollution prevention, remediation activities, and research and policy development activities were presented by Canada (Environment Canada 2000). In Mexico, a preliminary inventory on eighteen major sources was done (Asociados 2001).

In the Philippines, under Republic Act 6969 of 1990 and DENR Administrative Order (DAO) No. 29, Series of 1992, the Chemical Control Order (CCO) is being issued on the basis of authorities given to the Department of Environment and Natural Resources (DENR 1997). The CCO, in addition to all the other requirements, is concerned on

mercury and mercury compounds; their importation, manufacture, distribution and use. It is meant to control their use and dispersion into the environment to avoid adverse consequences.

The Environmental Management Bureau (EMB) of the DENR, as part of the CCO, has records of all the importer, manufacturer, distributor and purchaser, the end-use category of mercury or mercury -containing products, quantity of products supplied, and the quantity of wastes produced as a result of manufacturing and industrial use (DENR 1997). An inventory of mercury and mercury compounds is undertaken within the country.

2.0 Project Description

The UNEP Toolkit, for identification and quantification of mercury releases, is applied in the study. This report presents the major and subcategories sources of mercury in the Philippines. It includes pollution prevention measures and control technologies in reducing mercury uses and releases. From the mapped location of the various sources, populations at risk are identified.

In the UNEP Toolkit, data on production and usage of the various sources must be provided to come up with distribution estimates of mercury in the environment (UNEP 2005). This is where secondary information or indirect approaches are considered. On mercury source concentration and emissions, some default values are available in the UNEP Toolkit. In other sources where there is lack of data on source mercury concentration, published estimates of legitimate organizations such as the US EPA and the UNEP were used along with Philippine and international references.

3.0 Anthropogenic Sources of Mercury Emissions

Among the ten listed in the UNEP Toolkit, eight major sources are considered to be existent in the Philippines. Potential hot-spots are not included in the UNEP Toolkit Excel calculation file. It is noted though in the Toolkit Manual that if hot-spots are identifiable, these must be included in the inventory. These will be included in the final report after stakeholder consultation.

After identification of the major sources, subcategories are listed based on secondary data from various sources. Table 1 shows the major sources of releases.

Table 1. Major Sources of Mercury Releases

Sources
• Extraction and use of fuels/energy sources • Primary (virgin) metal production • Production of other minerals and materials with mercury impurities • Intentional use of mercury in industrial processes • Consumer products with intentional use of mercury • Other intentional product/process use • Waste deposition/landfilling and waste water treatment • Crematoria and Cemeteries

In the UNEP Toolkit, waste incineration and secondary metal production are presented as major sources. However, waste incineration is banned in the country and hospitals have stopped this practice of waste disposal (EMB 2003). No sources of secondary metal production were also identified.

3.1 Extraction and Use of Fuels/Energy Sources

There are six identified subcategories in the extraction and use of the different energy sources. Biomass production and other fossil fuels extraction and use are not included. The subcategories are presented in Table 2.

Table 2. Subcategories in Extraction and Use of fuels/energy sources

Subcategories
• Coal combustion in large power plants • Other coal use • Extraction, refining and use of mineral oil • Natural gas – extraction • Geothermal power production

3.1.1 Coal Combustion in Large Power Plants

The Department of Energy (DOE) reported 4,177 MW coal power generation for 2006 (DOE 2006). This is equivalent to 10.773 million tons per year. Table 3 shows the list of the major coal plants in the country. Only a representative 3263 MW from the different sources listed was gathered. Other power plants existing are obviously missed. Locations of the mapped power plants are plotted in Figure 1.

On the other hand, from the 2005 Philippines Energy Data, the total coal consumption of the country was 10.103 million tons per year – 28% locally produced and 72% imported from other countries.

In the calculation of the mercury consumption, the data from DOE will be used and it was assumed that 28% locally produces and 72% imported from other countries or 3.016 million tons per year is locally produced and 7.757 million tons per year is imported from other countries.

The air pollution devices used vary from each plant, but majority used ESP, such as that of Masinloc. The Quezon Plant which is run by Quezon Power Ltd even has a low-NOx burner. However, those which are run by Mirant have wet – FGD system.

There was no mention of coal pre-washing prior to firing in the burners.

Table 3. Coal Power Plants Generation and Location

Power Plant	Generation, MW	Location
Pagbilao Unit 1	382.00	Pagbilao, Quezon
Pagbilao Unit 2	382.00	Pagbilao, Quezon
Calaca Unit 1	300.00	Calaca, Batangas
Calaca Unit 2	300.00	Calaca, Batangas
Masinloc Unit 1	300.00	Masinloc, Zambales
Masinloc Unit 2	300.00	Masinloc, Zambales
Sual Unit 1	300.00	Sual, Pangasinan
Sual Unit 2	300.00	Sual, Pangasinan
Quezon Power	511.00	Mauban, Quezon
Toledo Power Corp.	88.00	Toledo City, Cebu
Cebu TPP1-2 (Salcon)	100.00	Naga, Cebu

The default input factor in the UNEP Toolkit is 0.05-0.5 g Hg/ton coal (UNEP 2005). The maximum value in the range is used for the calculation. A total of 5,387 kg Hg/year is emitted. The output distribution is allocated mostly in the air, comprising 90%, and general waste for the remaining.

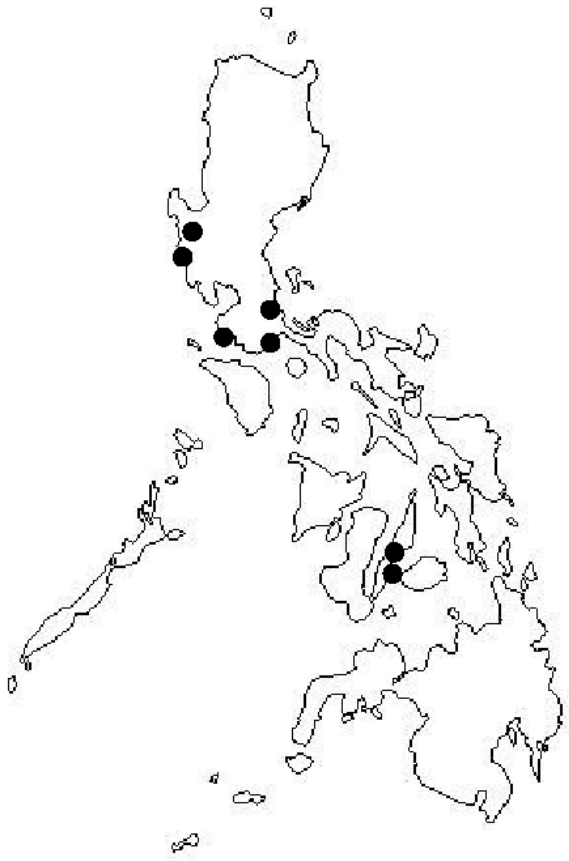

Figure 1. Location of Power Plants in the Philippines

3.1.2 Extraction, refining and use of mineral oil

Other oil combustion facilities are present in the country. Table 4 shows the list of plants and in Figure 2, their geographical locations in the country can be seen.

Table 4. Oil-Based Power Plants

Power Plants	Generation, MW	Location
FPPC- Bauang Diesel	235.20	Bauang, La Union
Duracom Unit 1 & 2	133.38	Navotas, Metro Manila
Duracom 3 & 4	109.00	Navotas, Metro Manila
Enron Subic 2	100.00	Subic, Olongapo City
5 power plants (< 50 MW)	188.00	Luzon
Panay Power Corp.	70.00	Ingore, Lapaz, Iloilo City
Cebu Private Power	60.00	Cebu City
PDPP III(Pinamucan)	110.00	Dingle, Iloilo
15 power plants(< 50 MW)	382.00	Visayas
Power Barge 117	100.00	Naspit, Agusan del Norte
Mindanao PB Dsl II	100.00	Maco, Davao del Norte
WestMindanao Corp.	107.00	Sangali, Zamboanga City
7 power plants (< 50 MW)	284.00	Mindanao

From Table 4, a total of 1978.60 MW is generated by all the plants. This list represents only a partial of the total existing plants and their generation. According to the DOE, for 2006, a total of 3602 MW is generated from the diesel/oil usage (DOE 2006). This corresponds to 2,222.81 kilo tons per year.

The default input factor in the UNEP Toolkit is 100 mg Hg/ton (UNEP 2005). A total of 222.28 kg Hg/year is emitted. An estimated 200 kg/year is emitted in the air, comprising 90%, and the remaining as general waste.

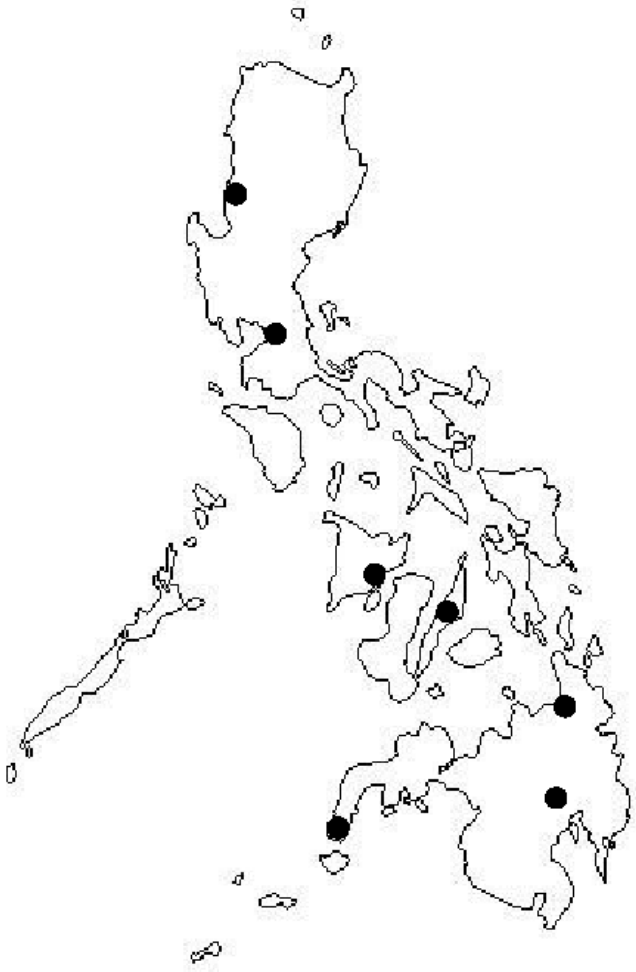

Figure 2. Location of Oil-based power plants

3.1.3 Natural Gas – Use

From the DOE, for 2006, a total of 2,763 MW is generated from natural gas (DOE 2006). This corresponds to 4.234 billion normal cubic meters per year. Figure 3 shows the locations of the different natural gas extraction. Table 5 shows the list of companies. These companies are components of the Camago-Malampaya Gas Power Project which supply the natural gas (First Gas 1998).

Table 5. Natural Gas-Fired Power Plants

Power Plants	Generation, MW	Location
Sta. Rita Natural Gas	1,060	Sta. Rita, Batangas
First Gas Holdings	500	Sta. Rita, Batangas
Ilijan	1,200	Ilijan,Batangas City

The default input factor in the UNEP Toolkit is 2-200 μg Hg/Nm^3 (UNEP 2005). The maximum value is used in the calculation. A total of 846.795 kg Hg/year is emitted. Emission is assı

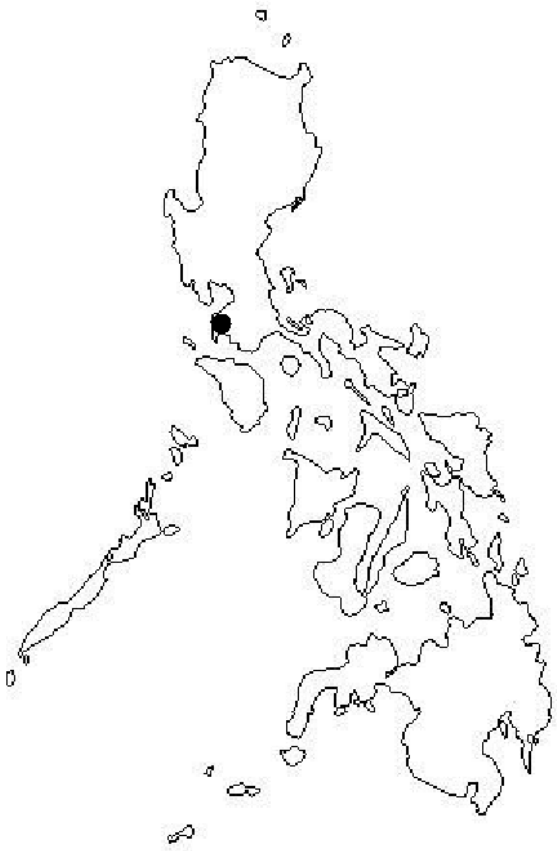

Figure 3: Location of Natural-gas Fired Power Plant

3.1.4 Geothermal Power Production

From the Department of Energy (DOE), there is a reported 1,978 MW geothermal power generation for 2006 (DOE 2006). Table 6 shows the list of the geothermal power plants in the country. Only a representative 1,838 MW from the different sources listed was gathered. Other geothermal power plants existing are obviously missed. Locations of the mapped power plants are plotted in Figure 4.

There is no default input factor in the UNEP Toolkit for geothermal power (UNEP 2005). A value of 3-4 g Hg/MWh was used (Bacci et al. 2000). A total of 46,372 kg Hg/year is emitted. Emission is assumed to be totally in the air.

Table 6. Geothermal Power Plants

Power Plants	Generation, MW	Location
MakBan 1-4	248	Calauan, Laguna
MakBan 5-6	100	Calauan, Laguna
MakBan 7-10	80	Calauan, Laguna
Bac Man I-1	110	Manito, Albay
Bac Man I-2	40	Manito, Albay
Tiwi 1-6	240	Tiwi, Albay
Tongonan II & III	600	Tongonan, Leyte
Leyte GPP	120	Tongonan, Leyte
Negros GPP1-2	200	Valencia, Negros Oriental
Mindanao 1-2	100	Mindanao

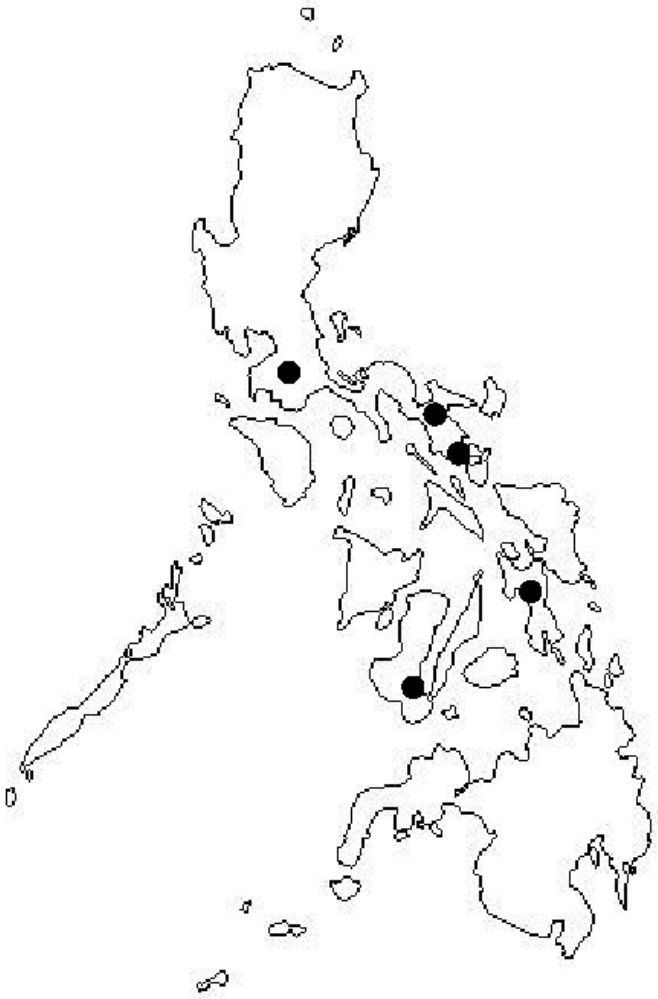

Figure 4. Location of Geothermal Power Plants

3.2 Primary (virgin) metal production

Gold and silver, lead and copper extraction from whole ore (with mercury-amalgamation process) is considered as the subcategory in this major source. Various

mining activities are happening in the country from small scale to big scale mining companies.

3.2.1 Gold and Silver Production

The country has an annual gold production of 18,680 kg gold as of 2006 (Makati Business Club 2007). Even though use of mercury is not allowed anymore, still it is considered since a lot of miners still use mercury.

From the Mines and Geosciences Bureau, a total of 1.4-1.9 tons of mercury is being used by mining operators in Mt. Diwalwal in Mindanao. Diwalwal is rich in gold deposits, with remaining gold ore conservatively estimated to be worth more than $700 M at current process. Today, there are nearly 3,000 HH and 12,000 small scale miners in the area, down from the peak of about 150,000 – 200,000 in the mid 1980s (Gozun 2004).

From the USGS Minerals Yearbook 2005, Volume III Philippines, the country has an annual silver mine output of 19, 150 kilogram per year.

In the calculation of the total mercury consumption for the silver and gold extraction, the mercury input rate is 37, 830 kg gold and silver per year. The default input factor in the UNEP Toolkit is 3 kg Hg/kg gold produced (UNEP 2005). A total of 113,490 kg Hg/year is emitted. Sixty percent of the emission is distributed in the air while the remaining is equally distributed in land and water.

3.2.2 Copper extraction and initial processing

From the USGS Minerals Yearbook 2005, Volume III Philippines, the country has an annual copper mine output of 16,320 tons per year. The default input factor is 1-15 g Hg/ton of coal. In the calculation, the maximum default factor of 15 was used in the calculation. A total of 244.80 kg Hg/year is emitted. Eighty percent of the emission is equally distributed in water and land while the remaining twenty percent is emitted in air.

3.2.3 Lead extraction and initial processing

From the USGS Minerals Yearbook 2005, Volume III Philippines, the country has lead production rate (secondary refined) of 30,000 ton per year. Lead ore in the Philippines is approximately 50% lead content.

Lead concentrate utilized to produce 30,000 tons per year of secondary refined lead, assuming 80% plant efficiency is 75,000 tons per year.

The maximum default factor of 200 g Hg/ton is used in the calculation. The total Hg emission is 15,000 kg Hg per year. Ten percent of the emission is in air while the remaining ninety percent is equally distributed in land, products and sector specific treatment or disposal

3.3 Production of Other Minerals and Materials with Mercury Impurities

The three subcategories identified for this major source are the cement, pulp and paper production and lime production.

Table 7. Subcategories of Production of other Minerals and Materials

Subcategories
• Cement production • Pulp and paper production • Production of lime

3.3.1 Cement Production

The Cement Manufacturer's Association of the Philippines (CeMAP) releases an annual report on the stand of the cement industry. Table 8, adapted from CeMAP, shows the list of existing companies in the country.

A total of 12,033 kilo tons of cement was produced in 2006 (CeMAP 2007). The default input factor in the UNEP Toolkit is 0.02-0.1 g Hg/ton cement produced (UNEP 2005). A total of 1,203 kg Hg/year is emitted. Unlike the other calculations, the UNEP Toolkit made use of the traditional release factor of 0.1-6 g Hg/t cement produced instead of the default input factor (UNEP 2005). The maximum value of 0.1 g Hg/ton was use in the calculation. The emission is assumed to be totally in the air.

Table 8. Cement Companies

1. Holcim Philippines
2. Republic Cement Corporation
3. Fortune Cement Corporation
4. FR Cement Corporation
5. Iligan Cement/Mindanao Portland Cement Corporation
6. Solid Cement Corporation/Apo Cement Corporation
7. Taiheiyo Cement Philippines Inc.
8. Lloyds Richfield Industrial Corporation
9. Northern Cement Corporation
10. Pacific Cement Philippines Inc.

Figure 5 is adapted from the CeMAP website and is a better representation of the locations of the companies.

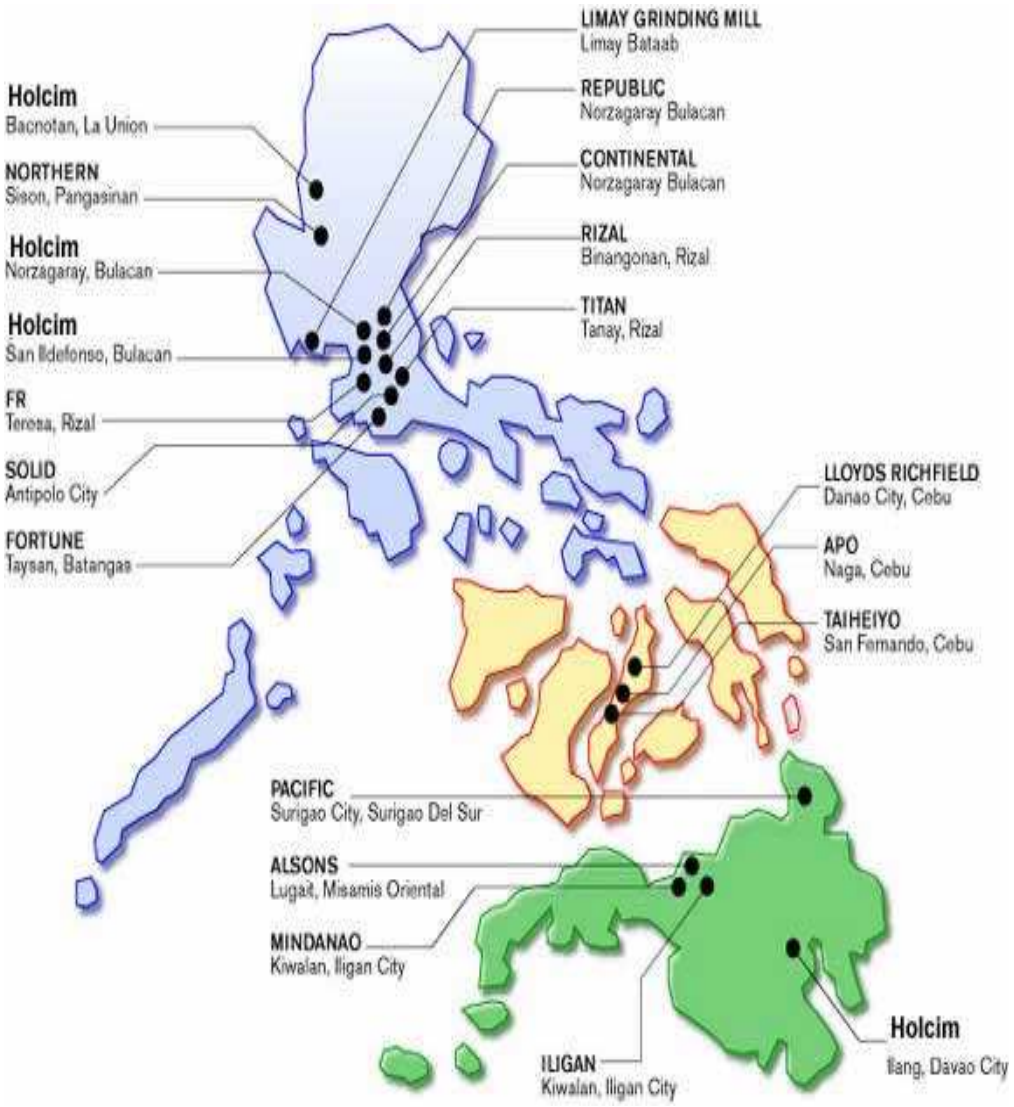

Figure 5. Location of Cement Plants

3.3.2 Pulp and Paper Production

Below is a list of the existing pulp and paper companies in the country. No default input factor is provided in the UNEP Toolkit for calculation (UNEP 2005). An input factor of 1.95×10^{-5} kg Hg/ton pulp or paper produced was used (Tsinghua University 2006).

Table 9. Pulp and Paper Companies

Company	Production, tons
Trust International Paper Corporation	230[+]
National Tobacco Administration	3,000[++]
Fiber Industry Development Authority	30,312[+++]
Bataan 2020	80,000[*]
United Pulp and Paper Co., Inc.	195,000[*]

(Molina 2005)[+]; (Austria 2002)[++]; (FIDA 2007)[+++]; (Bataan 2020)[*]; (UPPC 2008)[**]

A total of 308,542 tons of pulp and paper are produced per year. For this, 6.171 kg Hg/y is emitted. All of the emissions are assumed to be in the air.

3.3.3 Lime Production

The list of the lime producing companies in the country is presented in Table 10. No default input factor is provided in the UNEP Toolkit for calculation (UNEP 2005). A value of 5.5×10^{-5} kg Hg/ton lime produced was used in the calculation (Tsinghua University 2006).

Table 10. Lime Producing Companies

Company/Location	Production, tons
Guimaras	5,000[*]
Negros Integrated Industries Corporation	36,000[**]
Quezon	6,957[***]

(OTOP 2008)[*]; (NIIC 2007)[**]; (Quezon Province 2006)[***]

A total of 47,957 metric tons of lime are produced per year. A calculated value of 2.64 kg Hg/year is emitted. The emission is solely assumed to be in the air.

3.4. Intentional use of mercury in industrial processes

Only the Chlor-alkali production with mercury-technology is the industry considered. There is no vinyl chloride monomer and acetaldehyde production in the country.

The Mabuhay Vinyl Corporation is the sole producer of caustic soda (Valdez 2007). It has a capacity of 21,000 tons Cl_2 per year. Using the default input factor in the UNEP Toolkit, 25-400 g Hg/ton Cl_2 produced, a total of 8,400 kg Hg per year is emitted (UNEP 2005). The maximum value is used in the calculation. Emission is distributed in the air, land, water, and product.

3.5 Consumer products with intentional use of mercury

In terms of the consumer products with mercury, there are various sources present in the country but only those found in Table 11 are used as gross estimate. This needs further refinement.

Table 11. Subcategories of Consumer Products with Mercury

- Thermometers with mercury
- Electrical switches
- Light sources with mercury

3.5.1 Thermometers

The following assumptions were applied in the calculation:

1. A thermometer is included in the medical kit given by the hospital for every patient admitted (the kit often comes with a spoon and fork, a face towel, a glass, and a thermometer, placed in a hospital bag).
2. Hospitals will be filled to its actual full bed capacity twice every month to account for the thermometers in school, small clinics and hospitals which are not members of the Philippine Hospital Association.

3. The number of nursing students enrolled in 2005 and other allied medical courses is equated to the number of thermometers since each medical student has a kit with at least one thermometer.
4. The production phase is not included in the life phase of the thermometer.
5. A breakage rate of 5% was assumed based on the 1992 report of US EPA which conducted a telephone survey to US thermometer manufacturers

Calculation:

According to the Philippine Hospital Journal, the authorized bed capacity of hospitals is 94, 482 per hospital per year as of September 2006, this was assumed to be applicable for the whole year 2005.

The number of officially enrolled students in Medical and Allied Courses

(A.Y. 2003-2004) (CHED statistical bulletin) = **319, 774 students**

This number is estimated to increase by 15% in 2005 especially those enrolled in nursing courses.

Thus, estimated actual number of thermometers in use and possibly will be broken in 2005

= 2 (94,482) / month x 12 months/year + 319, 774 (1.15)

= 2,635,308 thermometers in use

The number of medical thermometers that may be broken = 0.05 (2,635,308)

= 131,765 thermometers

In the Philippines, there was no separate collection for thermometers. Using the default input factor in the UNEP Toolkit, 0.5-1.5 g Hg/item, a total of 198 kg Hg per year is emitted (UNEP 2005). The maximum value was used in the calculation. Emission is distributed in the air, land, water, and product.

3.5.2 Electrical Switches

In the UNEP Toolkit, there is a default value of 0.02 -0.25 g Hg per year per inhabitant (UNEP 2005). Using the projected population for 2006 with around 88.7 million, a total of 22.17 tons of mercury per year is used and disposed (NSCB 2000). The emission is distributed in the air, land, and general waste.

3.5.3 Light Sources with Mercury

3.5.3.1 Double end Fluorescent Tubes

Table 13 shows the assumptions used in the various sources included.

Table 13. Assumptions for Fluorescent Lamp Units Calculation

Sources	Assumptions or Ratio Used	Total Units
Schools (3325 Colleges and Universities)*	3 Fluorescent/lab	29925
Government	(4 Fluorescent/50 students)(3 labs/school)	165,836,200
Private	6 Fluorescent/35 students	334,251,750
Households**		
Income Bracket		
0-29,999	2 Fluoresent:1 Household	15020696
30,000-59999	4 Fluoresent:1 Household	35463354
60,000-149000	6 Fluoresent:1 Household	35221624
150000-over	8 Fluoresent:1 Household	
Hospitals***		
Level	Government (Fluorescent: Bed)	
1	6889 (3:1)	20667
2	14279 (3:1)	42837
3	12696 (2:1)	25392
4	16143 (2:1)	32286
	Private (Fluorescent: Bed)	
1	7597 (2:1)	15194
2	12546 (2:1)	25092
3	11298 (1:1)	11298
4	13394 (1:1)	13394
Government Agencies+	(359 agencies)(2 bldgs/agency)(10 fluorescent/room)(20 rooms/floor)(3floors/1bldg)	1292400
Manufacturing Establishments++	(7467 establishments)(500 employees/establishment)(1 fluorescent/3 employees)	1244500
	Total Units	**588,546,609**

(CHED 2004)*; (NSO 2001)**; (PHA 2006)***; (NCC 2007) +; (NSO 2003)++

From the total amount of 588.5 million units of double end fluorescent lamps, using the maximum default input factor of 40mg Hg/unit, 23.5 tons of Hg are used and disposed in a year. The emission is distributed in the air, land, and general waste.

3.5.3.2 Compact Fluorescent Lamp (CFL single end)

For the compact fluorescent Lamp, it was assumed that there is 1 compact fluorescent lamp for every four double end fluorescent bulb based on the US production rate of bulbs.
Therefore, based on the result of the estimation of the fluorescent lamps, there are 147.1 million units of CFL. Using the maximum default factor of 15 mg Hg/item, 2.2 tons of Hg are used and disposed in a year.

3.6 Other intentional product/process use

In terms of other intentional product or process use with mercury, there are various sources present in the country. But the ones listed in Table 11 are the ones wherein both input rates and activity rates were available.

Table 14. Subcategories in Other Intentional Product or Process Use of Mercury

Subcategories
• Dental mercury-amalgam fillings • Manometers and gauges with mercury • Laboratory chemicals and equipment with mercury • Miscellaneous product uses, mercury metal uses, and other sources

3.6.1 Dental Mercury-Amalgam Fillings

In the UNEP Toolkit, there is a default value of 0.05-0.20 g Hg per year per inhabitant (UNEP 2005). Using the projected population for 2006, around 88.7 million, a total of 17,741 kilograms of mercury per year is used and disposed (NSCB 2000). The emission is distributed in the air, land, product, and sector specific treatment or disposal.

3.6.2 Manometers and Gauges with mercury

Only the barometers in the airports and weather stations should have barometers and they are the ones considered in the counting. A one is to one ratio is used for calculation.

Table 15. Number of Barometers

Sources	Barometers
Airports*	118
Weather Stations**	55
Total	**173**

(NEDA 2007)*; (DOST-PAGASA 2002)**

The default input factor in the UNEP Toolkit is 300-600 g Hg/unit is presented in the UNEP Toolkit (UNEP 2005). When the maximum value is used for 173 barometers, a total of 104 kg Hg/year is emitted. The emission is distributed in the air, land, and general waste.

3.6.3 Laboratory Chemicals and Equipment with Mercury

Only the thermostat is considered here. The assumptions and data used are presented in Table 16.

Table 16. Assumptions for Thermostat Units Calculation

Thermostat	Assumptions or Ratio Used	Total Units
School (3325)*	(5 thermostat/lab)(3 labs/school)	49875
Government	1 A/C/50 students	16,583.62
Private	1 A/C/35 students	45,476.43
Vehicles**	Gauge	5,530,052
Number	A/C	
4561133	Private & Diplomatic -All	4561133
70528	Gov't - 50%	35264
887023	For Hire - 50%	443511.5
11368	Tax Exempt -Not Included	0
Hospitals***	Gov't (Thermostat:Patient)	
Level		
1	6889 (20:1)	344
2	14279 (20:1)	714
3	12696 (10:1)	1270
4	16143 (10:1)	1614
	Private (Thermostat:Patient)	
1	7597 (15:1)	506
2	12546 (15:1)	836
3	11298 (7:1)	1614
4	13394 (7:1)	1913
Government Agencies⁺	(359 agencies) (2 thermostat/room)(20 rooms/flr)(3 flrs/bldg)(2 bldgs/agency)	43080
Manufacturing Establishments⁺⁺	(7467 establishments)(500 employees/establishment)(1 thermo/20 employees)	186675
	Total Units	**10,920,463.14**

(CHED 2004)*;(LTO 2008)**; (PHA 2006)***; (NCC 2007)⁺; (NSO 2003)⁺⁺

From the total of 10.92 million units of thermostats, using the maximum default input factor of 6 g Hg/unit, 65.5 tons of Hg are used and disposed in a year. The emission is distributed in the air, land, and general waste.

3.6.4 Miscellaneous Product Uses, Mercury Metal Uses, and Other Sources

For this part, only the lighthouses were considered. There were no input factors and activity rate for the other sources. There are 57 lighthouses in the country (Stockinger 1998). The input used is 300-600 kg Hg/light. From here, a calculated total of 22.8 tons of Hg/year is emitted. The emission is distributed in the air and general waste.

3.7 Waste deposition/landfilling and waste water treatment

The controlled landfill, informal local disposal of industrial production waste and waste waster system treatment are considered. From a total disposal of 457, 718 metric tons, a total of 4.5 tons of Hg/year and 8.09 tons Hg/yr is emitted from these two sources, respectively (Chavez 2001; PREGA National Technical Experts 2006).

For the wastewater system treatment, according to the economic impact of sanitation in the Philippines (USAID, 2008), the amount of wastewater per year is 1,961,500,000 cubic meters per year. Using the maximum default factor or 10 mg Hg per cubic meter of wastewater, a total of 19, 615 kg Hg/year is emitted.

3.8 Crematoria and Cemeteries

Using the death data from the National Statistics Office, a total of 366,931 corpses are considered. Only 1 percent of these were considered to be cremated. A total of 1.3 tons of Hg/year are released from those that are buried. The maximum default input factor of 4 g Hg/corpse is used (UNEP 2005).

References:

Asociados, A. 2001, 'Preliminary Atmospheric Emissions Inventory of Mercury in Mexico'*, Instituto Nacional de Ecologia, Mexico, viewed 30 March 2008, < http://www.ine.gob.mx/dgicur/sqre/descargas/mxhg-airfinal_v2w-maps.pdf>*.

Austria, J. 2002, *'Despite Health Risks, Cabinet Okays Coal Plant'*, Manila Standard, Philippines, viewed 30 March 2008, <http://www.manilastandardtoday.com/?page=business01_sept27_2002>.

Bacci, E., et al. 2002, *'Geothermal power plants at Mt. Amiata (Tuscany–Italy): mercury and hydrogen sulphide deposition revealed by vegetation*', Elsevier BV, viewed 30 March 2008, <http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V74-3YGDD0T-29&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=4d898ce645bd7b3e084fbdaa1a20a9a7>.

Bataan 2020, *'About Us'*, Bataan 2020, Bataan, Philippines, viewed 30 March 2008, < http://www.bataan2020.net/aboutus.htm>.

Californians Against Waste 2008,*'Mercury in our Bodies and the Ocean'*, Californians Against Waste, USA, viewed 30 March 2008, < www.cawrecycles.org/files/images/mercury.jpg>.

CeMAP 2007, *'Annual Cement Industry Statistics'*, Cement Manufacturer's Association of the Philippines, Pasig City, viewed 30 March 2008, <http://www.cemap.org.ph/statistics.html>.

Chavez 2001, '*MMDA, QC government plan to develop Payatas dumpsite into sanitary landfill'*, The Manila Bulletin Online, Philippines, viewed 30 March 2008, <http://www.mb.com.ph/issues/2005/01/14/MTNN2005011426402.html>.

CHED 2004, '*Statistics*', Commission on Higher Education, Pasig City, Philippines, viewed 30 March 2008, < http://www.ched.gov.ph/statistics/index.html>.

DENR 1997, 'DENR Administrative Order No. 38'*, Environmental Management Bureau, Quezon City, Philippines, viewed 30 March 2008, <http://emb.gov.ph/chemicals/DAO%2097-38.pdf>*.

DOE 2006, '*Philippine Power Statistics'*, Department of Energy, Taguig, Philippines, viewed 30 March 2008, <http.doe.gov.ph/EP/Power Stat update 2006_files/sheet001_htm>.

*DOST-PAGASA 2002, '*A Brief History of the Philippine Meteorological Service'*, Department of Science and Technology - Philippine Atmospheric, Geophysical & Astronomical Services Administration, Metro Manila, Philippines, viewed 30 March 2008, <http://www.pagasa.dost.gov.ph/fullhistory.shtml>*.

Environment Canada 2000, 'The Status of Mercury in Canada: Report #2'*, Commission for Environmental Protection, Canada, viewed 30 March 2008, <http://www.cec.org/programs_projects/pollutants_health/smoc/pdfs/hgcan-e.pdf>*.

*EMB 2003, '*Legal Framework of Hazardous Waste Management'*, Environmental Management Bureau, Quezon City, Philippines, viewed 30 March 2008, <http://www.emb.gov.ph/hazardous/legalframework_hwms.htm>*.

*FIDA 2007, '*Market Report: Abaca'*, Fiber Industry Development Authority, Quezon City, Philippines, viewed 30 March 2008, <http://fida.da.gov.ph/home.html.html.>*.

*First Gas 1998, '*Sta. Rita Gas-Fired Power Plant Starts Testing*', First Gas Holdings Corporation, Batangas, Philippines, viewed 30 March 2008, <http://www.firstgas.com.ph/profiles/starita.html>*.

Gozun 2004 , '*Towards a revitalized mining and allied industries'*, Mines and Geosciences Bureau, Quezon City, Philippines, viewed 31 March 2008, <http://www.mgb.gov.ph/miningphilippines_speec_gozun.htm>.

*LTO 2008, '*Number of Motor Vehicles Registered by Classification & Mode of Registration'*, Land Transportation Office, Quezon City, Philippines, viewed 30 March 2008, <http://www.lto.gov.ph/stats2006.html>*.

Makati Business Club 2007, '*Metallic minerals production value up 58.8% in H1'*, Makati Business Club, Makati City, Philippines, viewed 31 March 2008 , <http://www.philippinebusiness.com.ph/news_updates/industry.htm>

Molina, T. 2005, '*NTA now producing pulp boards from tobacco stalks'*. National Tobacco Association, Philippines, viewed 30 March 2008, < http://www.nta.da.gov.ph/news060505.htm>.

NCC 2007, '*Status of National Government Agencies ISSP'*, National Computer Center, Quezon City, Philippines, viewed 30 March 2008, < http://www.ncc.gov.ph/files/statusdec07.pdf>.

NEDA 2007, *'Philippine Economic Indicators Online'*, National Economic and Development Authority, Pasig City, Philippines, viewed 31 March 2008 < http://222.127.10.196/national.html>.

NIIC 2007, *'Profile'*, Negros Integrated Industries Corporation, Negros Occidental, Philippines, viewed 31 March 2008, <http://niiclime.com/profile.html>.

NSCB 2000, *'Projected Populations by Sex, Region and Province, and by Single-Calendar Years: 2000-2010'*, National Statistical Coordination Board, Makati, Philippines, viewed 30 March 2008, <http://www.census.gov.ph/data/sectordata/popproj_tab3r.html>.

NSO 2002, 'Deaths in the Philippines 2000'*, National Statistics Office, Quezon City, Philippines, viewed 30 March 2008, <http://www.census.gov.ph/data/sectordata/sr0366tx.html>*.

NSO 2001, '2000 Family Income and Expenditures Survey', Integrated Survey of Households Bulletin*, 1 Volume, 293 pp.*

NSO 2003, '2000 Census of Philippine Business and Industry (CPBI)'*, National Statistics Office, Quezon City, Philippines, viewed 30 March 2008, <http://www.census.gov.ph/data/pressrelease/2003/cpbimfg00tx.html>*.

OTOP 2008, *'Region VI: Guimaras'*, Department of Trade and Industry, Makati City, Philippines, viewed 30 March 2008, <http://www.otopphilippines.gov.ph/sme.aspx?rid=7&provid=62&prodid=782>.

PHA 2006, 'Hospitals in the 21st Century'*, Hospital Journal (Semi-Annual Publication of the Philippine Hospital Association)*, 39 Volume 2 Issue, 162 pp.

PREGA 2006, '*Integration of Methane Capture to Solid Waste Management of Roxas City*', Asian Development Bank, Ortigas, Philippines, viewed 30 March 2008, <http://www.adb.org/Clean-Energy/documents/PHI-FS-Methane-Roxas-City.pdf>.

Quezon Province 2006, '*Manufacturing, Services & Labor Force'*, Quezon, Philippines, viewed 30 March 2008, <http://www.quezon.gov.ph/profile/agriculture.htm>.

Ransom, C. 2001, *'Mercury Switches in Appliances: Final Report'*, US Environmental Protection Agency, Washington, D.C., viewed 30 March 2008, < http://www.epa.gov/reg5oair/mercury/appliancereport.html>.

Stock 2005, 'The Dental Amalgam Issue'*, DAMS, Inc., Minnesota, USA, viewed 30 March 2008 <http://www.amalgam.org/#anchor96213>*.

*Stockinger, J. 1998, '*Picturesque Old Philippines: Philippine Lighthouses', *University of Vienna, Austria, viewed 31 March 2008 <http://www.univie.ac.at/voelkerkunde/apsis/aufi/pop/light.htm?>*.

Tsinghua University 2006, *Improve the Estimates of Anthropogenic Mercury Emissions in China,* United Nations Environment Programme, Kenya, viewed 31 March 2008, < http://www.chem.unep.ch/MERCURY/China%20emission%20inventory%20.pdf >.

UNEP 2002, *'Global Mercury Assessment Report'*, United Nations Environment Programme, Kenya, viewed 31 March 2008, http://www.chem.unep.ch/MERCURY/Report/Final%20Assessment%20report.htm

UNEP 2005, 'Toolkit for identification and quantification of mercury releases", *United Nations Environment Programme, Kenya, viewed 17 March 2008, <http://www.chem.unep.ch/mercury/Toolkit/default.htm>.*

US EPA 1997, 'Wisconsin Mercury Sourcebook: A Guide to Help your Community Identify and Reduce Releases of Elemental Mercury'*, US Environmental Protection Agency, Washington, D.C., viewed 30 March 2008, <http://www.p2pays.org/ref%5C02/03851.htm>.*

UPPC 2008, 'History of United Pulp and Paper Co., Inc.*', United Pulp and Paper Company, Inc., Bulacan, Philippines, viewed 30 March 2008, <http://www.uppc.com.ph/about%20us.php>.*

US EPA 1997, 'Wisconsin Mercury Sourcebook: A Guide to Help your Community Identify and Reduce Releases of Elemental Mercury'*, US Environmental Protection Agency, Washington, D.C., viewed 30 March 2008, <http://www.p2pays.org/ref%5C02/03851.htm>.*

US EPA 1997, 'Mercury Study Report to Congress*, US Environmental Protection Agency, Washington, D.C., viewed 30 March 2008, < http://www.epa.gov/mercury/report.htm/>.*

Valdez, K.M. A. 2007, *'Mabuhay Vinyl gets additional tax perks'*, The Manila Times, Philippines, viewed 31 March 2008 , < http://www.manilatimes.net/national/2007/mar/22/yehey/business/20070322bus10.html>.