UNITED NATIONS
ENVIRONMENT PROGRAMME
CHEMICALS BRANCH, DTIE

SUMMARY OF SUPPLY, TRADE AND DEMAND INFORMATION ON MERCURY

Requested by
UNEP Governing Council decision 23/9 IV

Geneva
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Executive summary

1. In 2001, through the UNEP Governing Council (GC) decision 21/5, the GC decided to initiate a process to undertake a global assessment of mercury and its compounds. The Global Mercury Assessment (UNEP, 2002) was presented to the 22nd session of the UNEP Governing Council in 2003. Based on the key findings of the report, the Governing Council concluded that there was sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment. They decided, through GC decision 22/4 V, that national, regional and global actions, both immediate and long-term, should be initiated as soon as possible, with the objective of identifying exposed populations and ecosystems, and reducing anthropogenic mercury releases that impact human health and the environment.

2. Discussions relating to the need for further measures to address the global adverse impacts of mercury on health and the environment continued at the 23rd session of the Governing Council in February 2005. The Governing Council adopted an omnibus decision on chemicals management, GC decision 23/9. With regard to mercury, the decision strengthened the UNEP mercury programme, called for partnerships between Governments and other stakeholders, and encouraged Governments, the private sector and international organizations to address the risks due to mercury in products and production processes.

3. As background material for the Governing Council's considerations at its 24th session in February 2007, it requested UNEP to provide a number of reports and documents demonstrating the implementation of decision 23/9 IV, including a report on supply, trade and demand for mercury on the global market. This document specifically responds to the request that UNEP should initiate, prepare and make public a report summarizing supply, trade and demand information for mercury, including its use in artisanal and small-scale gold mining.

4. The artisanal and small-scale gold mining sector is very important with regard to the use of mercury, adding the unique problems of poverty, the informal economy and considerable health and environmental impacts to the other challenges of dealing with mercury. Therefore, the UNIDO/UNDP/GEF Global Mercury Project has kindly contributed to the UNEP Governing Council a report on mercury issues associated with the small scale gold mining sector, including the benefit of its experience in supporting a number of developing countries, and countries with economies in transition. The Global Mercury Project report is referenced in various parts of this document, and is attached as Annex 3.

5. Many other reports and information sources have been drawn on in support of this document. These include information submitted by Governments, publicly available databases, papers, reports and publications containing national trade data, etc. These sources are identified in footnotes and references to the report. As available, peer-reviewed papers and reports have been used in support of this document. However, the number of papers on mercury supply, trade and demand that have appeared in scientific journals is rather limited in comparison to the number of papers addressing many other issues related to mercury. Fortunately, many of the reports on mercury supply, trade and demand that have not been published by scientific journals have, nevertheless, gone through an extensive review process.

6. Despite an apparent quantity of publicly available data, much of the world mercury market is private, and some of it is illegal. This adds an additional element of uncertainty even to those commercial mercury flows we believe we understand. This report demonstrates that increased scrutiny of mercury trade flows by national authorities worldwide – even if it involves only a closer inspection of statistics already collected – would bring us rapidly closer to a more effective control of the global mercury problem.

Global mercury supply

7. The five most common sources of global mercury supply in recent years include:

   i. Mining and processing of primary mercury ores;

ii. By-product mercury recovered from the refining of some ferrous and most non-ferrous metals, and from the cleaning of natural gas;
iii. Recovery of mercury from mercury cell chlor-alkali plants (MCCAPs) after decommissioning (when the plant is converted to a mercury-free process, or occasionally closed due to lack of economic viability);
iv. Recycled mercury from products (such as thermometers or batteries) containing mercury, or from mercury sludges and wastes generated by the chlor-alkali industry and others;
v. Stocks of mercury accumulated over time from various sources (typically the original source would have been mined or by-product mercury, mercury from decommissioned MCCAPs, or mercury recovered from wastes).

8. The following table summarises the estimated global mercury supply during 2005. Despite best efforts to clarify these data, there remain many uncertainties due to the wide range of sources, as well as the limited reporting of information with regard to most of these sources.

Table 1 Global mercury supply, 2005

Sources of mercury supply (2005)	**Mercury supply (metric tonnes)**
	Range
Mining and by-product	1,800-2,200
Recycled mercury from chlor-alkali wastes	90-140
Recycled mercury – other	450-520
Mercury from (decommissioned) chlor-alkali cells	600-800
Stocks	0-200
Total	**3,000-3,800**
Note: Further details and uncertainties are described in the full report, Sections 3.1 and 3.2.	

9. Overall, primary mining of mercury has decreased in recent years. Primary mercury mining in Spain was halted in 2003, and in Algeria in 2004. On the other hand, mining in China, primarily for domestic consumption, has increased.

10. Mercury wastes generated as a by-product of certain non-mercury mining and smelting activities are a potentially large and growing source of the metal. Mercury is extracted from these wastes depending on the specific regulatory and economic environment in which each mine operates.

11. Some Federal Government mercury stocks in the United States of America have been relegated to long-term storage for environmental reasons. Meanwhile, other stocks or inventories (Russia, 2005-6; MAYASA/Spain, yearly; Lambert Metals and other brokers, yearly), of which the ownership is not always clear, continue to move to the market, sometimes with no clear knowledge of the final destination or final user.

12. The greatest concentration of mercury cell chlor-alkali production remains in Europe. The European chlor-alkali industry intends to phase out most of its 40-50 mercury cell chlor-alkali units by 2020, freeing up at least 11,000 metric tonnes of elemental mercury. Some industry groups outside of Europe, such as in India, have also spoken of a voluntary transition to the economically and environmentally preferable membrane technology for producing chlorine and caustic.

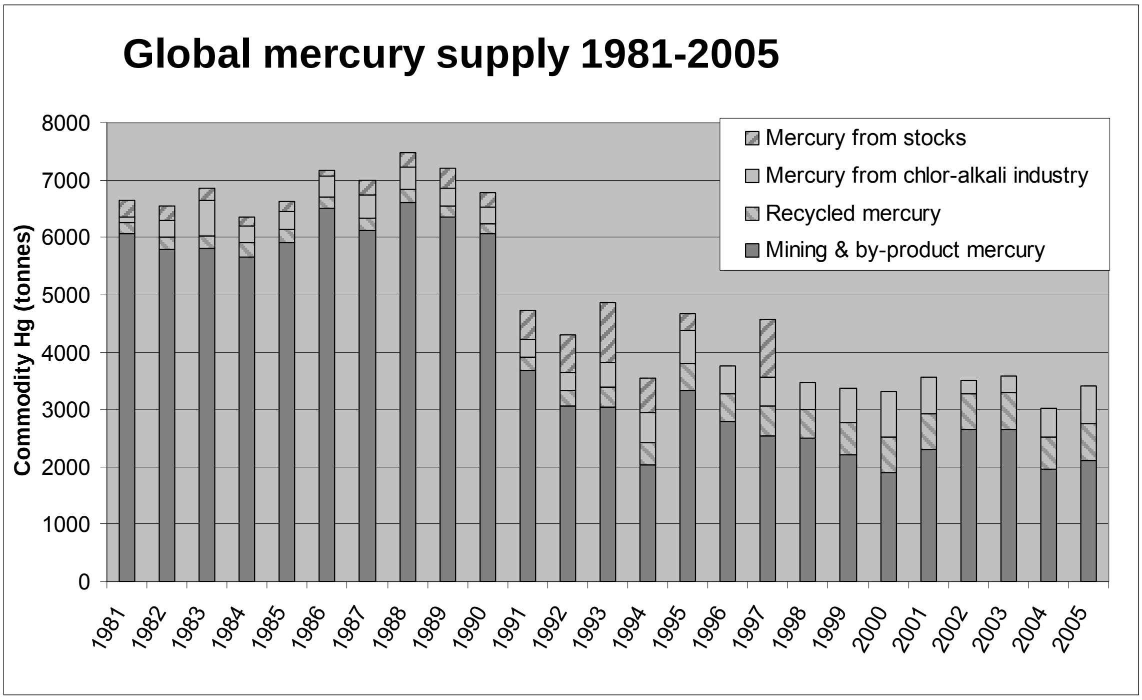
13. Due in part to the large quantities of "residual" mercury that will be generated as chlor-alkali units are decommissioned, the European Commission has proposed legislation to ban mercury exports and require long-term storage of residual mercury, implying that there are specific sources that should preferably be stored rather than put on the global market. Achieving a broad consensus on which mercury sources are preferred for legitimate commercial use, and which sources should be minimized or stored, would enhance the health and environmental benefits of the desired future reductions in global mercury supply and demand.

14. In that respect, it may be argued that some mercury supply sources are more environmentally advantageous than others. To maximize the benefits of mercury demand reduction, those supply resources that are least environmentally advantageous should be seen as global priorities for supply reduction measures. From this perspective, mercury mining would be the highest priority source to be

reduced, followed by mercury recovered from decommissioned chlor-alkali plants, other mercury inventories, etc. By-product mercury and mercury recycled from waste and products would be "preferred" sources in that they are, at least for the moment, inadvertent mercury sources that are impossible to avoid. Without collection, much of the by-product and waste mercury would be released into the environment.

15. Global mercury supply and demand decreased substantially during the 1980s and 1990s, but these major reductions have not continued in the first half of this decade, as seen in the figure below. Significantly, however, further large reductions may be anticipated as present and planned restrictions are implemented, such as phasing out the use of various mercury containing products, storing the residual mercury from decommissioned chlor-alkali facilities, etc.

Figure 1 Global mercury supply 1981-2005



Global mercury demand

16. Demand for mercury has long been widespread, although the global mercury commodity market is small in both tonnage and value of sales. Even though mercury may routinely be traded several times before final "consumption," the available statistics suggest that global yearly transactions of mercury and its compounds are estimated to be in the range of USD 100-150 million in value. Most transactions are between private parties and are not publicly reported. The major categories of mercury demand in higher income countries include:

- Chlor-alkali production;
- Dental amalgams;
- Fever and other thermometers;
- Other measuring and control equipment;
- Neon, fluorescent tubes, compact fluorescent, HID and other energy-efficient lamps;
- Electrical switches, contacts and relays;
- Laboratory and educational uses.

17. Additional categories of mercury demand more prevalent in, but not exclusive to, developing countries and countries with economies in transition include:

- Vinyl chloride monomer (VCM) production using the acetylene process and a mercury catalyst;
- Artisanal and small-scale gold mining (ASM);
- Batteries;
- Cosmetics and skin-lightening creams;

- Cultural uses and traditional medicine;
- Paints and pesticides/agricultural chemicals.

18. Apart from the great quantities of mercury used for large- and small-scale gold and silver mining over many centuries, chlor-alkali production, batteries, paints and pesticides/fungicides have been the biggest users of mercury in the 20th century, all declining steadily since the mid- to late-1980s.

19. While continuing its long-term decline in most of the higher income countries, there is evidence that demand for mercury remains relatively robust in many developing countries, and countries with economies in transition, although detailed data may be lacking. At the same time, there are far fewer details pertaining to the end use of mercury in many nations. The main factors behind the decrease in mercury demand in the higher income countries are the substantial reduction or substitution of mercury content in regulated products and processes (paints, batteries, pesticides, chlor-alkali, etc.), and a general shift of mercury product manufacturing operations (thermometers, batteries, etc.) from higher income to lower income countries.

20. As seen in the table below, artisanal and small-scale gold mining remains the largest global user of mercury, is reportedly still increasing, is the largest source of releases, and is a serious global poverty and health issue as well.

21. The large and increasing use of mercury in the production of vinyl chloride monomer (VCM), especially in China, is another area of major concern, especially as it is not yet clear where much of the mercury goes – estimated to be several hundred tonnes – as the catalyst is depleted.

22. The chlor-alkali industry is the third major mercury user. Many MCCAP operators have phased out this use of mercury technology, others have plans to do so, and still others have not announced any such plans. In many cases governments have worked with industry representatives and/or provided financial incentives to facilitate the transition away from mercury technology. More recently, governments and international agencies have created partnerships with industry to encourage broader industry improvements.

23. The use of mercury in batteries, while still considerable, continues to decline as the scale of diffuse mercury releases has become evident, and many nations have implemented policies to deal with the problem. Nevertheless, additional management measures could facilitate the transition.

24. While mercury use has declined in many sectors, generally assisted by government/regulatory action or public awareness and encouragement, this trend has been offset in recent years by increased use of mercury in artisanal and small-scale gold mining activities, and mercury use in VCM production, as discussed in the full report. There also appears to be a modest increase in mercury use in the lighting sector, and an apparently stable use for dental amalgams. In the latter case, viable alternatives are available. While the use of dental mercury is declining in many countries, an important reduction in the global use would require management measures to facilitate the transition of this sector and reduce significant mercury releases to the environment.

25. For 2005, global demand for mercury is summarised in the table below. Also included in the table are projections in line with two mercury demand reduction scenarios:

- The first scenario represents the "status quo," and assumes that few measures that are not already in place will be introduced during the next ten years. This scenario suggests approximately a 15% reduction in global mercury demand by 2015.
- The second scenario represents a more "focused mercury reduction" strategy, in which the key countries and companies involved identify mercury demand reduction as a clear priority, and adopt the more obvious measures necessary to move substantively toward that objective. This scenario suggests greater than a 30% reduction in global mercury demand by 2015.

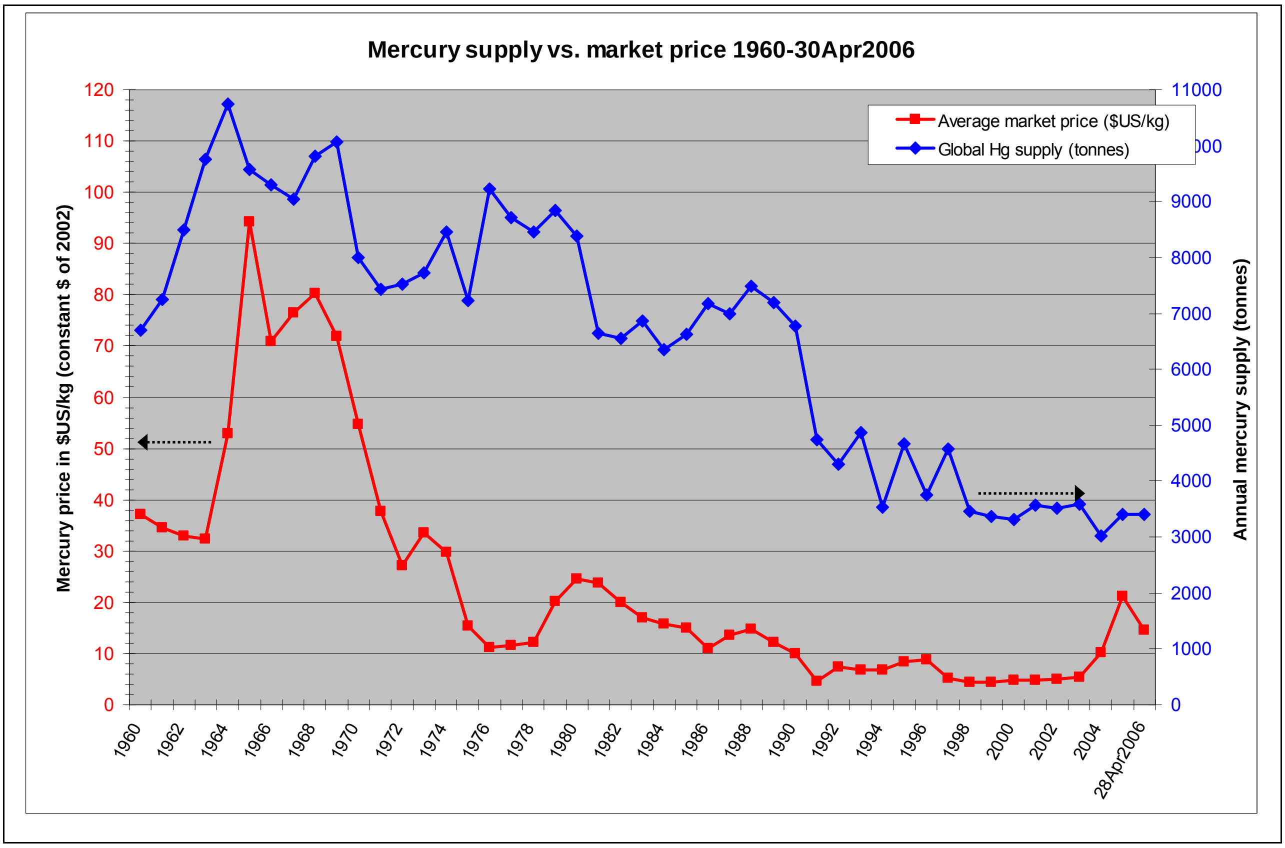
Table 2 Global mercury demand by sector (2005), and reduction scenarios

Global mercury demand, by sector (metric tonnes)	**Present (2005)**	**"Status quo" scenario (2015)**	**"Focused Hg reduction" scenario (2015)**
Small-scale/artisanal gold mining	650-1000	650	400
Vinyl chloride monomer (VCM) production	600-800	1,000	1,000
Chlor-alkali production	450-550	350	250
Batteries	300-600	200	100
Dental use	240-300	270	230
Measuring and control devices	150-350	125	100
Lighting	100-150	125	100
Electrical and electronic devices	150-350	110	90
Other (paints, laboratory, pharmaceutical, cultural/traditional uses, etc.)	30-60	40	30
Total	**3000-3900**	**2,870**	**2,300**
Note: "Demand" may also be termed "gross consumption," and is here defined as total annual throughput of mercury for each of these sectors. In each of these sectors some mercury recycling takes place, involving the recovery of mercury from products or wastes. Therefore, "net consumption" of mercury in any of these sectors may be significantly lower than "gross consumption." Further details and uncertainties are described in the full report, Sections 5.1, 5.2 and 5.3.			

Mercury market price

26. As evident in the following figure, mercury prices decreased for most of the past 40 years. From 1991-2003 mercury prices stabilized at their lowest real levels in 100 years – in the range of USD 4-5 per kilogram of mercury. The low price reflected a plentiful supply of mercury coupled with an increasing cost of using or dealing with mercury due to regulatory pressures, e.g., to reduce industrial emissions, to organize separate collection of mercury products, and to deal with increasing restrictions and costs of mercury waste disposal by sending more wastes to recyclers.

Figure 2 Global mercury supply and spot market price, 1960-2006



27. The subsequent and sudden 2004-2005 increase in the mercury price may be explained largely by the significant tightening of mercury supplies during 2004, mainly related to the closure of both the Spanish and Algerian mercury mines. Other contributing factors included increased demand for mercury by a growing number of artisanal and small scale gold miners, speculative activity by brokers, etc. Responding in part to the price rise, increased supplies of mercury appeared on the market in 2005 and 2006 , leading to a rapid fall-off in the mercury price, although still well above the levels of the last 10-15 years.

Global mercury trade

28. A solid appreciation of country and regional commercial mercury flows is a vital foundation upon which Governments can build effective strategies and promote specific measures to address national and global mercury challenges. A full understanding of commercial flows of mercury begins with the details of flows inside a specific country, proceeds to a larger and more complete picture by examining flows between different countries, and generates a still more aggregated picture by investigating flows between different regions.

29. Some of the main objectives of more closely examining commercial flows of mercury would be:

- To better understand the specific sources and uses, the trade routes, the main stakeholders involved, etc.;
- To better inform not only those countries and regions that have established plans and targets for reducing mercury supply and demand, but also international agencies mandated to take a broader approach to addressing mercury problems;
- To support the national and regional initiatives addressing mercury supply and demand – those already in place and those being developed – to be as effective as possible; and
- To provide a tool to measure progress toward national and international objectives of reducing mercury flows in the biosphere through reductions in mercury supply and demand.

30. The details of commercial flows of mercury **inside individual countries** are, in most cases, not very well known. Following the “mercury trail” is not especially difficult, but few countries have systems in place that would collect and centralize information on domestic commercial transactions of mercury.

31. Mercury transactions **between countries**, on the other hand, are more easily tracked through tariff codes by Customs authorities, and are typically reported to centralized databases such as the UN Statistics Division’s (UNSD) “Comtrade” database. UNEP was granted unrestricted access to all of the trade statistics in the Comtrade database as a resource for this report, and would like to express its appreciation to its colleagues at UNSD for their interest in, and support of, this effort.

32. The following table provides an example of the Comtrade data summarized by UNEP for transactions of elemental mercury for each country whose statistics have been reported to Comtrade during the last 10 years. Brazil was selected for this example because the data reflect, to some extent, the strong demand for mercury (typically 50-90 tonnes per year) during the well-known gold rush of artisanal and small-scale miners. As miners depleted the main deposits in Brazil in the late 1990s, it was observed that mercury imports by Brazil either declined or were diverted to similar activities in neighbouring countries. This and other country trade summaries are available online, along with a detailed explanation of the table, on UNEPs mercury program website, http://www.chem.unep.ch/mercury/Trade-information.htm.

Table 3 Example of mercury trade summary for a single country (Brazil)[*]

BRAZIL — **Elemental mercury imports and exports**

Data source: UN DESA/ESD/UNSD - Comtrade statistics - downloaded 11Apr2006
Tarif system: SITC rev.2
Tarif code: 52216
Filter: Trade value ≥ $US 0
Comments:

Period	**Exporting partner countries**			Target country: **Brazil**				**Importing partner countries**		
		Reported exports to target country		Reported imports from partner country (on left)		Reported exports to partner country (on right)		Reported imports from target country		
Year	Country name	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Country name
1995	Areas, nes			1	10	13	49			Areas, nes
1995	Germany	97	2000	3	885			93	1860	French Guiana
1995	Netherlands			35812	159343					
1995	Spain	4000	18497	4000	19024					
1995	Switzerland			2750	17399					
1995	United Kingdom			7812	37266					
1995	USA	4937	28580	4125	30276					
1996	Areas, nes			12	69	1	6			Areas, nes
1996	Germany	183	2657	519	4636	132	692			Bolivia
1996	Mexico	4000	19720							
1996	Russian Federation			61617	313375					
1996	Spain	6000	29397	5000	25477					
1996	United Kingdom	2062	10535							
1996	USA	3375	16000	8250	62570					
1997	Algeria			3437	17802	10	225			Areas, nes
1997	Central African Rep.			1750	8466	171	1818			Bolivia
1997	Finland			3437	17791					
1997	Germany	699	9804	62	5381					
1997	Mexico			4000	20647					
1997	Netherlands	10000	23076							
1997	Russian Federation			20597	104046					
1997	Spain	28425	140755	19082	97281					
1997	USA	5125	33727	4125	33600					

[*] Note: the abbreviation ‘nes’ means ‘not elsewhere specific’ and refers to countries that are not specifically identified for political, commercial or other reasons.

BRAZIL

Elemental mercury imports and exports

Data source: UN DESA/ESD/UNSD - Comtrade statistics - downloaded 11Apr2006
Tarif system: SITC rev.2
Tarif code: 52216
Filter: Trade value ≥ $US 0
Comments:

Period	Exporting partner countries			Target country: Brazil				Importing partner countries		
		Reported exports to target country		Reported imports from partner country (on left)		Reported exports to partner country (on right)		Reported imports from target country		
Year	Country name	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Country name
1998	Algeria			14812	74029	57	812			Areas, nes
1998	Areas, nes			3375	16373	28	731			Lebanon
1998	Central African Rep.			6875	33660					
1998	Finland			5125	24729					
1998	Germany	132	2000	890	7043					
1998	Netherlands	5312	29289	199	3044					
1998	Russian Federation			16835	80078					
1998	Spain	15937	79506	27156	139970					
1998	Switzerland	19	553	2	618					
1998	United Kingdom			3375	16917					
1998	USA	2500	14874	3562	28233					
1999	Algeria			3437	17500	48	819			Areas, nes
1999	Central African Rep.			1750	8032	17250	76309	17250	79328	Argentina
1999	Germany	97	7619	43	2413			47	1135	Bolivia
1999	Netherlands	500	48332	148	49768					
1999	Russian Federation			41402	186960					
1999	Spain	3062	14559	2937	15219					
1999	Switzerland	3	505	2	581					
1999	USA	1312	9970							
2000	Areas, nes			2	438	68	742			Areas, nes
2000	Finland			1750	8149	7187	41985	2437	10709	Argentina
2000	France	0	1123					1125	863	Paraguay
2000	Germany	398	27782	410	30813					
2000	Kyrgyzstan			3437	15000					
2000	Mexico	109	9899	89	10646					
2000	Netherlands	62320	318370	3687	121716					
2000	Russian Federation			18492	86727					
2000	Spain			10812	51203					
2000	USA			1875	13562					
2001	Algeria			2562	12375	24	187			Areas, nes
2001	Finland			10375	48901			49	895	Netherlands
2001	Germany	796	17906	687	19007					
2001	India	17500	34649							
2001	Netherlands	11562	94041	3562	85712					
2001	Russian Federation			3437	16313					
2001	Trinidad and Tobag	5812	28013							
2001	Spain			41886	208962					
2001	USA	3562	139199	13	517					
2002	Algeria			4500	22136	0	108			Areas, nes
2002	Belgium	5187	13354							
2002	Finland			27531	81292					
2002	France			1	578					
2002	Germany	296	14560	3687	33220					
2002	Netherlands	18519	336379	191	120011					
2002	Russian Federation			2500	12499					
2002	Spain			2000	5291					
2002	United Kingdom			7562	37559					
2002	USA	2000	22500	18917	31630					

BRAZIL **Elemental mercury imports and exports**

Data source: UN DESA/ESD/UNSD - Comtrade statistics - downloaded 11Apr2006
Tarif system: SITC rev.2
Tarif code: 52216
Filter: Trade value ≥ $US 0
Comments:

Period	Exporting partner countries			Target country: Brazil				Importing partner countries		
		Reported exports to target country		Reported imports from partner country (on left)		Reported exports to partner country (on right)		Reported imports from target country		
Year	Country name	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Country name
2003	Algeria			2750	15495	1	55			Areas, nes
2003	Belgium			3437	19117			140	18100	Netherlands
2003	Finland			7750	42225					
2003	Germany	398	26000	367	28763					
2003	Netherlands	11250	179972	156	165511					
2003	Spain	19421	43594	26175	83822					
2003	United Kingdom			31222	101634					
2003	USA	7187	50149	8875	53488					
2004	Algeria			1750	15212					
2004	Areas, nes			3	41					
2004	France	0	7407							
2004	Germany	199	5000	261	24587					
2004	Japan			6187	53576					
2004	Netherlands	10375	156771	109	199024					
2004	Russian Federation			17250	85298					
2004	Spain	20000	122227	8625	74740					
2004	USA	1750	19949	3625	39938					

Source: UNDESA/SD Comtrade (2006) export statistics – UN Commodity Trade Statistics Database, United Nations Department of Economic and Social Affairs—Statistics Division, at http://www.unstats.un.org/unsd/comtrade

33. It is difficult to determine how much country-to-country trade in elemental mercury may not have been reported. For the 163 countries and protectorates that have reported mercury imports or exports during at least one year since 1995, the Comtrade database appears reasonably comprehensive for many countries, and not very complete for a number of others, based on indications of experts working with artisanal and small-scale miners, and separate estimates of regional mercury consumption. According to the Comtrade data, the total quantity of elemental mercury traded/sold between countries (some of it clearly traded several times during the course of a year or two) amounted to some 60,000 metric tonnes during the ten years from 1995 to 2004, or an average of approximately 6,000 metric tonnes per year. The trend since 2000 has clearly been below that average. It should be noted that these data do not include commercial transactions inside individual countries – only between countries.

34. Using the same Comtrade statistics, the total value of the elemental mercury transactions between countries that reported to Comtrade comes to some USD 250 million for the period 1995-2004, or about USD 25 million per year. Again, this value does not include transactions within individual countries, commercial transactions of mercury compounds, etc., which would give a substantially higher number for the overall mercury "market."

35. Despite the official sources and general quality of the existing trade data, they reveal some weaknesses with regard to the objectives indicated in paragraph 29 above. Certain weaknesses could be reduced if the agencies collecting and reporting the data were better aware of how these data may be used to improve our understanding of mercury trade and use throughout the world. Other weaknesses can only be addressed through a modest increase in the types of data collected. For example:

- There are some inconsistencies and gaps in the data, as demonstrated in Annex 1 – Discrepancies in trade statistics (1) and Annex 2 – Discrepancies in trade statistics (2);
- There is some understandable confusion of tariff codes, such as the difficulty of determining, in some cases, whether a shipment consists of elemental mercury, a mercury compound or mercury waste; or whether a shipment of batteries ("primary cells") contains mercuric oxide batteries or other batteries;

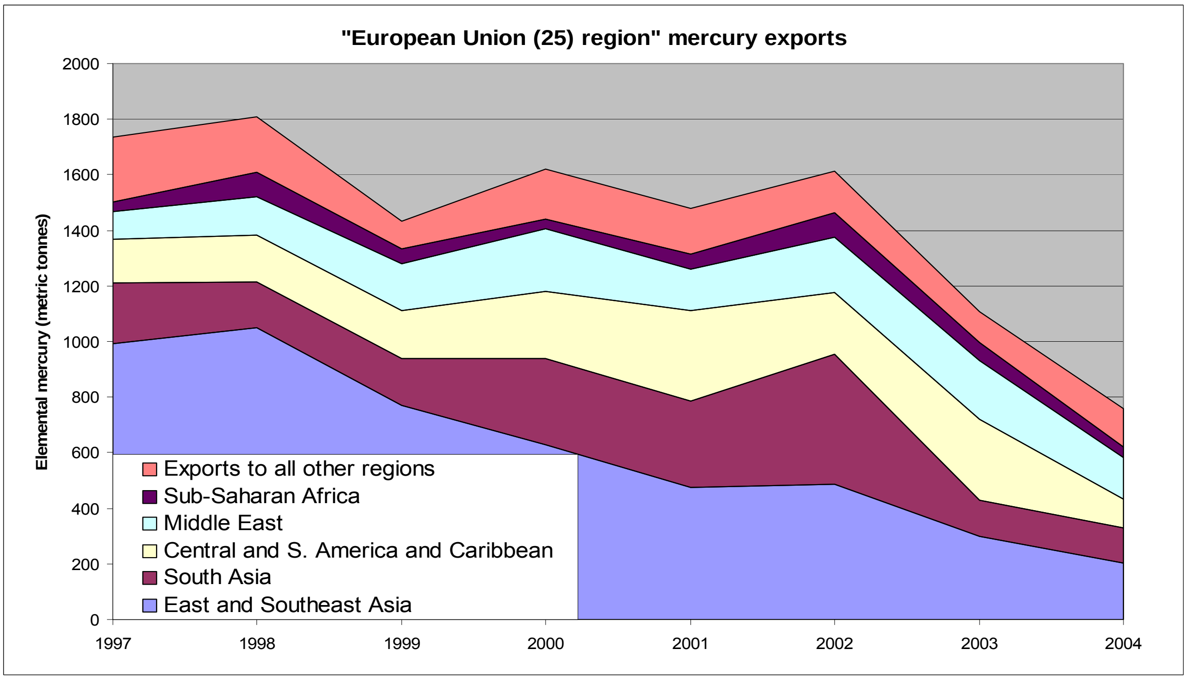
- For obvious reasons, the mercury trade data reported to Comtrade is consolidated into a single entry (quantity and value) for any given year – one entry for imports and one for exports between any two trading partners; for policy purposes a greater level of detail could be useful;
- The data most widely and consistently reported is for elemental mercury transactions, whereas the data on trade in mercury compounds is not as commonly reported; or the tariff code (e.g., non-ferrous metal compounds) is so broad as to include non-mercury compounds as well;
- Likewise, the tariff codes used by most countries do not differentiate between mercury products (e.g., thermometers) and mercury-free products, except in the case of certain lamps;
- As mentioned, most countries do not have very good information on commercial transactions and uses of mercury after it enters a country; such domestic statistics may be useful not only as a check on country-to-country trade statistics, but also in determining the effects of various policies on different sectors dealing with elemental mercury, mercury compounds or mercury containing products;
- Finally, goods and materials passing through Customs Free Zones (also known as Free Trade Zones) are subject to very different Customs procedures, or none at all. It could be useful to review any reporting requirements for transactions to and from these zones involving certain hazardous substances.

36. Overall, since some countries do not report their trade statistics routinely to UNSD, the Comtrade data may be considered to provide a low-end approximation of the global market in elemental mercury. However, there is very little reporting of trade in mercury compounds and products. More standardised, comprehensive and timely reporting of international (and domestic, to the extent possible) trades would improve the quality and value of future assessments.

37. The Comtrade data on trade in elemental mercury between individual countries may be further analyzed to show commercial transactions **between different regions** of the world, and their evolution in recent years. This analysis may especially be valuable to authorities involved in regional policy deliberations.

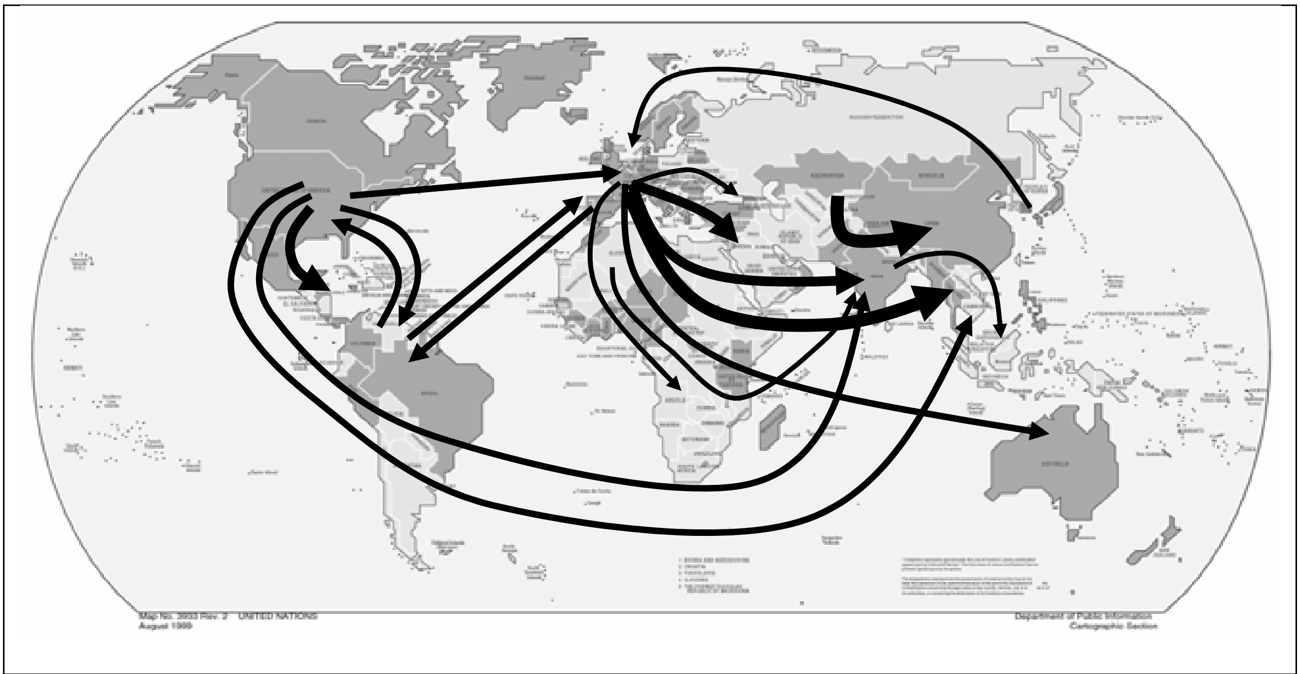
38. As an example, the following figure shows the 1997-2004 elemental mercury exports from the European Union to all other regions of the world. The figure also shows the main regions that were recipients of European Union exports during those years.

Figure** 3* ***Exports of elemental mercury from the European Union, 1997-2004



39. In order to put the European Union regional exports into the larger context, the following figure indicates the major trade flows between regions for the year 2004. This figure shows the main exporters of mercury in 2004 to be the region that includes primarily the CIS countries, and Western Europe. In fact, according to the Comtrade statistics, the largest regional activity in 2004 consisted of over 750 tonnes of worldwide mercury exports from the European Union (EU), including more than 300 tonnes the EU had received in 2004 from Switzerland. The CIS region also exported over 700 tonnes of mercury, which included over 400 tonnes exported from Kyrgyzstan to China, and some 200 tonnes from other CIS countries to the European Union.

Figure 4 Commodity mercury shipments among world regions, 2004



40. Summaries of mercury exports and imports for 1997-2004 among all regions may be found in Annex 5. In general, it may be seen that the volumes of mercury traded globally have declined since the late 1980s; however, during the last 10 years that decline has been less evident.

41. As part of a larger regulatory strategy to reduce the amount of mercury available to the biosphere, a number of countries have already implemented policies with the express purpose of restricting or regulating mercury trade, supply and demand. In other countries such policies are under discussion. Focussing primarily on trade issues in this analysis, the following relevant examples of mercury trade restrictions may be noted:

- China has officially restricted mercury imports since 2002;
- The European Union has agreed a mercury strategy that calls for a ban on mercury exports from 2011, and is now in the process of adopting relevant legislation, including a long-term storage requirement for mercury removed from decommissioned chlor-alkali plants;
- The United States Government has stored over 4000 metric tonnes of surplus mercury in order to keep it from the marketplace; in addition, a bill has been recently introduced to the United States Senate proposing legislation to ban mercury exports from 2010, among other restrictions on mercury;
- Sweden and Denmark have banned the export of elemental mercury, among other restrictions on mercury in products, etc.;
- Some mercury compounds are subject to the procedures of the 1998 Rotterdam Convention (also known as the Prior Informed Consent (PIC) Convention). According to action 16 of the European Union Mercury Strategy, the European Community should promote an initiative to make elemental mercury subject to the PIC procedure, as Sweden has, in fact, recently proposed.

Artisanal and small-scale gold mining

42. As mentioned above, due to the scale and global impact of mercury use in artisanal and small-scale gold mining, it is given special attention in this report.

43. The Global Mercury Project (GMP) is an initiative of the U.N. Industrial Development Organization. The GMP was launched in 2002 with financial support from the U.N. Development Program and the Global Environment Facility, co-financed by partner countries and civil society. The GMP works with governments, NGOs, industry and community stakeholders, building capacity to monitor factors related to mercury use and pollution in artisanal and small-scale gold mining (ASM), and developing policy and institutional capacities to remove barriers to the adoption of cleaner technologies of mineral extraction. Several countries are participating in this pilot program, with primary field activities taking place in Brazil, Indonesia, Lao People's Democratic Republic, Sudan, Tanzania and Zimbabwe.

44. The Global Mercury Project has kindly submitted a report in response to the UNEP Governing Council's request (*Decision 23/9 IV*) for information on mercury supply, trade and demand in artisanal and small-scale gold mining. The GMP report is included in this document as Annex 3. All of the information in this section is drawn very closely from the GMP report, which highlights some of the project's findings and outlines some major policy implications for nations worldwide – particularly nations exporting, importing and/or using mercury, as well as all countries affected by global pollution and/or involved in providing assistance to populations involved in ASM.

45. At least 100 million people in over 55 countries depend on ASM for their livelihood, mainly in Africa, Asia and South America. ASM produces 20-30% of the world's gold production, or approximately 500-800 tonnes per annum. It involves an estimated 10-15 million miners, including 4.5 million women and 1 million children. This type of mining relies on rudimentary methods and technologies and is often performed by miners with little or no economic capital, who operate in the informal economic sector, often illegally and with little organization. As mercury amalgamation is an inexpensive, quick and simple way to extract gold particles, it is currently the method most commonly used in ASM.

46. As a consequence of poor practices, mercury amalgamation in ASM results in the release of an estimated 650 to 1000 tonnes of mercury per annum, equivalent to perhaps one-third of all global anthropogenic (human-caused) mercury releases into the environment. This makes ASM the single largest intentional-use source of mercury pollution in the world. In addition to the severe occupational hazards associated with mercury use, ASM has generated thousands of polluted sites with impacts extending far beyond localized ecological degradation, often presenting serious, long-term environmental health hazards to populations living near and downstream of mining regions.

47. Though large-scale gold mine operations have phased out mercury use by adopting alternative technologies, mercury demand in ASM continues to increase. With the spot market price of gold rising from US$260/oz in March 2001 to US$725 in May 2006, a gold rush involving poverty-driven miners is being observed in many countries. This increase in mining activity is compounded by escalating poverty due to factors such the failure of subsistence economies, displacement of populations in areas of conflict, and the ravages of diseases such as HIV/AIDS.

48. The highest ASM mercury consumption levels appear to be in China (with 200 to 250 tonnes consumed and released), followed by Indonesia (100 to 150 tonnes), and between 10 and 30 tonnes in each of Brazil, Bolivia, Colombia, Ecuador, Ghana, Peru, Philippines, Venezuela, Tanzania and Zimbabwe. Mercury may be used to varying degrees in as many as 40 other countries as well. Mercury releases primarily depend on the nature of mining technology employed, which is influenced by cultural, social and economic factors.

49. Various location-specific GMP training programs and assessments have demonstrated that when mercury is less available and/or more expensive, less mercury is consumed as miners switch to more efficient practices, sometimes eliminating mercury use entirely.

50. At present, the unregulated trading of mercury from industrialized countries means that mercury often enters ASM countries legally, i.e. for use in dental amalgams or the chlor-alkali industry. However, there is evidence that in many developing countries and countries with economies in transition, most of the mercury imported ends up being used in ASM. In most countries, mercury is readily available and relatively inexpensive to miners at ASM sites. In some cases it is given for free, contingent on the recovered gold being sold to the mercury provider. GMP assessments have found that monitoring and regulating imports and domestic trade of mercury in ASM countries is generally significantly more difficult than regulating mercury supply at the export stage, particularly exports from developed countries.

51. Global commitments are critically needed to address challenges – from community-level issues such as technologies and gender inequities, to broader policies such as international mercury export controls and policies to improve regulation and assistance in the ASM sector. The GMP asserts that it could be possible to achieve at least a 50% reduction of mercury consumption (demand) in ASM by 2017. As called for by the GMP, this goal can be achieved if the main stakeholders support strategies that will help ASM communities to:

- eliminate amalgamation of “whole ore” by introducing a mercury-free concentration process prior to amalgamation;
- reduce mercury use in the amalgamation of concentrates through closed circuit process, so that mercury is always recycled;
- eliminate the burning of mercury without the use of a retort; the retort serves to contain emissions and thereby allow recycling;
- introduce completely mercury free techniques where feasible, beginning with “alluvial” ores, from which gold may be readily recovered without the use of mercury.

Key observations

52. In order to effectively reduce the quantities of mercury circulating in the biosphere, it is widely agreed that there is an urgent need to reduce simultaneously both the supply of, and demand for, mercury worldwide. That objective is increasingly being pursued through a range of policies and instruments that deserve to be far more widely diffused. Commercial transfers of mercury comprise the critical link between mercury supply and demand.

53. Country-to-country and region-to-region commercial ("trade") flows of mercury are now understood well enough to show the consistent transfer of mercury from higher to lower income countries. However, some countries still lack a reliable system for recording cross-border transactions of mercury; therefore, the picture is not yet complete. Better information can only lend itself to more effective policies, both nationally and globally.

54. Further emphasis on improving and expanding the information collected on commercial mercury transactions would bring benefits as policies are further developed. However, it must be kept in mind that, based on the extensive information already available, immediate and longer term actions were called for by the Governing Council in 2003, following their adoption of the key findings of the Global Mercury Assessment.

55. The report prepared for UNEP by the UNIDO/UNDP/GEF Global Mercury Project estimates artisanal and small-scale gold mining activities in more than 50 countries, and puts mercury consumption (and releases) in the ASM sector at some 650-1000 tonnes annually. That is equivalent to about 25% of global consumption, and most of that mercury originates in or transits through industrialized nations. The GMP report arrives at a similar conclusion to that in the previous paragraph, confirming the great importance of reducing the global mercury supply through export controls and other mechanisms, in order to increase the cost of mercury and pressure the ASM sector to greatly reduce demand. The GMP report also stresses that parallel measures in the field are critical to provide miners with the necessary information about alternatives to the present excessive and often inefficient use of mercury. With such measures in place, even for such a diverse and seemingly intractable sector, the GMP makes a serious case for reducing mercury consumption by the ASM community by some 50% over the next 10 years – largely by focusing on the elimination of mercury use in processing “whole ore.”

1 Background

1.1 Context of this report

56. In 2001, through GC decision 21/5, the UNEP Governing Council decided to initiate a global assessment of mercury and its compounds. The resulting Global Mercury Assessment (UNEP, 2002) was presented to the 22nd session of the UNEP Governing Council in 2003. Based on the key findings of the report, the Governing Council concluded that there was sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment. They decided, through GC decision 22/4 V, that national, regional and global actions, both immediate and long-term, should be initiated as soon as possible. The decision urged all countries to adopt goals and take national actions, as appropriate, with the objective of identifying exposed populations and ecosystems, and reducing anthropogenic mercury releases that impact human health and the environment. To support the efforts of countries to take action against mercury pollution, UNEP established a mercury programme within the Chemicals Branch of its Division of Technology, Industry and Economics, to promote technical assistance and capacity building activities.

57. Discussions relating to the need for further measures to address the global adverse effects of mercury on health and the environment continued at the 23rd session of the Governing Council in February 2005. The Governing Council adopted an omnibus decision on chemicals management – GC decision 23/9. With regard to mercury, the decision *inter alia* strengthened the UNEP mercury programme, and called for partnerships between Governments and other stakeholders as one approach to reducing risks from mercury to human health and the environment. The decision also encouraged Governments, intergovernmental organizations (IGOs), non-governmental organizations (NGOs) and the private sector to take immediate actions to reduce the risks to human health and the environment posed on a global scale by mercury in products and production processes.

58. The Governing Council will again consider progress and assess, at its 24th session in February 2007, the need for further action on mercury, considering a full range of options, including the possibility of a legally binding instrument, further partnerships and other actions. As part of the background materials for the Governing Council's considerations at its 24th session, it requested UNEP to provide a number of reports and documents demonstrating the implementation of decision 23/9 IV – including a report on supply, trade and demand for mercury on the global market – and also to facilitate the establishment of partnerships between Governments and other stakeholders, as one approach to reducing risks from mercury to human health and the environment.

59. This document specifically responds to the request that UNEP should initiate, prepare and make public a report summarizing supply, trade and demand information for mercury, including in artisanal and small-scale gold mining. The latter is a very special sector with regard to the use of mercury, adding the unique problems of poverty, the informal economy and special health and environmental impacts to the other challenges of dealing with mercury. Therefore, as a supplement to this analysis, and based on its extensive work in this sector, UNIDO agreed to submit a report to the UNEP Governing Council on mercury trade issues associated with the small scale gold mining sector, summarising its experience in supporting a number of developing countries, and countries with economies in transition, in addressing these issues. The findings of the UNIDO report have been integrated into this document, and the report itself is included as Annex 3 – Global Mercury Project report.

60. This document has been drafted with the assistance of a consultant, Mr. Peter Maxson, a well-known European expert in a wide range of issues relating to mercury and other heavy metals, including technical, economic and policy aspects. In recent years he has authored or co-authored for UNEP, the European Commission and others a number of relevant reports and technical publications, several of which are referenced in this work.

1.2 Content of this report

61. This report contains the following sections:

- The “Background” section, in addition to explaining the reason for this report, briefly summarises the ongoing challenges of mercury as a global pollutant. It demonstrates how these challenges may be exacerbated by the ease with which mercury moves through the global economy, and how more detailed information on commercial transactions and final uses could help many countries and regions to better understand the role of mercury in their economies, as well as contribute to more effective policies.
- The section, “Mercury trade statistics,” presents the main sources of statistics on commercial trade of mercury and its compounds, and the organisations that maintain them; describes the commodity classifications and tariff codes used; presents the types of statistics generated; explains the value, scope and limitations of these sources; and describes a number of challenges related to understanding and exploiting the statistics.
- The section, “Global production and supply of mercury,” discusses the two key countries that still mine mercury, as well as the other major sources, including mercury recovered during decommissioning of chlor-alkali factories; “by-product” mercury recovered from mining and processing of non-ferrous metals or cleaning the mercury from natural gas; mercury recycled from wastes and mercury-containing products; and stocks of mercury accumulated over the years from various sources. This section also discusses expectations for the supply of mercury during the next 10 years.
- The section, “International trade in mercury,” presents an analysis of the available data on commercial mercury flows around the world. For each country that submits mercury trade data to the UN Statistics Division, a summary of imports and exports from 1995 to 2004, with some data for 2005, has been prepared, using the UN Comtrade database (reports for each country are available at http://www.chem.unep.ch/mercury/COMTRADE-data-per-country.htm). This section also analyzes these trade data to show commercial flows of mercury between regions, and their evolution in recent years. Despite the official sources and general quality of the trade data, this section identifies a number of inconsistencies that could be targeted and reduced if the agencies collecting the data are better aware of how these data can be used to improve our understanding of how mercury is traded and used throughout the world.
- The section, “Global demand for mercury,” discusses the basic structure of the mercury market, the evolution of mercury prices, the major uses of mercury around the world, regional demand for mercury, and presents two scenarios of evolving mercury demand during the next 10 years.
- Finally, the section, “Relevant legislation and measures affecting supply and trade,” provides examples of legislative measures that have been implemented (or are under discussion) to monitor and restrict the commercial flows of mercury. Such measures are increasingly being viewed as important efforts to complement other measures and actions, both regulatory and voluntary, aimed at reducing the circulation of mercury in the global biosphere.

62. All of these elements of the mercury supply chain help us to better understand mercury markets and movements in order to effectively respond to the key challenges posed by mercury.

1.3 Mercury is present throughout the environment

63. Environmental mercury (Hg)[1]/ levels have increased considerably since the onset of the industrial age. Mercury is now present in various environmental media and food (especially fish) all over the globe at levels that adversely affect humans and wildlife. Widespread exposures occur due to human-generated sources, and past practices have left a legacy of mercury in landfills, mine tailings, contaminated industrial and waste sites, soils and sediments. Even regions with no significant anthropogenic mercury releases, such as the Arctic, are adversely affected by the transcontinental and global transport of mercury (UNEP, 2002; Swain *et al.*, submitted).

64. Mercury and its compounds are highly toxic to humans, ecosystems and wildlife. Initially seen as an acute and local problem, mercury pollution is now recognized as a problem of global concern. High exposures can be fatal to humans, but even relatively low doses may have serious adverse neuro-developmental impacts. Moreover, in both fish-eating wildlife and humans, evidence is mounting in

[1]/ The chemical symbol for mercury is Hg.

support of a range of further adverse health impacts, notably endocrine and reproductive effects in wildlife,[2]/ and cardiovascular effects in humans. Mercury also retards microbiological activity in soil (UNEP, 2002).

65. The largest source of elemental mercury exposure for most people in industrialised countries is inhalation of mercury vapour from dental amalgam. The range of exposure from dental amalgam may vary greatly among individuals. There is a body of research that has concluded that the average exposure from dental amalgam is below the level at which there are health effects. However, other research has indicated that a significant subset of the population may be vulnerable to mercury exposure at these same levels (Echeverria *et al.*, 2006; FDA, 2006). About 80 percent of inhaled vapours are absorbed by the lung tissues. This vapour also easily penetrates the blood-brain barrier and is a well-documented neurotoxicant. Neurological and behavioural disorders in humans have been observed following inhalation of elemental mercury vapour (UNEP, 2002). Mercury is persistent and can change in the environment into methylmercury, the most toxic form.

66. Exposure to methylmercury mostly occurs via diet. Methylmercury collects and concentrates especially in the aquatic food chain, making populations with a high intake of fish and seafood particularly vulnerable. Large populations are exposed to methylmercury, and its toxicity is better characterized than that of other organic mercury compounds. Within the group of organic mercury compounds, alkylmercury compounds (especially ethylmercury and methylmercury) are thought to be rather similar in toxicity to methylmercury, while other organic mercury compounds, such as phenylmercury (still used in many countries in paints), more closely resemble inorganic mercury in their toxicity.

67. Methylmercury is a well-documented neurotoxicant, which may in particular cause adverse effects on the developing brain. This compound readily passes both the placental barrier and the blood-brain barrier; therefore, exposures during pregnancy are of highest concern. The neurotoxic effect, or brain damage, is the most important effect on which recent risk assessments have been based. Brain damage has also been linked to the health effects observed in extremities such as fingers and feet, earlier thought to be due to damage to the peripheral nervous system (Ninomiya *et al*., 2005). Some studies suggest that even small increases in methylmercury exposures may also cause adverse effects on the cardiovascular system, thereby leading to increased mortality. Moreover, methylmercury compounds are considered possibly carcinogenic to humans (group 2B) according to the International Agency for Research on Cancer (IARC, 1993). The most current summary of health effects of methylmercury exposure is found in Mergler *et al.* (submitted).

68. In developing countries and countries with economies in transition, the largest sources of environmental mercury release include coal combustion, smelting of non-ferrous metals, and artisanal and small-scale gold mining. All of these sources can potentially lead to high levels of human exposure through bioaccumulation, consumption of contaminated fish and shellfish, and through direct exposure to elemental mercury during artisanal mining activities. Recent studies conducted by UNIDO in Brazil, Lao People's Democratic Republic, Indonesia, Sudan, Tanzania, Zimbabwe and Venezuela have indicated that inhalation of mercury vapour by miners, their families and neighbours is a more important pathway than methylmercury ingestion from fish in the diet (UNIDO, 2005).

69. Although mercury is released by natural sources like volcanoes, additional releases from anthropogenic sources, like coal burning and use in products, have led to significant increases in environmental exposure and deposition. Elevated (above pre-industrial) levels of mercury in all environmental media (air, soil, water, and fish) now occur in all parts of the world, even the most remote regions such as the poles. Some are due largely to local sources, especially small scale gold mining in South America, Africa and Asia. But as a transboundary air pollutant, mercury can also be transported globally to regions far from its source. Past releases have created a "global pool" of mercury in the biosphere, part of which is continuously mobilised, deposited and re-mobilised. Further emissions add to this global pool circulating between air, water, sediments, soil and biota – thereby further increasing any related health effects.

1.4 Mercury remains a priority concern

70. As mentioned above, there is now consensus among Governments that the global adverse impacts from mercury and its compounds are a priority concern warranting further international action. The UNEP Governing Council, in GC decision 22/4 V, formulated a number of priority objectives for a long-term programme for international action on mercury, including:

[2]/ The most current summary of exposure and effects of methylmercury in wildlife is found in Scheuhammer *et al.* (submitted).

(a) Reducing anthropogenic releases of mercury that impact human health and the environment including, but not limited to, reductions from combustion sources, commercial processes, operations, products, and waste streams;

(b) Reducing the demand for and the uses of mercury that impact human health and the environment (giving consideration to application of feasible alternatives);

(c) Reducing mercury exposures by enhancing risk communication on mercury, particularly to populations at risk, including sensitive populations;

(d) Developing an enhanced capacity to assess the risks and impacts of mercury to humans, ecosystems, fish, and wildlife, and to facilitate actions to manage those risks;

(e) Improving the scientific basis for health and environmental policies regarding mercury and mercury compounds, such as understanding what populations and ecosystems are at risk and the fate and transport of mercury in the environment;

(f) Improving global collection and exchange of information on mercury exposure, use, production, trade, disposal and release;

(g) Identifying environmentally harmful subsidization of mercury mining and encourage a phase-down and eventual removal of such subsidization.

1.5 Mercury is subject to significant international use and commerce

71. Despite improved awareness of risks, mercury continues to be used in a great variety of products and processes around the world. This may be due to lack of locally available alternatives, lack of awareness of alternatives, lack of awareness of risks, perceived or real price differences, etc. Elemental mercury metal is used in small-scale mining of gold and silver; chlor-alkali production; button cell batteries; manometers for measurement and control; thermometers; electrical switches; fluorescent and high-intensity-discharge (HID) lamps; and dental amalgam fillings, as well as some natural medicines, and cultural and religious practices. Mercury compounds are used in batteries; biocides in the paper industry; pharmaceuticals; beauty products; paints; to protect seed grain from spoiling; and as laboratory reagents and industrial catalysts.

72. There is significant ongoing trade in mercury and mercury-containing products, some of which is illegal, uncontrolled and/or unregulated. Yet, considering the health and environmental hazards posed by mercury, its flow through international commerce deserves to be better understood. While overall quantities of mercury traded (and mined) have diminished in recent years, significant amounts are still transported. The unabated demand in many developing countries, and countries with economies in transition, is a particular concern. This has been met by a ready supply from a number of sources, including, among others, mining of mercury (extracted from ores within the earth's crust) either as the main product or as a by-product of mining and refining other metals (gold, zinc) or minerals; private and government stocks (mercury in chlor-alkali plants, stocks held by brokers, government reserves); and recycled mercury from spent products and industrial wastes.

73. Even under current regulations and restrictions, many of the uses and movements of mercury and mercury containing products are likely to eventually result in the release of mercury to the global environment. Meanwhile, large amounts of mercury that remain in mine tailings, landfills and sediments, as well as stockpiles, continue to present a threat of future release (UNEP, 2002). Hence, further actions to address, manage and reduce mercury supplies, uses, stocks and trade may be useful at local, regional, national and international levels to prevent or minimize future releases (NGO, 2004).

74. A better picture of the life-cycle of commercially traded mercury throughout the world would be helpful in order to fairly and cost-effectively prioritize needed measures at the various levels. It is especially important to improve our understanding of commercial mercury's life-cycle from the mine or other source, through the economy, and to its eventual release to the environment or safe disposal.

1.6 Benefits of improved mercury flow information

75. Improved information collection and greater transparency of the export and import flows of commodity mercury (and mercury compounds) would permit governments to be better aware of their own situation with regard to mercury trade and would inform national and regional priorities, policies and targets.

76. Greater transparency and scrutiny would also, over time, help to promote global reductions and phasing out of processes or products that have already been phased out in some countries, and are

under discussion in others, such as the mercury cell process for producing chlorine, mercury-containing thermometers, soaps and cosmetics, paints, fungicides, batteries, etc.[3]/

77. Not least, better information on mercury trade flows would provide a firm foundation on which the global community could develop targets and set priorities, as appropriate, for reducing global flows of mercury in line with the objectives established by the UNEP Governing Council. In light of limited resources, it is imperative that activities in this area be cost-effective. Good information is the cornerstone of cost-effective strategies for reducing both mercury supply and demand.

1.7 Key information sources

78. Many reports and information sources have been drawn on in support of this document. These are mentioned in footnotes and references. In addition, UNEP invited Governments, in a letter of 15 March 2006, to provide national information relevant to mercury supply, trade and demand in their countries. Information submitted in response to this request is available on the UNEP mercury webpage at http://www.chem.unep.ch/mercury/Trade-information.htm. The information provided by various Governments has been taken fully into consideration when finalizing this report.

79. Finally, this analysis draws heavily on information available in the UNSD Comtrade database (see especially Sections 2 and 4). UNEP was granted unrestricted access to all of the trade statistics available in the Comtrade database as a basis for this report, and would like to express its appreciation to its colleagues at the UN Statistics Division (UNSD) for their active interest in, and support of, this effort.

2 Mercury trade statistics

80. Comprehensive statistics concerning the commercial trade of elemental mercury among United Nations member states are publicly available through the United Nations Commodity Trade Statistics Database (Comtrade). Comtrade contains detailed import and export statistics reported by Customs and other government authorities. These data are processed by the UN Statistics Division (UNSD) into a standard format with consistent coding and valuation. The data are then stored in a computerized database system known as UN Comtrade. For many countries the data coverage starts as far back as 1962 and goes up to the most recent completed year. The data can be accessed at http://unstats.un.org/unsd/comtrade/

81. One objective of this report is to analyse the comprehensive UN Comtrade data on the trade and transfers of mercury throughout the world, and to publish these data in such a manner as to enhance the international community's understanding of the flow of mercury through the global economy and society. A better knowledge of these flows is especially helpful to Governments interested in optimising national and international policies to reduce the uses and emissions of mercury.

82. The background data (1995-2005 data) for this analysis have been downloaded from the UN Comtrade database, as described in Section 4, and organised into data sheets for each individual country that routinely submits the relevant statistics to the system, showing trade with other partner countries. These background data are not included in this report, but may be accessed for each individual country through the UNEP mercury webpage at http://www.chem.unep.ch/mercury/Trade-information.htm. Hardcopies may also be obtained by contacting the UNEP Chemicals Branch at mercury@chemicals.unep.ch.

83. It should be noted that UNSD has confirmed to UNEP that use of the COMTRADE data for the purpose of developing this report on supply, trade and demand information on mercury is in accordance with the dissemination and copyright policy of UNSD. However, outside users should take note of the UN Comtrade License Agreement that can be found on the web pages of the UN Comtrade site. The License Agreement specifies that the UN Comtrade data are copyrighted by the United Nations and are made available for internal use only. They may not be re-disseminated in any form without prior written consent of the United Nations Statistics Division. Please also see the Policy on Re-Dissemination of UN Comtrade data for further information on re-disseminating data.

[3]/ It is important to note that increased scrutiny could also drive some transactions "underground," thus effectively making them invisible to the formal economy.

2.1 Key organizations and databases

84. While this report focuses on the mercury statistics available through the Comtrade database, since it is the most comprehensive and accessible, there are several other key organizations collecting and maintaining databases of commercial statistics on mercury trade. All of these primary databases are described briefly below.

2.1.1 Comtrade

85. UN Comtrade is an acronym for "United Nations Commodity Trade Statistics Database," maintained by the United Nations Statistics Division (UNSD). Every year over 140 countries provide the International Trade Statistics Branch of the United Nations Statistics Division (UN Department of Economic and Social Affairs) with their annual international trade statistics involving trade with over 160 partner countries, detailed by commodity and partner country. These data are processed into a standard format with consistent coding and valuation. All values are converted into US dollars using exchange rates supplied by the countries, or derived from monthly market rates and volume of trade. Trade quantities (generally weight or number of items) are, if provided by the reporting country and if possible, converted into metric units. The data are then stored in the computerized UN Comtrade database system. For many countries the data coverage starts as far back as 1962 and goes up to the most recent completed year.

86. The general scope of activities of the International Trade Statistics Branch therefore includes:

a) Collection of the basic data on international merchandise trade from countries or regions of the world, maintenance of the relevant databases, and data dissemination;

b) Analysis of data and dissemination of the related statistics; and

c) Development of the methodology for international merchandise trade statistics, and assistance to countries in implementing the recommendations of the United Nations Statistical Commission in this field of statistics.

87. Commodities are classified primarily according to SITC (Rev.1 from 1962, Rev.2 from 1976 and Rev.3 from 1988) and the Harmonized System (HS from 1988 with revisions in 1996 and 2002), as well as some more specialised systems. Currently most data are reported according to HS-2002, and automatically converted and stored in all of the other classifications.

2.1.2 Eurostat

88. Eurostat (the Statistical Office of the European Communities) is responsible for harmonising European Community legislation in the field of statistics on the trading in goods, and ensuring that the legislation is applied correctly. The statistics provided to Eurostat are therefore based on precise legal texts, directly applicable in the Member States of the European Union, and on definitions and procedures that have to a large extent been harmonised. The main areas for which Eurostat is responsible are as follows:

- Methodology;
- Classifications;
- Dissemination of European Union statistics;
- Analysis;
- Co-operation; and
- The EDICOM program.[4]/

89. Eurostat operates in close collaboration with other European Commission services and various agencies of European Union Member States with an interest in the use of statistics on international trade in goods.

90. Despite the existence of the European Union Single Market and the substantial easing of cross-border reporting obligations, Member States of the European Union are still required to declare cross-border trade. However, in some cases Member States may request that certain data remain confidential if they believe that publishing the data may compromise a business in that country. While Member States are required to report cross-border commercial transactions, other countries may not have the same requirements, leading to gaps and/or inconsistencies in the statistics.

[4]/ A set of actions relating to the trans-European network for the collection, production and dissemination of statistics on the intra- and extra-European Union trading of goods (Edicom).

91. The main structural limitation of Eurostat statistics, as far as the international community is concerned, is that they are concerned only with trade relating to European Union Member States. In other words, they include all trade (as reported by the European Union Member States) between these countries and non-European Union countries (as reported by Member State authorities), but they do not include trade between non-European Union countries, thus omitting some two-thirds of global mercury trade flows.

2.1.3 United States (US) International Trade Commission

92. The US International Trade Commission has a mandate similar to that of Eurostat, but focused on the US economy, i.e., it is concerned only with statistics for trade between the United States of America and other countries, and the statistics are those that are compiled and submitted by US government agencies.

2.1.4 Other organizations maintaining commercial trade databases

The TRAINS database

93. TRAINS (TRade Analysis and INformation System) is maintained by the United Nations Conference on Trade and Development (UNCTAD); TRAINS is a comprehensive computerized information system at the HS-based (Harmonized System) tariff line level covering tariff, para-tariff and non-tariff measures as well as import flows by origin for more than 140 countries.

94. Data for TRAINS are collected from publicly available sources, such as official government or commercially available publications, including machine-readable ones such as those in CD-ROM or downloaded from the web site.

95. Data are collected by UNCTAD, as well as by the International Trade Centre, UNCTAD/WTO (ITC). In addition, Inter-American Development Bank as well as the secretariats of the Organization of American States (OAS), the Latin American Integration Association (ALADI), Caribbean Community (CARICOM) and the General Treaty on Central American Economic Integration (SIECA) have jointly signed a Memorandum of Understanding with UNCTAD for the establishment of a sub-system TRAINS for the Americas, under which the database has been extended with information on bilateral preferential tariffs for the most important trade agreements in the American Hemisphere.

96. Other sub-regional institutions that actively contribute to the data collection effort through the inter-active TRAINS dissemination program are: the South Asian Association for Regional Cooperation (SAARC); the Economic and Monetary Community of Central Africa (CEMAC = ex-UDEAC); as well as the Industry and Trade Coordination Division of the Southern African Development Community (SITDC).

97. Government offices, including national TRAINS Focal Points, etc., may gain unrestricted and free access to the database by contacting the TRAINS System Manager by email at Info@unctad-trains.org. As regards other interested parties, e.g. enterprises, chambers of commerce, etc., accessing TRAINS for the first time, there is typically a fee.

The IDB/CTS databases

98. The information contained in the Inter-American Development Bank (IDB) database covers tariffs and imports at the tariff line level. The mandatory tariff information covers Most-Favoured-Nation (MFN) duties for applied and current bound duty levels on an annual basis, and correlation tables showing changes in the tariff nomenclature from one year to the next. Optional information includes *ad valorem* equivalents of specific, mixed and compound duties and preferential duties. Import information includes value, quantity, and country of origin by tariff line.

99. The CTS database contains Members' commitments on goods made in the context of the Uruguay Round and previous negotiations as well as post-Uruguay Round concessions. The CTS database also includes provisions to link the concessions to the information contained in the IDB.

100. Access to WTO, IDB and CTS is free of charge for the following users:

- All WTO Members;
- Acceding countries or territories that have provided IDB submissions;
- The WTO Secretariat; and
- The following intergovernmental organizations: Food and Agricultural Organization, International Monetary Fund, International Trade Center, Organization for Economic Co-operation and Development, United Nations Conference on Trade and Development and the World Bank.

101. Additional requests by other intergovernmental organizations for access to the IDB and the CTS databases are subject to approval by the Committee on Market Access on a case-by-case basis.

2.2 Commodity classifications and codes

102. In most countries the national statistical office is responsible for assembling, harmonizing and organizing the national trade statistics, although in some countries central banks, Customs administrations, and specialized governmental organizations carry out these tasks.

103. The more commonly used commodity classifications include:

- Standard International Trade Classification (SITC),
- Harmonized Commodity Description and Coding System (HS),
- Combined Nomenclature (CN) and
- Classification by Broad Economic Categories (BEC).

104. The range of commodity mercury, products and compounds that are routinely reported by national authorities include the following entries from the main commodity classification systems indicated in the table below.

Table 4 Typical statistical classifications used for tracking mercury trade

Classification	Code	Product description	Statistics compiled by:		
			Comtrade	Eurostat	USITC
Mercury					
SITC rev 1	51325	Mercury	yes	yes	yes
SITC rev. 2	52216	Mercury	yes	yes	yes
SITC rev. 3 (BEC Rev.3)	52227	Mercury	yes	yes	yes
HS1992/1996/2002	280540	Mercury	yes	yes	yes
CN 2002/2004	2805 40	Mercury	yes	yes	yes
CN 2004	2805 40 10	Mercury, standard 34.5 kilo flasks	no	yes	no
CN 2004	2805 40 90	Mercury, other than standard 34.5 kilo flasks	no	yes	no
Mercury compounds					
CN 2002/2004	2825 90 50	Mercury oxides	no	yes	no
SITC rev 1	51283	Organo-mercury compounds	yes	yes	no
SITC rev 2	51551	Organo-mercury compounds	yes	yes	no
CN 2002/2004	2833 29 70	Sulphates of mercury (and of lead)	no	yes	no
CN 2002/2004	2834 29 30	Nitrates of mercury (and of copper)	no	yes	no

Sources: http://europa.eu.int/comm/eurostat/ramon/index.cfm?TargetUrl=DSP_PUB_WELC, as well as UNSD and USITC web-sites. Regular updates to CN codes (search under "Taric") and tariffs may be found at http://europa.eu.int/comm/taxation_customs/dds/en/tarhome.htm.

2.3 Data collection and reporting

105. In recent years the United Nations Statistics Division (UNSD) conducted a survey of national practices in compilation and dissemination of statistics on external trade. By December 2002, UNSD had collected information on compilation practices of seventy-six countries and one Customs union. The findings of the survey were published in 2003; some of the relevant findings are summarized below. The survey was not focused only on issues related to mercury trade, as was the recent questionnaire (see Section 2.4 below), but the survey results are indicative of national reporting practices.

What agency collects the trade data, and in what form?

106. *Sources of information*: The majority (95%) of respondents reported using customs records, and for 60% of these, customs records are the sole source of trade statistics. For 35% of respondents, customs records are supplemented by other sources, such as reports of various governmental agencies or commercial organizations.

107. *Compiling agency*: In 84% of the cases, the national statistical office is the compiling agency – responsible for assembling, harmonizing and organizing the statistics. In the remaining countries,

central banks, customs administrations, and specialized governmental organizations act as the compiling agency.

How is the trade data organized and reported?

108. All 77 respondents reported that they compile unit value or price statistics. Of these, 75% compile unit value statistics only, 17% compile price statistics only and 8% compile both unit value and price statistics. Trade volume statistics are compiled by 79% of respondents.

109. Ninety-six % of respondents compile statistics for total exports and imports, while the remaining 4% compile statistics for imports only. Ninety-five % of total respondents compile statistics by various commodity groups. The most commonly used commodity classifications are Standard International Trade Classification (SITC), used by 45% of respondents; Harmonized Commodity Description and Coding System (HS), used by 19%; and Classification by Broad Economic Categories (BEC), used by 16%. Many (21%) compile statistics by other classifications, notably by national (e.g., PRODCOM - List of PRODucts of the European COMmunity) or international classifications of industrial activities, such as the International Standard Industrial Classification of All Economic Activities (ISIC), or Combined Nomenclature (CN).

How is the trade data used, analyzed or reported?

110. *Data availability*: Annual statistics are, in the majority of cases, released within 46 to 90 days after the end of the year. Twenty-eight % of national respondents take more than three months to release annual statistics. Even after these delays, however, it must be noted that within the UN, once data is received from the national authorities, there is necessarily further delay associated with clarifying, harmonizing, and publishing trade data. The referenced report did not estimate the length of the delay between the time UNSD receives statistics and the time they are published on-line.

How comprehensive and/or reliable are the trade data?

111. *Data update, revision*: Of the 69% of respondents who revise their statistics, 24% do so only if and when trade or other related data are revised, while 45% set a fixed month (at least in principle) for a final revision. For the latter group, data may be revised continually throughout the year, or at the end of every quarter; the final revision month ranges anywhere from February to December of the following year. Some respondents indicated that they do not revise their statistics because they use only final trade data to compile statistics. Even after all revisions, the reliability and/or comprehensiveness of the published statistics, while generally commendable, depend on many factors, including the commodity in question, the country and agency submitting trade statistics, the quality of information provided by transport brokers, etc.[5]/

2.4 Scope and limitations of trade data

112. The overall objectives of more closely tracking commercial flows of mercury are to:

i. Better understand the specific sources and uses, the trade routes, the main stakeholders involved, etc.;

ii. Better inform not only those countries and regions that have established plans and targets for reducing mercury production, but also international agencies mandated to take a broader approach to addressing mercury problems; and

iii. Help to measure progress, and otherwise support, all relevant national and regional initiatives – those already in place and those being developed – aimed at reducing mercury flows in the biosphere.

113. It should be kept in mind that a large volume of trade data is already collected and reported. While most statistics may be considered to be accurate, the most common problems with some of the data are largely matters of quality control, incomplete data on products and compounds, lack of consistent reporting by countries, etc. In future, to complement the trade statistics, and recognizing the barriers to certain information collection, it would be useful to have better information on specific mercury sources and end uses.

114. For the statistical analysis that follows, it is necessary to focus mainly on elemental (commodity) mercury, as reported by the key agencies handling commercial statistics. This approach is chosen not only for simplification of the data collection and interpretation, but also because statistics for other

[5]/ Further information concerning the reliability of Comtrade statistics may be consulted at the Comtrade website (UNDESA/SD Comtrade, 2006).

products and compounds are less detailed and sometimes less reliable. For example, the mixes or formulations from which mercury-containing dental amalgams are prepared by dentists may be found under CN (and HS) code 300640, under the rather comprehensive heading, "dental cements and other dental fillings; bone reconstruction cements." Thus, from the data provided under this tariff code, it is impossible to know what part of these dental supplies involves products containing mercury. Likewise it is impossible for national authorities to determine, on the basis of trade statistics, how much mercury their country has imported for dental purposes. For this reason, among others, a questionnaire was sent out dealing with mercury compounds, products and other issues, in order to better understand these trade flows and related statistical problems. The questionnaire is included as Annex 4 – UNEP questionnaire.

2.4.1 Typical challenges associated with trade statistics in general

115. As reported by the UNSD survey respondents (see above), the most frequently encountered problems in the compilation of statistics of external trade are:

- Data entry errors and omissions;
- Incorrect commodity coding and/or description;
- Changes in the Harmonised System (HS);
- Commodity groups that are too heterogeneous at certain levels of SITC;
- Inaccuracy and inconsistency of quantity data for some commodities.

116. Many countries also indicated such problems as:

- Lack of trained personnel or experts to train existing staff;
- Uncertainty regarding treatment of extreme unit values;
- Lack of up-to-date or appropriate technology and/or funds;
- Accounting for exchange-rate fluctuations.

117. Some other challenges associated with mercury trade statistics in particular are discussed in Section 4 below.

3 Global production and supply of mercury

118. The following information on global production and supply of mercury is an update of recent research carried out as background information for the European Commission's proposed legislation to ban mercury exports and store excess mercury (Maxson, 2006).

3.1 Mercury sources and supply

119. There are five common sources of mercury supply:

1. Recovery of mercury from mercury cell chlor-alkali plants (MCCAPs) converted to a mercury-free process, or occasionally closed;
2. Mining and processing of primary mercury ores;
3. Stocks of mercury accumulated from previous years (typically the source would have originally been mercury mine or by-product, chlor-alkali decommissioning, or mercury recovered from wastes);
4. By-product mercury from the refining of some ferrous and most non-ferrous metals; and from the cleaning of natural gas;
5. Recycled mercury from products, wastes, etc.

3.1.1 Recovery of mercury from chlor-alkali plants

120. In 2005, there remained about 5.8 million metric tonnes of mercury cell chlorine capacity operating in the EU-25 (Euro Chlor, 2005). During 2005-2007, the discontinuation of some one million metric tonnes of European Union mercury cell chlorine capacity have been announced by industry, including two plants in Italy (ENS, 2005), one plant in Poland, etc.

121. Outside the EU-25, there remained in 2005 approximately four million metric tonnes of mercury cell chlorine capacity, including about 1.1 million metric tonnes in the United States of America, 428 thousand metric tonnes in India, 430 thousand metric tonnes in the Russian Federation, 341 thousand metric tonnes in Brazil, and 1.5-2.0 million metric tonnes in other parts of the world (WCC, 2006). In these regions as well, mercury cell chlor-alkali plants occasionally close, and mercury-free plants are

constructed, implying a slow transition away from the mercury cell process. For example, two plants in the United States of America have announced they will close or convert during the next two years.

122. One point of occasional confusion is that mercury recovered from decommissioned mercury cell chlor-alkali plants may be sold or transferred within the industry, or it may be sold outside the industry on the international market. Information about the intra-industry transfers of mercury is not readily available, as most regulatory authorities do not yet appreciate the importance of this data to understanding the overall picture of how much mercury is consumed by the industry, and where it goes. It may be expected that, also in the interest of most of the stakeholders, this level of transparency will improve as all aspects of the mercury life-cycle are more closely examined.

123. A voluntary phase-out date of 2020 has been agreed by European companies as being consistent with the end of the economic lifetime of most of the European mercury cell facilities. The decommissioning of nearly 6 million metric tonnes of mercury cell chlorine capacity (as of 2005) in the European Union will liberate up to 11,000 metric tonnes of mercury from the cells, and more from other parts of the plants, between now and 2020. Euro Chlor, the European industry trade association, has an agreement since 2001 with MAYASA, the Spanish trading (and former mining) company, that all European mercury not needed by the chlor-alkali industry should be sold to MAYASA, who then sells it on the world market. Some years ago it was argued that this arrangement avoided the mining by MAYASA of an equivalent amount of mercury. Now that the Almadén mercury mine has closed, the environmental benefit of sending this mercury to MAYASA is not evident. The European Commission has recently proposed legislation that would require mercury from decommissioned chlor-alkali plants to be sent to long-term “safe storage” in order to keep it out of the biosphere.[6]/

3.1.2 Mining and processing of primary mercury ores

124. A comprehensive summary of historical mercury mine operations is provided by Hylander and Meili (2003). Global mercury mining in recent decades has been dominated by three nations mining mercury for export (Spain, Kyrgyzstan and Algeria), and China, which has mostly provided for its own robust home market. However, both Spain and Algeria have decided recently to terminate mercury mining operations.

125. At the last operational mercury mining site within the European Union, Almadén (Spain), the mining and processing of primary mercury ores stopped in 2003, and is not expected to restart. However, the parent trading (and former mining) company, MAYASA, stores mercury and continues to sell it in the global marketplace.

Table 5 Annual mercury mine production (metric tonnes) in Spain, 2000-2005

Mercury mine production (metric tonnes)	2000	2001	2002	2003	2004	2005
Spain	236	523	727	745	0	0

Source: MAYASA.

126. Algeria closed its mercury mine at the end of 2004, in light of continuing technical problems, in spite of increasing world mercury prices. Since about 2000, Algeria rarely produced more than 200 metric tonnes/year (Algeria, 2000-2005).

127. During the last several years, the People’s Republic of China has restricted mercury imports and increased domestic production of mercury, as it determined that it could once again produce mercury at the Guizhou mines for less than it would cost to import the mercury from elsewhere. China has a substantial internal market for mercury, has not historically exported much mercury, and is not expected to start now (NRDC, 2006). While Chinese demand for mercury in batteries and most other products has declined significantly in recent years, an increasing demand for mercury in the production of vinyl chloride monomer (VCM) and measuring equipment (Global Village, 2006), combined with import controls, has spurred an increase in domestic mercury production.

[6]/ The text of the proposed legislation, COM(2006) 636 final, may be consulted at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52006PC0636:EN:HTML

Table 6 Annual mercury mine production (metric tonnes) in China, 2000-2005

Mercury mine production (metric tonnes)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
China	203	193	495	612	700	>700

Sources: NRDC (2006), author estimate for 2005, not including a modest amount of mercury said to come from "informal" mining operations.

128. The only other major mercury mine still in operation is the Khaidarkan mining complex in Kyrgyzstan. Despite technical challenges, including relative inaccessibility and difficulty obtaining spare parts, this mine is very important to the local economy and has been producing close to its practical capacity of 600 metric tonnes of mercury per year.

Table 7 Mercury mine production (metric tonnes) in Kyrgyzstan, 2000-2005

Mercury mine production (metric tonnes)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Kyrgyz Republic	590	574	542	397	500	600

Sources: UNEP awareness raising workshop, Kiev, Ukraine (UNEP, 2004), author estimate (2004 production), Masters (2006) email concerning 2005 production

3.1.3 Stocks of mercury

129. Large reserve stocks of mercury held by some governments are greater than quantities needed to meet domestic needs, and have been traded on the world market when authorized by the relevant national authorities. The sale of such stocks has, in past years, contributed significantly to the supply of mercury exported from the United States of America and from the former Soviet Union.

130. At the end of 2005, the U.S. Defense Logistics Agency's (DLA) Defense National Stockpile Center (DNSC) held an inventory of 4,436 metric tonnes of mercury at several sites in the United States of America. Mercury sales from the DNSC were suspended in 1994 in response to environmental concerns (USGS, 2006). The DNSC subsequently prepared a Mercury Management Environmental Impact Statement to determine how to manage its elemental mercury inventory (DNSC, 2003), and on 30 April 2004, it was officially announced that consolidation and long-term above-ground storage of the excess mercury stockpile was the preferred alternative (DNSC, 2004). In 2006 the DNSC decided that the mercury stocks would be consolidated at a single site in Nevada. In addition to the DNSC stockpile, 1,306 metric tonnes of elemental mercury is held by the US Department of Energy (DoE) at Oak Ridge, Tennessee (US comments, 2006); the final disposition of these US DoE stocks is presently under discussion.

131. Based on an on-site inspection, stocks of elemental mercury held by MAYASA at Almadén, Spain, in 2005 were estimated at 1,000-2,000 metric tonnes (Maxson, 2006). These have been accumulated over a number of years from previous mining activities at Almadén, mercury purchased from Kyrgyzstan, deliveries of mercury from decommissioned chlor-alkali plants in Europe, etc.

132. There is no information on stocks that may be held by either the Kyrgyz or the former Algerian mining operation.

133. Despite information some years ago from the main European mercury broker that the former Soviet stockpiles of mercury had been depleted, about 500 metric tonnes of mercury, said to have originated in Kyrgyzstan, were recently made available by Russian dealers. The same broker purchased about half of the 500 metric tonnes early in 2006, and anticipates receiving the rest later in 2006 or early in 2007. It is not clear how much more than this 500 metric tonnes may be available (Masters, 2006).

134. Besides some stocks held on-site by chlor-alkali producers, it is likely there are other stocks remaining as well, especially in light of increased speculation by brokers, fuelled by the volatility of mercury prices since 2004. Lambert Metals has mercury storage facilities at the ports of Antwerp and Rotterdam (Fialka, 2006), and the company has in the past purchased mercury from the Russian Federation and Kyrgyzstan, among others. Likewise, the largest Indian mercury broker has been

especially active in recent years, and logically maintains stocks in Mumbai, although there is no precise information available regarding quantities.

3.1.4 By-product mercury from non-ferrous metals mining

135. Mercury is found in trace quantities in most non-ferrous (zinc, copper, lead, gold, silver and other) ores, the quantities depending on a variety of geological characteristics. This is especially the case when these metals are extracted from sulphide ores, where mercury is often found as a trace element due to its affinity for sulphur (Hylander, 2005). Mercury is also found in ferrous ores – especially sulphide ores – and even if these ores are not the majority of those used in steel refining, they may still represent a considerable amount of mercury in wastes.

3.1.4.1 Zinc mining

136. Recovering mercury during the refining process may be done to comply with regulatory requirements, or it may be done if the value of the mercury recovered is greater than the cost of alternative disposal of mercury waste. For many years the largest producer of by-product mercury from zinc refining has been Finland, where Boliden (formerly Outokumpu Oyj) has long refined zinc and copper ores, including zinc concentrates imported from Sweden, Spain and other countries. Recent Boliden recovery and sales of mercury from zinc refining wastes are summarised in the following table. The decline in mercury recovery in recent years is reportedly due largely to the fact that the Finnish refiner no longer receives zinc concentrates from one of the Spanish mines, which was known to have a particularly high content of mercury in the zinc ore.

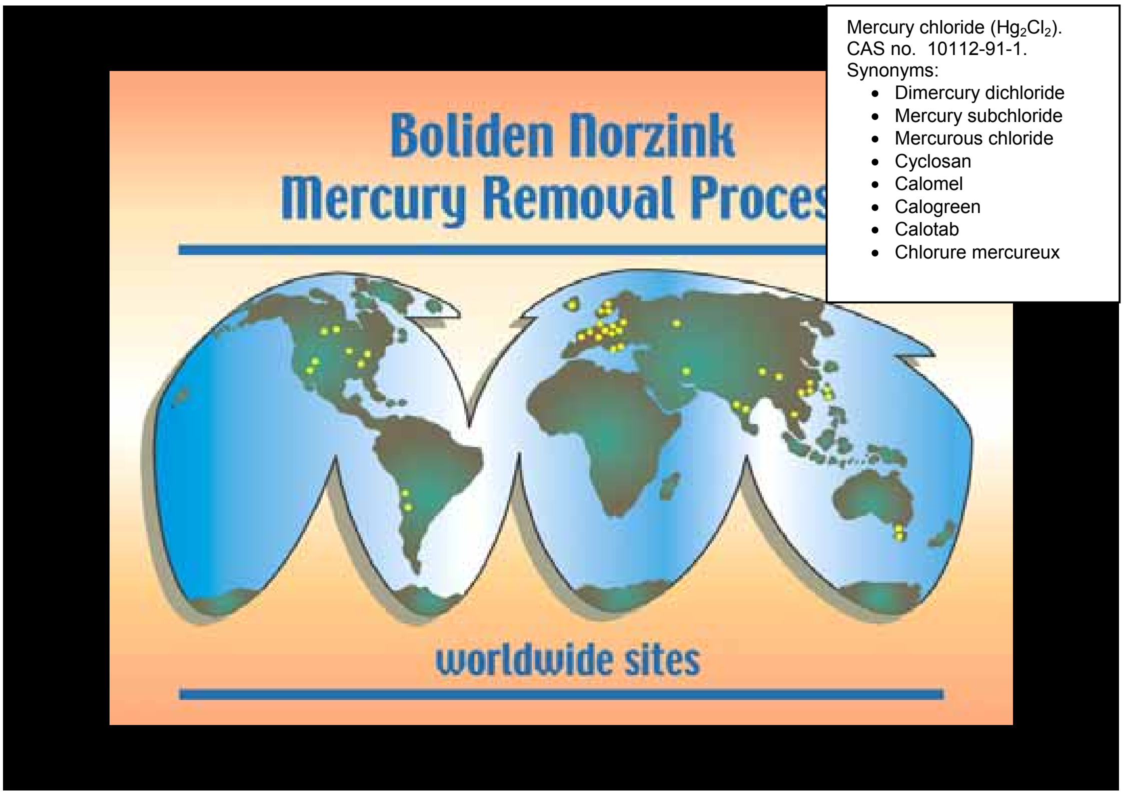
Table 8 Annual mercury sales by Boliden, Finland 2001-2005

Finland	2001	2002	2003	2004	2005
Zinc smelter production (metric tonnes zinc)	222,880	247,180	235,300	265,900	235,000
Mercury exported to Netherlands (metric tonnes mercury)	82.8	77.6	54.9	25.5	23.5
Mercury export/zinc production	0.000372	0.000314	0.000233	0.000096	0.000100

Sources: ILZSG (2006) "Lead and Zinc Statistics," Boliden (2006), UNDESA/SD Comtrade (2006) export statistics.

137. As seen in the figure below, Boliden-Norzink mercury removal systems have been installed on zinc smelters in Australia, Belgium, Canada, Chile, China, France, Netherlands, Germany, Italy, Japan, Norway, United States of America, etc. There are other processes or technologies for removing mercury from gaseous emissions, but only the Norzinc and related Outokumpu processes are associated with by-product mercury production (European Commission, 2001).

Figure 5 Worldwide locations of Boliden-Norzink mercury removal systems



Mercury chloride (Hg_2Cl_2).
CAS no. 10112-91-1.
Synonyms:
- Dimercury dichloride
- Mercury subchloride
- Mercurous chloride
- Cyclosan
- Calomel
- Calogreen
- Calotab
- Chlorure mercureux

Source: Map presented by Lawrence (2002).

138. While most smelting operations do not remove mercury from the flue gases, according to a recent report by Natural Resources Defense Council, there are now about 35 mercury removal systems in operation, based on information provided by Boliden (NRDC, 2006). NRDC and Boliden have estimated that the mercury content of the calomel produced by all of the mercury removal systems in operation at zinc smelters around the world, added to the 24 tonnes of by-product mercury produced in Finland with the Outokumpu process, amounts to 284 tonnes of mercury annually. However, it must be pointed out that most of this mercury content is not presently separated from the calomel waste. Globally, the quantity of elemental mercury removed from zinc refining wastes is estimated at less than 100 metric tonnes (Maxson, 2006).

3.1.4.2 Gold mining

139. Regarding by-product recovery of mercury from industrial gold mining (as opposed to artisanal and small-scale gold mining), the main sources of recovered mercury are South America and the United States of America. In the aggregate, there are five gold mines in South America recovering mercury – three in Peru, one in Chile (an especially large operation), and one starting up in Argentina. Not counting the Argentina operation (because it is too early to estimate), the total amount of mercury recovered from these four mines is 80-100 metric tonnes annually.

140. NRDC (2006) also discusses this sector in some detail and, recalling that the United States of America presently recovers at least 100 metric tonnes of mercury from gold mining operations (Brooks and Matos, 2005; Jones and Miller, 2006), provides the basis for an estimate of 200-250 metric tonnes of mercury presently recovered from gold mining operations worldwide. A significant motivation for mercury recovery is said to be some companies' concern about their environmental image, which suggests that mercury recovery is a practice that will likely grow.

3.1.4.3 Gold and silver mine tailings

141. Yet another likely source of mercury is the proposed recovery of mercury as a by-product of the proposed gold and silver recovery from mine tailings in Mexico, programmed during 2007-2015. The operators have estimated future mercury production from this source at over 200 metric tonnes/year (Minco, 2006).

3.1.4.4 All non-ferrous ores combined

142. Based on data on mercury content of non-ferrous ores provided in the UNEP "Toolkit for identification and quantification of mercury releases" (UNEP, 2005), it has been roughly estimated that 1,000-1,500 metric tonnes of mercury every year are released from these ores by refining processes (Maxson, 2006). Most of that mercury goes to the atmosphere (Wu (2006) reported as much as 200 metric tonnes from zinc refining in China alone), but much is captured and recovered, as described above, or disposed of. Simply adding the various non-ferrous sources, and recalling that there are some ferrous sources as well, gives an estimated 300-400 metric tonnes of mercury recovered globally from zinc, gold, copper, lead and silver refining in 2005, as summarised in Table 10 below.

143. It should be mentioned that the preceding by-product mercury summary does not include the approximately 4,000 metric tonnes of accumulated Russian mining wastes (possibly mostly from the Chelyabinsk zinc smelter) transported to Kyrgyzstan for refining, starting in 2004. This contract concerned a specific quantity of waste accumulated in the Russian Federation over several years, but suggests that significant (and likely increasing) quantities of mercury continue to be removed from Russian ores (many of them having high trace mercury content) in compliance with regulatory requirements and responding to customer needs. It has been estimated that approximately 2,000 metric tonnes of mercury are being extracted from these wastes at the Khaidarkan facility, after which the mercury is reportedly owned and marketed by Kyrgyzstan (Noruzbaev, 2004).

3.1.5 By-product mercury from natural gas cleaning

144. Another source of by-product mercury, although not related to mining *per se*, is natural gas. Most natural gas contains some mercury in trace quantities. In many regions of the world, depending on geology, such as the Netherlands, North Sea, Algeria, Croatia, etc., the mercury concentrations are high enough to cause serious equipment problems during processing.[7]/ Pirrone *et al.* (2001) reported that "a reduction of mercury to below 10 $\mu g/m^3$ has to be obtained before the gas can be used, although mercury is sometimes removed from gas even at far lower concentrations". It is estimated that 20-30 metric tonnes of mercury are recovered yearly from natural gas wastes in the European Union (Maxson, 2006).

145. The data in the following table suggest that mercury is removed from natural gas in such diverse regions as South Africa, the Far East and Sumatra. However, there is no information as to how many of these wastes are treated to separate the mercury. It has been estimated that other countries recover about half of the amount of mercury recovered from gas cleaning wastes in the European Union in a typical year. If so, then about 10 metric tonnes of mercury are presently produced from gas wastes outside the European Union.

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[7]/ Specifically, mercury condenses as liquid mercury on the inside of piping and equipment, or it amalgamates with aluminium (most problematic) and other metals (except iron), gradually corroding and weakening the metals, which has resulted in serious industrial accidents.

Table 9 Examples of mercury concentrations in wellhead gas (µg/Nm3)

Notes	Range (µg/Nm^3)
USA wellhead gas (estimated)	<1 (mean)
Russian Federation, wellhead gas from oil wells	0.05-70 *
Russian Federation, free gas from gas wells (after primary condensate separator)	0.07-14 *
San Joaquin Valley, California, USA	1.9-21
Middle East	<50
The Netherlands	0.001-180
South Africa	100
Netherlands	0-300
Groningen, the Netherlands	180
Far East	50-300
Sumatra	180-300
South America	69-119
North Africa	0.3-130

* The sources cited refer to the unit µg/m^3 without indicating whether the volume is normalized to Nm^3.
Sources: UNEP (2005), Openshaw and Woodward (2001).

3.1.6 Total by-product mercury production

146. The quantities of mercury from all by-product sources are summarized in Table 10 below. In light of the uncertainties described previously and in the various sources, data ranges are estimated.

Table 10 By-product mercury recovered world-wide in 2005 (metric tonnes)

SUMMARY BY-PRODUCT (metric tonnes mercury)	Worldwide in 2005
Zinc refining	80-100
Gold refining	200-250
Copper, lead, silver refining	20-40
Other by-product:	
Russian Federation including Ukraine	60-100
Tajikistan Sb-Hg mine	30-50
Other	20-50
Natural gas cleaning	30-40
Total	**450-600**

Sources: Hylander and Meili (2003), Maxson (2004, 2006), Brooks and Matos (2005), NRDC (2006), UNDESA/SD Comtrade (2006) and US ITC trade statistics

3.1.7 Recycled mercury

147. There are two main sources of recycled mercury. One source is the mercury that may be recovered from various wastes produced by industries using mercury in a production process; the other is mercury containing products that have reached the end of their life.

3.1.7.1 Process mercury

148. The two key industries of concern are the chlor-alkali industry, described previously, and the vinyl chloride monomer (VCM) production process using a mercury catalyst. Most of the VCM is subsequently used in the production of polyvinyl chloride (PVC).

149. With regard to the chlor-alkali industry, in the United States of America regulations require that most mercury wastes be treated and the mercury recovered (Chlorine Institute, 2006), whereas in the European Union some of the wastes are recycled, but it is more typical (and less expensive) for the mercury wastes to be disposed of. On average, recycling of mercury wastes in the rest of the world is rather limited. While conceding that there may be variations in plant layout and management from one chlor-alkali plant to another, for the purposes of calculating the quantities of chlor-alkali mercury waste

currently recycled, the global mercury-cell capacity may be divided among several main groups: the 25 member countries of the European Union (EU-25), the United States of America, Brazil, India, Russia and a large number of operators (including many smaller plants) who, on average, do not have the resources, information, etc., to reduce mercury consumption to the same extent, as in the table below.

Table 11 Global recycling of mercury by the chlor-alkali industry for 2005 (metric tonnes)

Country/region	Mercury cell Cl_2 capacity (metric tonnes/year)	Mercury total net consumption (metric tonnes)	Mercury recycled and recovered from waste (metric tonnes)	Mercury total consumption (metric tonnes)
Europe	5,824,000	147	25-40	175-190
United States of America	1,108,000	9	35-60	45-70
Brazil	341,000	10-15	0-5	11-25
India	428,000	20-28	0-5	20-35
Russia	430,000	25-45	0-5	25-50
Other MCCAPs	1,600,000	120-180	10-40	140-210
Total	**9,731,000**	**350-430**	**90-140**	**450-550**

Sources: See discussion and sources in Section 5.1.1 and Table 18.

150. The table indicates that probably less than 400 metric tonnes of mercury in 2005 were released (i.e., put into the process, and not recovered – referred to in the table as "net consumption") by the chlor-alkali industry, of which some were emissions, some were left as trace contaminants in products, and the rest were disposed of in various wastes. In addition, probably over 100 metric tonnes of mercury were put into the chlor-alkali process that were recovered as elemental mercury, i.e., typically contained in wastes that are retorted or otherwise treated to recover the mercury. Note that mercury retorted or recovered from mercury wastes is typically reused within the industry. In other words, the total annual throughput (referred to in the table as "total consumption") of mercury by the industry in 2005 is estimated here at 450-550 metric tonnes, of which 90-140 metric tonnes were estimated to have been recycled/recovered.

151. With regard to the use of mercury in vinyl chloride monomer (VCM) production, one process (acetylene process) typically uses mercuric chloride on carbon pellets as a catalyst, and the other (mercury-free) is based on the oxychlorination of ethylene. There are no known remaining VCM producers in the EU-25 using the mercury process. One facility in the United States of America used the mercuric chloride process (US EPA, 1997) until 2001, but is now closed. In The Russian Federation four enterprises were identified by Lassen *et al.* (2004) that still use the mercuric chloride process. In China, on the other hand, 62 facilities are known to use this process,[8]/ consuming some 6,000 metric tonnes of catalyst (containing an estimated 600 metric tonnes of mercury) in 2004 – and the number continues to increase along with China's rapid economic expansion (NRDC, 2006; Tsinghua, 2006). Some facilities in other parts of the world may continue to use the mercuric chloride process as well, but China represents an estimated 80-90% of the world total.

152. Theoretically, the mercuric chloride VCM process does not have to be especially polluting because the catalyst can be recycled and the hydrochloric acid product can be cleaned. Mercury releases to the atmosphere may be as low as one percent of the mercury content of the catalyst (Lassen *et al.*, 2004). However, in the case of the Chinese industry, typically, the catalyst is recycled only when the mercuric chloride content of the catalyst has been sufficiently depleted. In 2004, the Chinese VCM industry estimated that they recycled nearly half of the mercury originally contained in the catalyst used during the year (NRDC, 2006). Even assuming these estimates were accurate (Global Village (2006) points to significant involvement of the informal sector), the final destination of the hydrochloric acid and its mercury content, equivalent to over 300 metric tonnes of mercury in that year alone, are unknown.[9]/

[8]/ A small number of plants may instead use a mercuric sulphate catalyst, which was known to be used in China in the past, and which was associated with the Minamata disaster in Japan, but any such plants that may remain in operation have not been specifically identified (Feng, 2004).

[9]/ The data regarding mercury catalyst purchasing and use are considered to be rather reliable since all 62 facilities known to use the catalyst completed questionnaires. The principal uncertainty is the quantity of catalyst sent to recycling facilities, and the recycling efficiency, reported by industry to be 95%.

3.1.7.2 Product mercury

153. The second main source of recycled mercury is mercury containing products, manufacturing wastes from the production of mercury containing products, etc. The key sources of recycled product mercury are separately collected batteries (both button cells and cylindrical batteries), control and measuring instruments (thermometers, barometers, manometers, hospital equipment such as sphygmomanometers, etc.), dental wastes, electrical and electronic equipment, etc., although the collection rates vary from nil to well over 50%, depending on the country and the product category. Mercury containing lamps are also collected by many countries, and while the mercury content is not as high as other mercury products, the large volumes of lamps and the typical disposal practices make used lamps an important waste stream for mercury.

154. In Maxson (2006) the author has estimated the main mercury product and process waste streams, and the amounts of mercury recycled globally. Based on the available data, which is quite limited for most countries, it was assumed that, on average, some 15% of mercury product waste may be recycled globally, giving rise to 180-190 metric tonnes of mercury. Accepting Chinese industry estimates of recycled VCM catalyst, and excluding recycled chlor-alkali industry mercury waste, one can estimate an additional 450-520 metric tonnes of mercury recovered from recycled process wastes. Mukherjee *et al.* (2004) used a different methodology to arrive at a larger estimate of the total waste stream, and a lower estimate of the percentage recycled.

3.1.7.3 All recycled mercury combined

155. Therefore, the global total for recycled mercury, including all of the elements described above, is estimated at 500-600 metric tonnes. Considering the many uncertainties, and especially that of vinyl chloride monomer catalyst recycling in China, as discussed previously, the margin of error associated with this total could bring it as much as 50% lower, but probably not more than 10% higher.

156. As mentioned previously, government regulations and policies, as well as mercury recovery costs versus disposal costs, of course, determine how much of the mercury product and process waste stream is eventually recovered.

3.2 Summary of global mercury supply

157. Any summary of mercury sources obliges one to address the recurrent problem of deciding at what point to account for a given source. For example, mined cinnabar may be accounted for as “mercury production” in the year it is refined into elemental mercury (this is the convention used here). Or it may be accounted for in the year it is sold by the mine. Or if it is sold by the mine in bulk to a broker, it may not be accounted for until it is eventually sold by the broker to an end-user.

158. Likewise, mercury from a decommissioned chlor-alkali plant may be assumed to be “available,” and accounted for, in the year the plant is closed. Or it may be accounted for (the convention used here) in the year it is removed from the cells and sold to another party, e.g. MAYASA, in the case of European Union plants. In general, the information necessary to make all of these sorts of distinctions is not readily available. This is one of the arguments for better reporting of all mercury movements, which will greatly help our understanding of mercury flows through the economy.

159. Even in the case of mercury stocks that have recently become available in the Former Soviet Union, it has not been possible to determine whether they have come from Kyrgyz mine production during the last several years (and therefore should have already been included in previous accounting of primary mine production); or whether they originate from large quantities of Russian mercury wastes being refined by Kyrgyzstan (and should therefore be considered as recycled or by-product mercury); or whether they represent a stockpile that has been warehoused in the Russian Federation already for many years.

160. From the previous analysis, Table 12 summarises the estimated global mercury supply during 2005. As noted in the above text, despite best efforts to clarify these data, there remain many uncertainties. Based on the level of uncertainty in the various categories that comprise the total, and considering the incomplete reporting on several of these categories, it is estimated that the total global supply of mercury – according to the definitions used in this report – falls within the ranges shown below.

Table 12 Global mercury supply, 2005

Sources of mercury supply (2005)	**Mercury supply (metric tonnes)**
	Range
Primary mercury mining	1350-1600
By-product mercury	450-600
Recycled mercury from chlor-alkali wastes[a)]	90-140
Recycled mercury - other[b)]	450-520
Mercury from chlor-alkali cells (decommissioning)[c)]	600-800
Stocks[d)]	0-200
Total	**3000-3800**

Notes:

a) Recycled mercury from chlor-alkali plants includes mercury from sludges and wastes that are retorted on-site, as well as mercury from wastes that are sent off-site for recycling.

b) “Recycled mercury – other” includes all non-chlor-alkali sources

c) “Hg from chlor-alkali cells” is elemental mercury removed from cells at decommissioning.

d) The mercury made available from Former Soviet Union stocks in 2005 was not delivered until early 2006, as described in Section 3.1.3. There is no information on other stocks that may have been exploited.

161. Table 13 summarises the global mercury supply during the period 1995-2005. While the mercury supply and demand for 2005 have been calculated separately for this report, in previous years it has generally been assumed that supply and demand for mercury were in reasonable balance, with data on mercury supply (such as Hylander and Meili (2003), for example) naturally suggesting equivalent demand over time.

Table 13 Global mercury supply during 1995-2005 (metric tonnes)

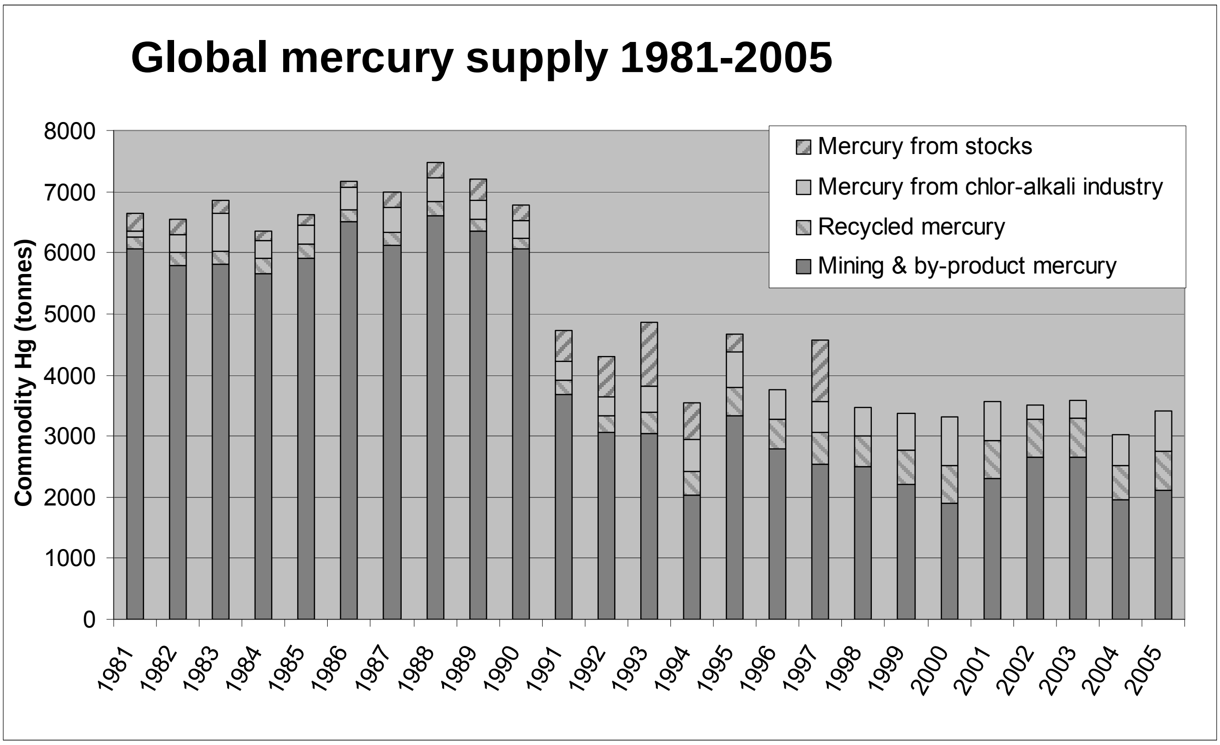
Year	Mining and by-product mercury[a]/	Recycled mercury incl. chlor-alkali wastes	Mercury recovered from decommissioned MCCAPs[a]/	Mercury from stocks[b]/	Total[c]/
1995	3338	459	575	300	**4672**
1996	2782	501	475	0	**3758**
1997	2529	539	500	1000	**4568**
1998	2496	510	460	0	**3466**
1999	2200	575	600	0	**3375**
2000	1900	610	800	0	**3310**
2001	2300	620	650	0	**3570**
2002	2650	630	230	0	**3510**
2003	2650	640	290	0	**3580**
2004	1965	560	489	0	**3014**
2005	2100	600	700	0	**3400**

Notes:
[a]/ – Due to different methods of accounting, the numbers for “Mining and by-product mercury” and “Mercury recovered from decommissioned MCCAPs” in 2002 and 2003 are not directly comparable to the numbers for other years, although the numbers for “Total” mercury supply should be comparable for all years.
[b]/ – Since the closure of the Almadén mine in Spain in 2003, the parent company MAYASA continues trading mercury from its stocks. However, since virtually all of the mercury in the MAYASA stocks has been accounted for elsewhere (as mined mercury, as mercury recovered from chlor-alkali decommissioning, etc.), the amounts sold from MAYASA stocks are not included in the “Stocks” column here.
[c]/ – As suggested in the text, all numbers in this table are best estimates from within wider ranges of uncertainty. Within the scope of this report, it is not possible to discuss uncertainties for years before 2005.

Sources: Hylander and Meili (2003), Maxson (2004 and 2005), NRDC (2006), Euro Chlor publications (http://www.eurochlor.org/).

162. Table 13 above, and Figure 6 below, which presents the longer-term global mercury supply, graphically demonstrate the serious supply shortage that developed in 2004, which strongly influenced the price increase in 2004-2005 (see further discussion in Section 5.4 of this report).

Figure 6 Global mercury supply 1981-2005



3.3 Future mercury supply

163. In this section a scenario is developed to describe the possible evolution of the mercury supply during the next ten years. Since any such projections can be no more than guesses based on our present understanding of mercury markets, the main assumptions are noted. Eventually, the evolution of mercury supplies will be further influenced by legislative and other measures such as those discussed in Section 6. However, the discussion in this section focuses primarily on trends and initiatives already in place.

164. **Mercury mining** – China is expected to continue mining mercury to provide for domestic demand, which is expected to increase for use in vinyl chloride monomer (VCM) production, at least in the near term, as it decreases for use in batteries and most other applications. Kyrgyzstan is expected to continue to produce up to 600 metric tonnes per year as long as there is remaining demand, even at a low price (based on past practice). Mercury mining will only decrease as other sources increase, or as mercury demand decreases to the point that mercury mining becomes unnecessary.

165. **By-product mercury** – Based on the discussion of by-product mercury sources in Section 3.1.4, there are large quantities of mercury in refining and smelting wastes produced every year that could be recovered, but presently are not. More by-product mercury may be expected to be recovered if mercury prices stay high, as demand increases for raw materials (especially zinc and lead), and as regulations may require increased recovery of the mercury. Moreover, there appear to be significant stores of refining wastes in different parts of the world that may occasionally be processed to extract the mercury content (see Section 3.1.4.4).

166. **Chlor-alkali industry** – Based on present trends, EU-25 mercury cell chlorine capacity is expected to decrease from nearly six million metric tonnes of chlorine in 2005 to under one million metric tonnes in 2020. Capacity in the United States of America may be expected to decrease from 1.1 million metric tonnes of chlorine in 2005 to perhaps less than half that in 2020.[10]/ Mercury cell chlorine capacity in the rest of the world may be expected to decrease from close to three million metric tonnes of chlorine in 2005 to 2 to 2.5 million metric tonnes in 2020. In total, therefore, approximately 10 million metric tonnes of chlorine capacity in 2005 may be expected to decrease to 3.5 to 4 million metric tonnes

[10]/ Comments submitted by the World Chlorine Council (WCC comments, 2006) state that annual chlorine capacity in the United States of America will be reduced to 733,000 tonnes by the end of 2007.

capacity in 2020. On average at decommissioning, around two metric tonnes of mercury may be recovered for each 1,000 metric tonnes of chlorine production capacity, freeing up some 12,000 metric tonnes of mercury, or an average of about 800 metric tonnes per year, between 2005 and 2020.

167. The total mercury demand (consumption) for operating chlor-alkali plants includes all mercury that goes into process wastes, some of which are later retorted (on-site or off-site) in order to recover the mercury. Any mercury recycled from wastes is included in the "recycled" category below.

168. **Recycled mercury** – Separate collection of mercury products may be expected to increase in coming years, but the quantity of mercury recovered from them will depend largely on legal requirements, the cost of alternative mercury waste disposal, etc. Under present regulations, the quantity of mercury recycled from products and wastes is expected to increase modestly. The recovery of mercury from spent VCM catalyst in China may be expected to increase more rapidly, if only because the consumption of mercury in this sector is expected to also increase significantly.

169. **Mercury from stocks** – Based on information from one of the key parties in contact with the sellers, the "Former Soviet Union" stocks made available in 2005 apparently comprise 500 metric tonnes of mercury in total (Masters, 2006). After this stock is sold, all known "government" stocks outside the United States of America will have been exhausted, although experience suggests that there may be other stocks that may come to market if the price of mercury is high enough. As mentioned in Section 3.1.3, in addition to mercury held by the U.S. government in long-term storage, the U.S. Department of Energy holds 1,306 metric tonnes of mercury, and has not yet decided what the final disposition of that stock will be.

170. In virtually all of the areas mentioned above, improved tracking and reporting of commercial mercury transfers would aid greatly in understanding and dealing with such developments and a range of other mercury issues – both national and global.

4 International trade in mercury

171. A full understanding of commercial flows of mercury begins with the details of flows inside a specific country, proceeds to a larger and more complete picture by examining flows between different countries, and generates a still more aggregated picture by investigating flows between different regions. A general appreciation of country and regional flows, as facilitated by this report, is an important foundation upon which Governments can build effective strategies and design specific measures to address the national and global mercury challenges mentioned in Section 1.

4.1 Overview of Comtrade mercury statistics

172. The details of commercial flows of mercury inside individual countries are generally sketchy, but as described in Section 2, the national trade statistics available through the UN COMTRADE database are quite extensive.

173. Since the COMTRADE database includes several tariff codes, in order to ensure the broadest possible coverage of statistical data, the SITC rev.2 tariff code was selected. Revision 2 was implemented in 1988; therefore, all subsequent mercury trade data, even if submitted under one of the HS tariff codes, for example, has been "translated" by the Comtrade software into SITC rev.2. On the other hand, if one searches the Comtrade database for mercury trades according to the HS2002 tariff codes, one does not see any of the trade data submitted (under HS or SITC codes) prior to 2002, since that data has not been "translated" forward into HS2002.

174. Under SITC rev.2, tariff 52216, a search was carried out for all national imports and exports of elemental mercury. Some 15,000 records were listed for the years 1995-2005 for 163 countries and legal areas – some of which do not routinely submit trade statistics to UNSD, but which are mentioned in submissions of their trading partners. It should be noted that a minor amount of data are entered with the abbreviation "nes," which means "not elsewhere specified." This refers to countries that are not specifically identified for political, commercial or other reasons. Also, since many data are submitted up to six months (and some even more) late, the 2005 data are incomplete. Likewise, it may be assumed that a relatively small percentage of 2004 data may also not yet be included in the statistics downloaded for this analysis. Otherwise these statistics appear to be the best available, under present reporting conditions, from any database with a global coverage.

4.1.1 Avoiding any misconceptions

175. In order to avoid any misconceptions about the Comtrade statistics and the use of those statistics in this report, several comments should be made.

176. The trade flows between countries as published by Comtrade provide the opportunity to combine the reports of any two countries reporting trades with each other. Effectively, each country, whether importer or exporter, has its own “picture” of that year’s mercury trade. Combining both countries’ trade flow reports may generate a combined picture, or “collage,” that no longer resembles either country’s national statistics, each of which presents only one country’s picture of trade.

177. All of the data available, both import and export data, are used to develop the most complete collage possible of the trade between any two countries. It is possible the collage is inaccurate, but this can only be determined by a careful look at the data on which two countries may differ.

178. Since the combined trade flow collage may not resemble either country’s national statistics, the initial reaction may be to challenge the accuracy of the collage. It is hoped that the collage will rather be recognised for its value in encouraging countries to explore the reasons for any statistical differences.

179. In dealing with global mercury trade, it is evident that there are some major brokers who accumulate stocks of mercury for subsequent sale and distribution. Mercury is traded as a commodity. It is not the intent of this Comtrade-based trade analysis to determine the mercury supply and demand of different countries. It is clearly recognized that significant amounts of mercury may be shipped and re-shipped several times during the same year. Rather, the intent is to show the global and regional movements of commodity mercury so that governments may better understand them. It is especially through a better understanding of global mercury trade that countries wishing to more closely monitor or restrict trade flows may best respond with whatever measures they may consider appropriate.

4.2 Mercury trade (imports and exports) for individual countries

180. Analysing the detailed country statistics on mercury imports and exports, Table 14 provides a summary example of the data for a single country. Brazil was selected for this example because the data reflect, to a large extent, the well-known gold rush of artisanal and small-scale miners; as miners depleted the main deposits in the late 1990s, it is evident that mercury imports to Brazil also declined. For each country in the UN database, a similar summary of the 1995-2004 statistics has been compiled, and may be viewed online at http://www.chem.unep.ch/mercury/Trade-information.htm.

Table 14 Example of mercury trade summary for a single country (Brazil)

BRAZIL — **Elemental mercury imports and exports**

Data source: UN DESA/ESD/UNSD - Comtrade statistics - downloaded 11Apr2006
Tarif system: SITC rev.2
Tarif code: 52216
Filter: Trade value ≥ $US 0
Comments:

Period	Exporting partner countries			Target country: Brazil				Importing partner countries		
		Reported exports to target country		Reported imports from partner country (on left)		Reported exports to partner country (on right)		Reported imports from target country		
Year	Country name	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Country name
1995	Areas, nes			1	10	13	49			Areas, nes
1995	Germany	97	2000	3	885			93	1860	French Guiana
1995	Netherlands			35812	159343					
1995	Spain	4000	18497	4000	19024					
1995	Switzerland			2750	17399					
1995	United Kingdom			7812	37266					
1995	USA	4937	28580	4125	30276					
1996	Areas, nes			12	69	1	6			Areas, nes
1996	Germany	183	2657	519	4636	132	692			Bolivia
1996	Mexico	4000	19720							
1996	Russian Federation			61617	313375					
1996	Spain	6000	29397	5000	25477					
1996	United Kingdom	2062	10535							
1996	USA	3375	16000	8250	62570					

BRAZIL

Elemental mercury imports and exports

Data source: UN DESA/ESD/UNSD - Comtrade statistics - downloaded 11Apr2006
Tarif system: SITC rev.2
Tarif code: 52216
Filter: Trade value ≥ $US 0
Comments:

Period	Exporting partner countries			Target country: Brazil				Importing partner countries		
		Reported exports to target country		Reported imports from partner country (on left)		Reported exports to partner country (on right)		Reported imports from target country		
Year	Country name	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Country name
1997	Algeria			3437	17802	10	225			Areas, nes
1997	Central African Rep.			1750	8466	171	1818			Bolivia
1997	Finland			3437	17791					
1997	Germany	699	9804	62	5381					
1997	Mexico			4000	20647					
1997	Netherlands	10000	23076							
1997	Russian Federation			20597	104046					
1997	Spain	28425	140755	19082	97281					
1997	USA	5125	33727	4125	33600					
1998	Algeria			14812	74029	57	812			Areas, nes
1998	Areas, nes			3375	16373	28	731			Lebanon
1998	Central African Rep.			6875	33660					
1998	Finland			5125	24729					
1998	Germany	132	2000	890	7043					
1998	Netherlands	5312	29289	199	3044					
1998	Russian Federation			16835	80078					
1998	Spain	15937	79506	27156	139970					
1998	Switzerland	19	553	2	618					
1998	United Kingdom			3375	16917					
1998	USA	2500	14874	3562	28233					
1999	Algeria			3437	17500	48	819			Areas, nes
1999	Central African Rep.			1750	8032	17250	76309	17250	79328	Argentina
1999	Germany	97	7619	43	2413			47	1135	Bolivia
1999	Netherlands	500	48332	148	49768					
1999	Russian Federation			41402	186960					
1999	Spain	3062	14559	2937	15219					
1999	Switzerland	3	505	2	581					
1999	USA	1312	9970							
2000	Areas, nes			2	438	68	742			Areas, nes
2000	Finland			1750	8149	7187	41985	2437	10709	Argentina
2000	France	0	1123					1125	863	Paraguay
2000	Germany	398	27782	410	30813					
2000	Kyrgyzstan			3437	15000					
2000	Mexico	109	9899	89	10646					
2000	Netherlands	62320	318370	3687	121716					
2000	Russian Federation			18492	86727					
2000	Spain			10812	51203					
2000	USA			1875	13562					
2001	Algeria			2562	12375	24	187			Areas, nes
2001	Finland			10375	48901			49	895	Netherlands
2001	Germany	796	17906	687	19007					
2001	India	17500	34649							
2001	Netherlands	11562	94041	3562	85712					
2001	Russian Federation			3437	16313					
2001	Trinidad and Tobag	5812	28013							
2001	Spain			41886	208962					
2001	USA	3562	139199	13	517					

BRAZIL **Elemental mercury imports and exports**

Data source: UN DESA/ESD/UNSD - Comtrade statistics - downloaded 11Apr2006
Tarif system: SITC rev.2
Tarif code: 52216
Filter: Trade value ≥ $US 0
Comments:

Period	Exporting partner countries			Target country: Brazil				Importing partner countries		
		Reported exports to target country		Reported imports from partner country (on left)		Reported exports to partner country (on right)		Reported imports from target country		
Year	Country name	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Kg mercury	Value ($US)	Country name
2002	Algeria			4500	22136	0	108			Areas, nes
2002	Belgium	5187	13354							
2002	Finland			27531	81292					
2002	France			1	578					
2002	Germany	296	14560	3687	33220					
2002	Netherlands	18519	336379	191	120011					
2002	Russian Federation			2500	12499					
2002	Spain			2000	5291					
2002	United Kingdom			7562	37559					
2002	USA	2000	22500	18917	31630					
2003	Algeria			2750	15495	1	55			Areas, nes
2003	Belgium			3437	19117			140	18100	Netherlands
2003	Finland			7750	42225					
2003	Germany	398	26000	367	28763					
2003	Netherlands	11250	179972	156	165511					
2003	Spain	19421	43594	26175	83822					
2003	United Kingdom			31222	101634					
2003	USA	7187	50149	8875	53488					
2004	Algeria			1750	15212					
2004	Areas, nes			3	41					
2004	France	0	7407							
2004	Germany	199	5000	261	24587					
2004	Japan			6187	53576					
2004	Netherlands	10375	156771	109	199024					
2004	Russian Federation			17250	85298					
2004	Spain	20000	122227	8625	74740					
2004	USA	1750	19949	3625	39938					

Note: Corresponding summaries for other countries can be found at http://www.chem.unep.ch/mercury/Trade-information.htm.

Source: UN DESA/ESD/UNSD Comtrade statistics, downloaded 11 April 2006.

181. The purpose of the summary table is to combine all of the basic statistics for imports and exports of elemental mercury to and from the” target” country during 1995-2005. On the date of 11 April 2006, when these statistics were downloaded from the Comtrade database, the database was observed to be rather incomplete for the year 2005, relatively complete for the year 2004, and quite complete for previous years.

182. The six columns on the left side of this table present mercury flows from other countries into the target country. These six columns include four columns with details of the mercury import flows into the target country – two columns for reported mercury quantity, and two columns for reported mercury value. The rationale for presenting these four columns is quite simple. For a variety of reasons, the trade flow of mercury between the partner country (second column on the left) and the target country may have been recorded (and reported to Comtrade) by the partner country, by the target country, or by both countries. Regardless of which country or countries submitted trade statistics to the Comtrade database, and regardless of the details of the statistics submitted, all statistics concerning mercury flows into the target country are included in the left side of this table.

183. The five columns on the right side of this table list mercury flows from the target country into other countries. These five columns include four columns with details of the mercury export flows from the target country to each partner country (far right column) – two columns for reported mercury quantity, and two columns for reported mercury value. As described above, different countries may have

submitted different sets of trade statistics to Comtrade. Regardless of which country or countries submitted trade statistics to the Comtrade database, and regardless of the details of the statistics submitted, all statistics concerning mercury flows leaving the target country are included in the right side of this table.

184. In some cases the statistics submitted by some trade partners are not the same as those submitted by the target country. If the discrepancies are large, as has sometimes been the case, it could be useful for the reporting agencies of the partner country and the target country to compare their records in order to better understand the details of the mercury trade between their two countries. In the interest of improving its own understanding of global mercury trade and the related statistical challenges, UNEP would be pleased to receive explanations of any such discrepancies investigated by the reporting agencies, as appropriate.

4.3 Regional mercury trade

4.3.1 Value of regional information

185. As mentioned above, an analysis of regional mercury trade is the next step in aggregating commercial flows after specific country flows are reasonably well known. The regional groupings in the table below were developed for this purpose. It should be noted that:

- this is not a political document, and the regional groupings proposed here have no political motivation; they are merely an attempt to be all-inclusive of the countries and regions that appear in the Comtrade statistics (of which some used in this analysis date back to 1995);
- while these regional groupings of countries are not official UN groupings, some of them are similar, but have been adapted to this specific analysis;
- these regional groupings also reflect data availability and/or geographical proximity and/or economic relations between the countries, such as EU-25, North America, etc.; in this sense, some of them also reflect more closely regions used by Comtrade;
- these regional groupings reflect generally similar mercury use profiles within the countries of each region;
- this presentation shows more geographic regions than those used in official UN regional groupings, in order to enhance the value of the analysis;
- the objective is to facilitate the presentation of total imports and exports for each region.

Table 15 Regional country groups, as defined for this report

Region	Countries assumed to be grouped in each region
East and Southeast Asia	Brunei Darussalam, Cambodia, China, China-Hong Kong SAR, China-Macao SAR, Democratic People's Republic of Korea, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Other Asia nes, Papua New Guinea, Philippines, Republic of Korea, Singapore, Thailand, Viet Nam
South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
European Union (EU-25)	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom
Commonwealth of Independent States(CIS) and Other Europe[11]/	Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia Herzegovina, Bulgaria, Croatia, Georgia, Gibraltar, Iceland, Kazakhstan, Kyrgyzstan, Norway, Republic of Moldova, Romania, Russian Federation, Serbia and Montenegro, Switzerland, Tajikistan, The Former Yugoslav Republic of Macedonia, Turkmenistan, Ukraine, Uzbekistan
Middle East	Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Occupied Palestinian Territories, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen
North Africa	Algeria, Egypt, Libya, Morocco, Tunisia
Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Saint Helena, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia,

[11]/ In order to consider the European Union as a single region, the decision was made to include neighboring countries such as Switzerland and Norway in the “CIS and Other Europe” region.

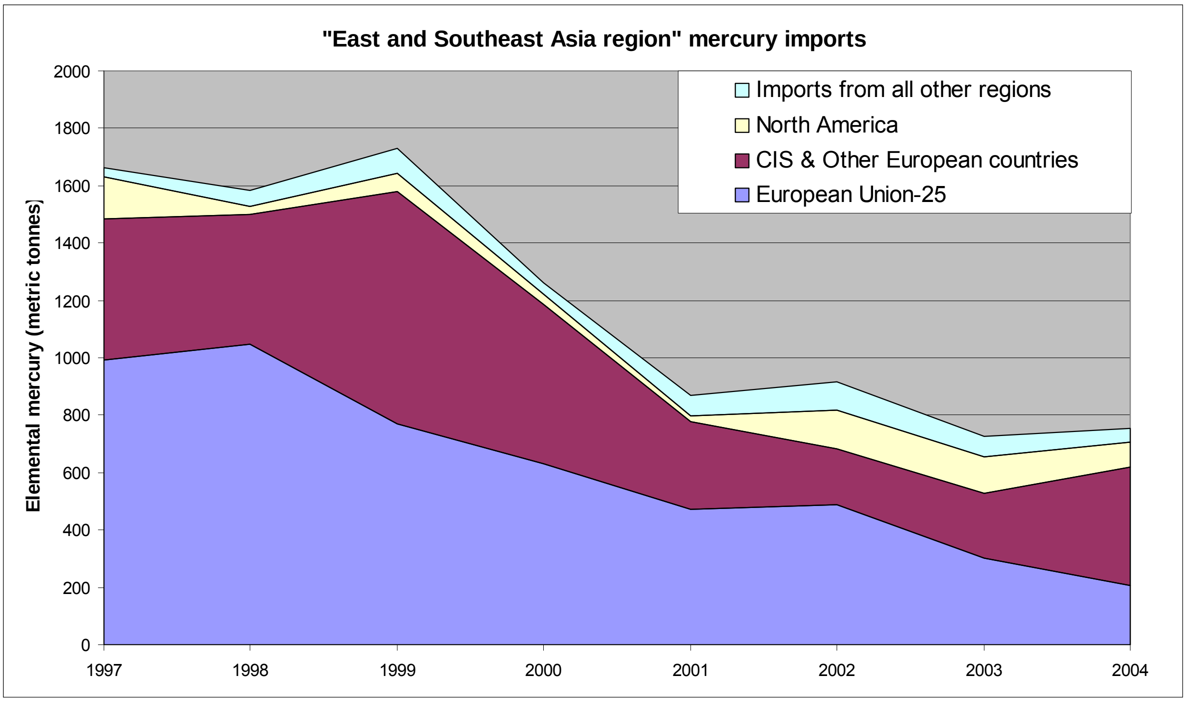
Region	Countries assumed to be grouped in each region
	Zimbabwe
North America	Canada, Greenland, United States of America
Central America and the Caribbean	Anguilla, Antigua, Barbuda, Aruba, Bahamas, Barbados, Belize, British Virgin Islands, Cayman Islands, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Aruba, Nicaragua, Panama, Saint Kitts, Nevis, Anguilla, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, US Virgin Islands
South America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela
Australia, New Zealand and Oceania	Australia, Christmas Islands, Cocos Islands, Cook Islands, Fiji, French Polynesia, Federated States of Micronesia, Kiribati, Marshall Islands, North Mariana Islands, Nauru, New Caledonia, New Zealand, Niue, Norfolk Islands, Palau, Pitcairn, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna Islands

Note: The abbreviation "nes" means "not elsewhere specified," and refers to countries that are not specifically identified for political, commercial or other reasons.

4.3.2 Examples of regional trade movements

186. While this section of the report will not indicate individual country contributions to regional trade flows (these are available through the data compiled for the country trade summaries, as described in the previous section), it will provide some examples of the regional analysis that is made possible using the existing trade statistics. The first example uses data as it relates to the East and Southeast Asia region. Since this region is the main global user of mercury, Figure 7 below shows the main country contributors to this region's mercury imports during the period 1997-2004.

Figure 7 Mercury imports from the world by the "East and Southeast Asia" region

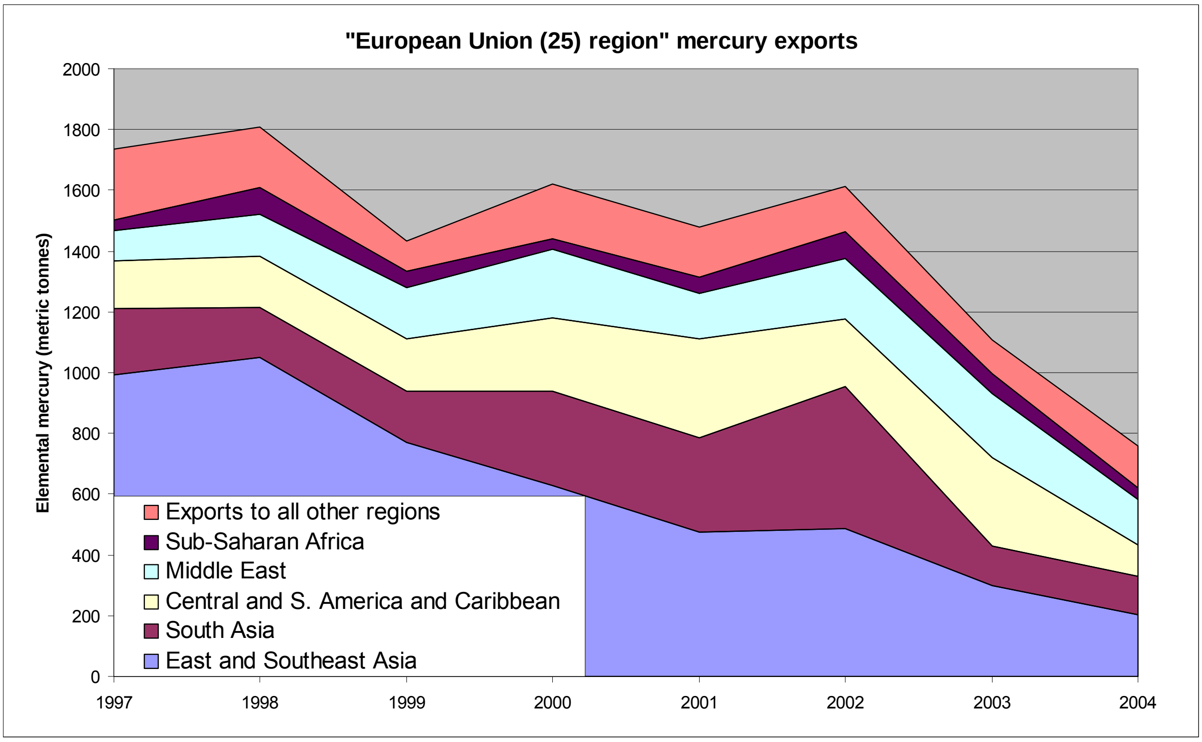


Note: It should be noted that this figure includes some trade flows recorded in the Comtrade database that the importing region did not itself report. These and other discrepancies are discussed in the text, especially at the end of Section 4.1.

Source: UNSD Comtrade statistics, as of April 2006.

187. Likewise, since it is known that the European Union has long been the largest regional exporter of mercury, the following figure shows that the European Union has exported to all major regions of the world. Not surprisingly, the European Union does more business than North America (see Figure 9 below) with Africa and the Middle East. The apparent drop in European Union exports in the last two years is striking, and likely related to the closure of the Almadén mine, and closer scrutiny (by sellers) of buyers and end-uses of mercury.

Figure 8 Mercury exports to the world from the European Union (25 member countries)

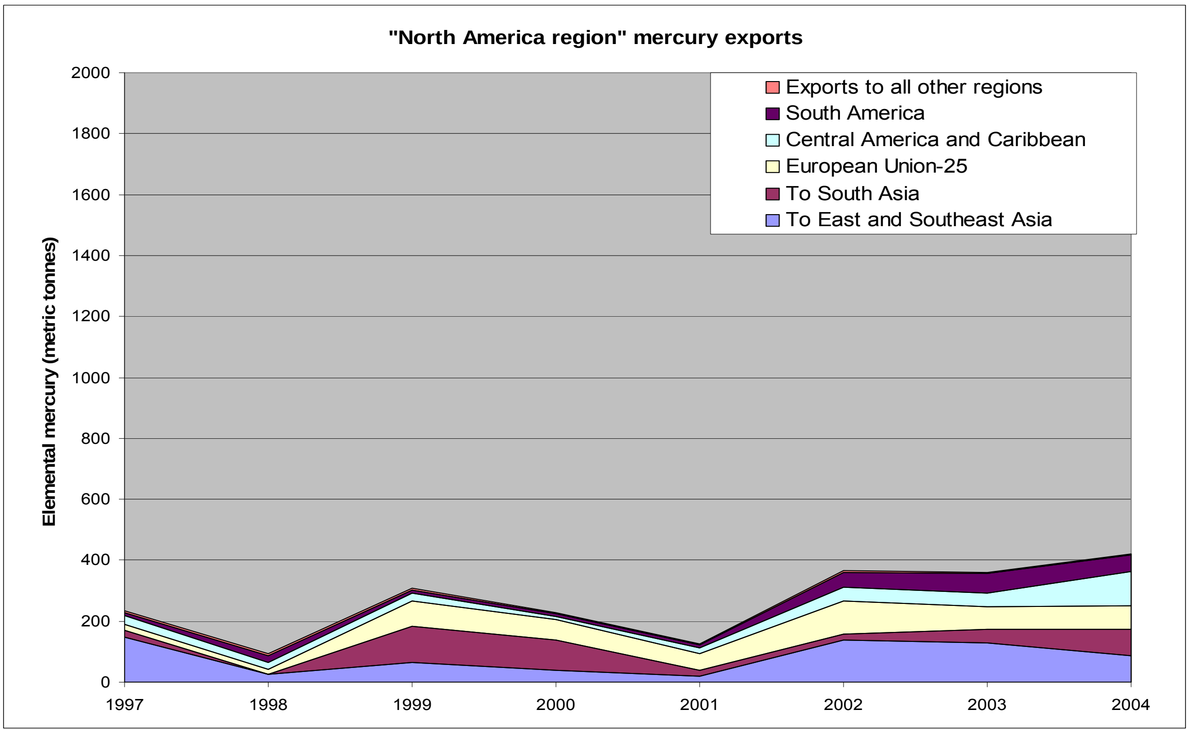


Note: It should be noted that this figure includes some trade flows recorded in the Comtrade database that the exporting region did not itself report. These and other discrepancies are discussed in the text, especially at the end of Section 4.1.

Source: UNSD Comtrade statistics, as of April 2006.

188. As another example, since the data has suggested an increase in recent years in the amount of mercury recovered by industry (especially gold mining companies) in North America, along with increased imports of by-product mercury from mines in South America, combined with reduced domestic consumption, it is interesting to see what other regions are receiving increased North American exports. Comtrade data demonstrates that North America has become the third largest regional exporter of mercury, behind the European Union and the Commonwealth of Independent States (which includes the Kyrgyzstan mercury mine within the region).

Figure 9 Mercury exports to the world from the North American region



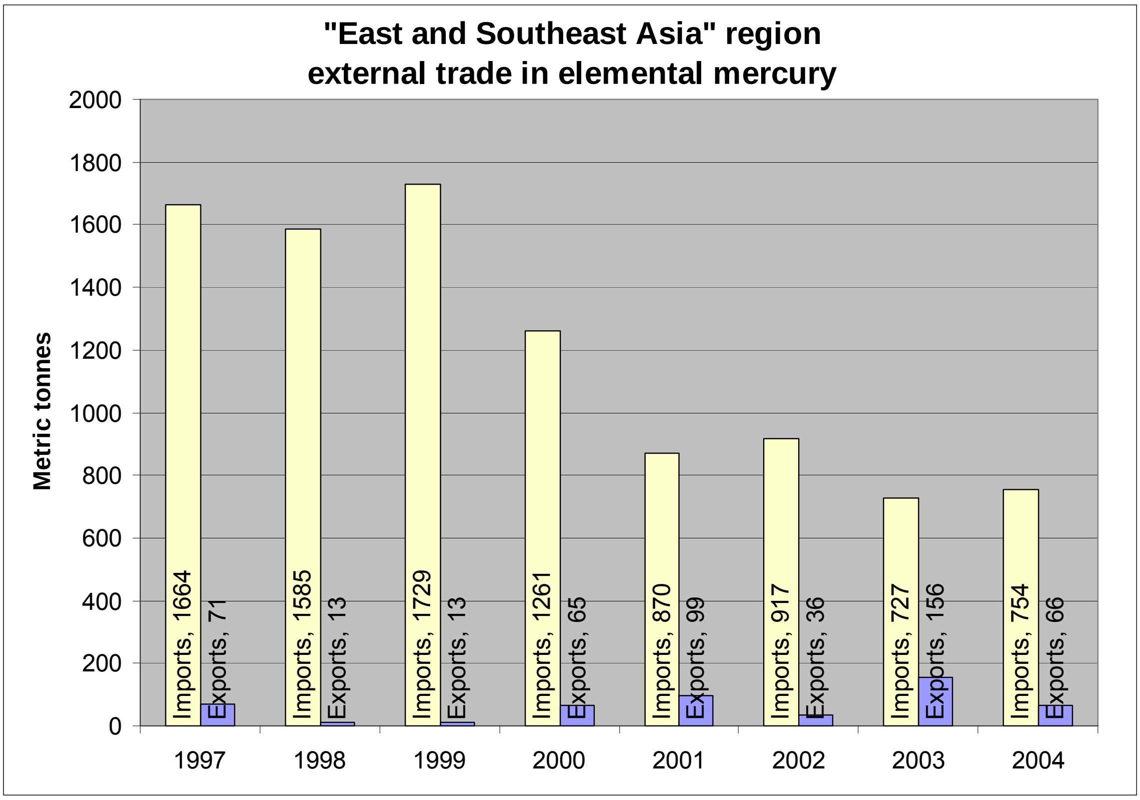
Note: Most of these North American exports were in fact shipped by the United States. It should be noted that this figure includes some trade flows recorded in the Comtrade database that the exporting region did not itself report. These and other discrepancies are discussed in the text, especially at the end of Section 4.1.

Source: UNSD Comtrade statistics, as of April 2006.

189. Finally, as a rough indicator of regional consumption of mercury, the following figure shows simultaneously imports and exports for the East and Southeast Asia region for 1997-2004. In this particular case the figure needs to be further qualified:

- It should be recalled that China has an active mercury mining industry, the output of which is also reportedly mostly consumed domestically; and
- One needs to keep in mind that the Comtrade export data is less complete than the import data, although some attempt has been made to reduce the effect of this difference by consulting the statistics of all other trade partners who report importing mercury from the region.

Figure 10 Mercury imports/exports to/from the East and Southeast Asia region



Note: It should be noted that this figure includes some trade flows recorded in the Comtrade database that the East and Southeast Asia region did not itself report. These and other discrepancies are discussed in the text, especially at the end of Section 4.1.

Source: UNSD Comtrade statistics, as of April 2006.

190. Export, import and combined figures similar to the above are provided in Annex 5 – Regional mercury trade flows for all regions defined here. It should be noted that these figures summarise the consolidated Comtrade mercury trade statistics for the year in question and the regions as defined in this report. For a variety of reasons discussed in the report, the Comtrade statistics pertaining to any given country may also include statistics provided by a country's trade partners. For this reason, the body of Comtrade statistics relevant to the trade of a given country may not be identical to the body of trade statistics as registered in the country's own national database.

4.4 Other observations regarding country and regional trade

191. The 2004 trade report published by the European Commission (Maxson, 2004) documented the large amounts of mercury imported by lower-income countries, and the role of the European Union, especially, as the principal source of supply and/or transit. European Union exports accounted for half of Southeast and East Asia's needs, and virtually all of South Asia's mercury imports. The report observed the already disproportionate demand for mercury in developing countries and countries with economies in transition for artisanal and small-scale gold mining, for batteries no longer considered

acceptable by consumers in many higher-income countries, for the chlor-alkali production process, for thermometers and other measuring devices, etc.

192. This more recent assessment of Comtrade statistics shows that some changes have taken place. However, due to ongoing reductions in mercury use in higher-income countries, mercury use in developing countries and countries with economies in transition is perhaps even more concentrated than in 2000. The European Union (plus Switzerland) remains the largest global exporter of mercury, followed by the CIS region, including Kyrgyzstan, which continues to operate the largest remaining single mercury mine in the world. Within the European Union, the Netherlands (centre of transit operations of the largest European mercury broker) and Spain (former mining centre, and major destination for residual mercury from decommissioned chlor-alkali plants, which is then sold internationally) are jointly responsible for the vast majority of European Union exports. As mentioned above, the United States as well has increased exports of mercury since 2000, partly due to increased recovery of by-product mercury by United States mining operations, and partly due to increased purification and transhipment of by-product mercury coming from some of the large mines in South America.

193. With regard to typical trading partners, Kyrgyzstan for many years supplied mercury mostly to larger Asian and CIS customers, but has more recently sold to brokers in Europe, who have ties to a greater range of smaller customers. European brokers, in turn, tend to supply the majority of demand in Africa and the Middle East, while United States brokers supply most of the demand in Central and South America. These divisions in the global marketplace appear to be based especially on language similarities, geographical proximity and, of course, optimal warehousing and shipping costs.

194. Two graphics are presented below summarizing the available Comtrade statistics showing regional mercury flows for 2004. Table 16 is a global summary of the regional commercial flows of metallic (elemental) mercury, showing quantities flowing into each specified region from other regions, and quantities flowing out. It may be seen that regional inflows of mercury were dominated by over 700 tonnes entering both the East and Southeast Asia region (754 tonnes), and the European Union region (723 tonnes), followed by South Asia, which received just over 300 tonnes. Regional outflows were dominated by over 1000 tonnes flowing out of the "CIS and Other Europe" region, which includes, according to these regional definitions, over 300 tonnes exported from Switzerland[12]/ into the European Union. 758 tonnes were also reported flowing out of the European Union region in 2004, and 420 tonnes reported as leaving North America.

Table 16 Regional trade flows of elemental mercury, 2004

Elemental mercury transfers between regions

Data source:	UN DESA/ESD/UNSD - Comtrade statistics - downloaded 11Apr2006
Tarif system:	SITC rev.2
Tarif code:	52216
Filter:	No filter, all trade included

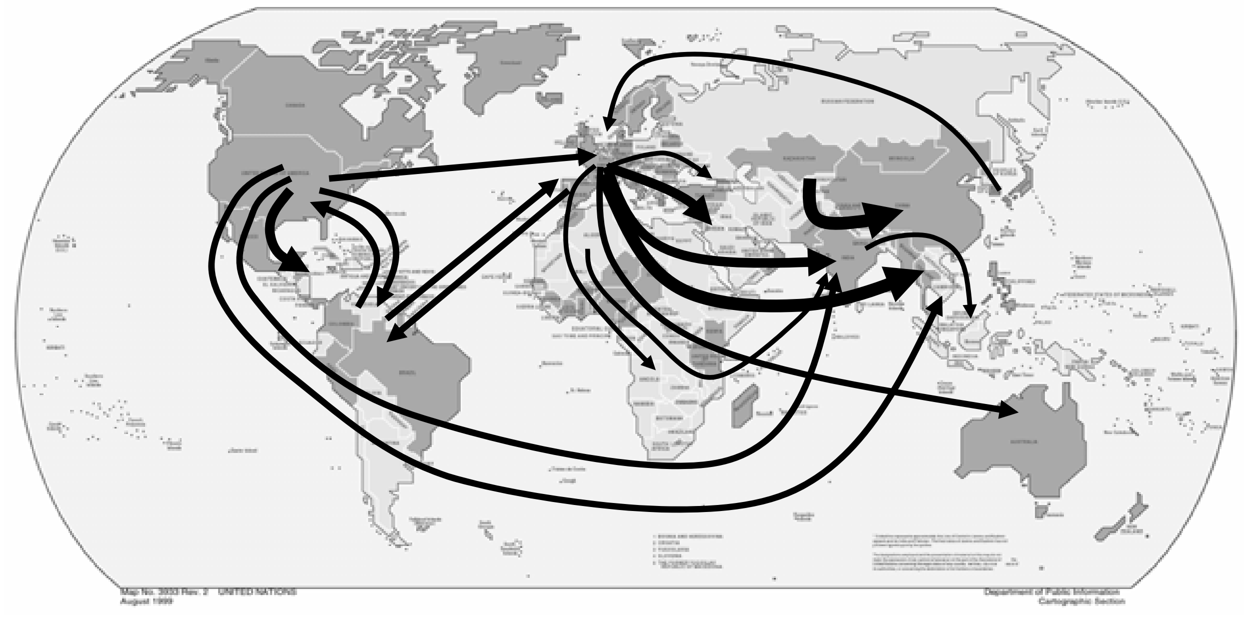
2004	**REPORTED MERCURY TRANSFERS (KILOGRAMMES)**												
	Mercury transported to:												
Mercury transported from this region ?	East and Southeast Asia	South Asia	European Union-25	CIS & Other Europe	Middle East	North Africa	Sub-Saharan Africa	North America	Central America and Caribbean	South America	Australia, N. Zealand and Oceania	Other not specified	Total
East and Southeast Asia		21585	36581	11	550	718	0	0	82	6187	0	38	65752
South Asia	31000		2000	0	12097	0	3812	0	0	0	0	816	49725
European Union-25	204535	128426		32728	152232	3248	38031	27753	6567	94117	58898	11857	758392
CIS & Other Europe	415125	14624	495106		15072	0	1628	48300	0	22187	3	33	1012078
Middle East	0	6000	0	0		0	0	5312	0	0	0	2	11314
North Africa	0	41769	32429	0	0		0	0	0	25574	0	1	99773
Sub-Saharan Africa	0	0	15750	0	0	0		0	0	0	0	129	15879
North America	85500	87616	76084	70	1978	0	78		113841	54341	0	9	419517
Central America and Caribbean	0	0	339	0	0	0	0	27246		0	0	0	27585
South America	0	0	55152	0	0	0	0	97409	0		0	78	152639
Australia, N. Zealand & Oceania	18197	0	9062	0	0	0	0	0	0	0		0	27259
Other not specified	1	105	193	115	0	9	762	44	235	146	10		1620
Total	754358	300125	722696	32924	181929	3975	44311	206064	120725	202552	58911	12963	2641533

Source: Derived from Comtrade statistics. It should be noted that this figure includes some trade flows in the Comtrade database that were reported by some regions but not necessarily confirmed by their trade partners. These and other discrepancies are discussed in the text, especially at the end of Section 4.1.

[12]/ See footnote 11.

Figure 11 presents graphically the major commercial mercury flows shown above for 2004, with different sizes of arrows representing larger and smaller volumes of mercury moving between regions during the year. Once again, the dominance of Western Europe, i.e., the European Union plus Switzerland in this example, is evident in shipping and transhipping mercury to other regions of the world.

Figure 11 Regional trade of elemental mercury, 2004



Source: Derived from Comtrade statistics. It should be noted that this figure includes some trade flows in the Comtrade database that were reported by some regions but not necessarily confirmed by their trade partners. These and other discrepancies are discussed in the text, especially at the end of Section 4.1.

4.5 Discussion of limitations of trade statistics

4.5.1 Typical challenges associated with mercury trade statistics

195. Some of the general challenges associated with trade statistics have been discussed in Sections 2.4 and 4.1.1 above. While commodity trade statistics were not originally intended to be used to monitor global mercury flows, there is no intrinsic reason they cannot make a significant contribution to this objective. However, despite the fact that the vast majority of trade statistics are perfectly viable, and despite the great efforts that go into the compilation of trade statistics by a large number of agencies worldwide, any user of such statistics for monitoring purposes is confronted with two key problems.

1. There is a problem of data gaps, in which information about movements of mercury between two countries is not collected or not reported by one or both countries.
2. And there is a problem of inconsistent data, in which two different reports summarising the same trade between two countries may provide conflicting information.

Data gaps

196. The first problem has been pointed out by a number of countries commenting on a draft version of this report. When all imports and exports to and from reporting countries are combined, one observes, not infrequently, that an export reported by Country A to Country B is not found among Country B's reported imports. Or vice versa, an import reported by Country A from Country B is not found among Country B's reported exports. Some possible explanations for such discrepancies are discussed below. However, until the specific reason for a discrepancy is identified, it is not possible for the analyst to determine whether one of the reports could be mistaken, whether different reporting guidelines are being used, or whether there is another explanation.

197. In analyzing regional trade statistics, the trade volumes represented by data gaps may be significant. For example, taking the cases of the major mercury exporting regions in 2004:

- the trade partners of the "CIS and other European countries" region reported receiving about 15% more mercury than the "CIS and other European countries" region reported as exports;
- the European Union's trade partners reported receiving about 30% more mercury than the EU reported as exports; and
- North America's trade partners reported receiving about 50% more mercury than North America reported as exports.

"Mirror" analysis

198. With regard to the first point, a "mirror" analysis of Comtrade statistics reveals occasionally significant discrepancies in country reporting of mercury trade. For example, if country A reports mercury imports from country B, then theoretically country B should report equivalent exports of mercury to country A. In fact, however, the quantities of mercury reported as traded between countries A and B occasionally do not match. This is not surprising, for a number of reasons discussed below. Furthermore, as most countries are more concerned with the nature of goods that are imported (tariffs are frequently applied) than those that are exported – it may be assumed that imports are scrutinized more closely. Nevertheless, this fact obliges one to pay close attention to both imports and exports reported to Comtrade. Furthermore, when confronted with conflicting statistics from two different countries that claim to represent the same bilateral flow of mercury during a given year, it could be argued that the analyst should perhaps put greater faith in the larger of the two quantities. There are several reasons for this:

- It is evident that some transactions are not reported, and there are a number of possible explanations for this;
- Countries are not likely to report a commercial transaction that didn't take place; and
- The chance of two different countries recording the same transaction in different years, while not impossible, may be assumed to be relatively rare.

199. There are a number of other explanations for inconsistencies in mercury statistics, or for data that may be missing from a trade database, including:

- Late reporting;
- Possible confusion as to whether certain types or shipments of mercury are to be considered as a waste or a commodity;
- Differences among countries as to how they deal with the "country of consignment" when recording trade statistics;[13]/
- Data entry errors and omissions related directly to weight or currency conversions, exacerbated by the lack of harmonisation with regard to trade of certain commodities;
- Smuggling of mercury, or other methods that would prevent a shipment from appearing in formal records;
- Possibly less rigorous reporting of the movement of certain commodities on which no tariff is imposed;
- Certain quantity or value data withheld or concealed by the exporter or importer for "competitive" reasons.

200. However, in spite of these inconveniences, the existing statistics provide a solid foundation for this report's objective of better understanding global mercury movements, and for seeking further clarification. The following discussion may help to clarify some of these areas.

201. Annex 1 – Discrepancies in trade statistics (1) and Annex 2 – Discrepancies in trade statistics (2) provide several examples of inconsistencies and data gaps in mercury trade data. The examples listed in these annexes were chosen at random. During the analysis of data for this report, many more inconsistencies were noted. There is a small chance that occasional inconsistencies may be introduced during treatment of the data by the database administrators, despite the fact that rigorous procedures are in place to minimise any such errors.

Access to trade statistics

[13]/ The "country of consignment" is the last country from which a shipment departed. As an example (that may not in any way reflect the practices of the countries cited), a shipment of mercury from Kyrgyzstan to Estonia may pass through the Russian Federation in transit. The Estonian authorities might record the shipment as "originating" from the Russian Federation rather than from Kyrgyzstan. This is a common practice, and there is no broadly accepted convention that dictates whether the country of origin or the country of consignment should be listed as the "country of origin."

202. Dissemination of statistics normally includes their being made accessible to various governmental agencies, the business community, and the general public. Nine per cent of respondents, however, do not disseminate their statistics either to the business community or to the general public. The main means of dissemination remains publication in monthly, quarterly and annual reports. About 43% of respondents disseminate the statistics through publications as well as via websites – the latter increasing most rapidly in popularity (UNSD, 2003).

National legislation requires mercury trade to be reported

203. Customs Declarations in all countries require reporting of all commodity mercury imported or exported. However, trade statistics for the main mercury compounds are sometimes not reported separately. For example, for the case of mercury oxides, Eurostat publishes the statistics but Comtrade does not. For mercury chlorides, the national statistics are generally included in a broader category of trade, and cannot then be identified specifically as mercury chlorides. Other examples where trade statistics may be less useful in tracking mercury flows involve two main subject areas:

1. The typical cases where products, such as mercury-containing batteries or thermometers, are not required to be identified in the trade statistics as mercury-containing products; and
2. Free trade zones, customs unions, or "single market" regions, where trade between participating countries may be subject to less rigorous reporting than normal customs arrangements.

End-use may not be reported accurately

204. Up to now, there is no evidence that increased scrutiny of mercury imports and exports has led to any less rigorous reporting. On the other hand, there is evidence that in some countries mercury has for some years been imported for one (reported) purpose, such as dental use, and then diverted to another use, such as artisanal gold mining (Veiga and Baker, 2004). In countries where the use of mercury for artisanal or small scale gold mining is illegal, it is not surprising that some individuals might look for a way to circumvent the legal restriction as long as there continues to be a significant demand for mercury from this sector.

5 Global demand for mercury

5.1 Principal uses

205. Through recent history, mercury demand has been marked by new and significant applications that wax and eventually wane several decades later – typically for health and environmental reasons. Prime examples are the use of mercury in paints and batteries. On the other hand, chlor-alkali electrolysis with mercury, in use for more than 100 years, saw maximum demand for mercury in the 1970s. The prime exception, small-scale gold and silver mining with mercury, has been pursued for millennia, and has gone through many cycles of greater and lesser demand for mercury. Apart from the staggering use of mercury for gold and silver mining over this long period, chlor-alkali, paints and batteries have been the biggest users of mercury in the 20th century, all declining steadily since the mid to late 1980s. However, the large and growing use of mercury for VCM/PVC production, discussed below, could soon challenge these other major users for a similar place in history.

206. Demand for mercury has long been widespread, although the global mercury commodity market is relatively small in both tonnage and value of sales. Even though mercury may routinely be traded several times before final "consumption," the available statistics suggest that global yearly trades of mercury and its compounds are probably in the range of USD 100-150 million in value. Most transactions are between private parties and are not publicly reported.

207. Mercury is consumed in a broad range of products and processes around the world. The major categories of mercury demand in higher income countries include:

- Chlor-alkali production;
- Dental amalgams;
- Fever and other thermometers;
- Other measuring and control equipment;
- Mercuric oxide and other batteries;
- Neon, fluorescent tubes, compact fluorescent, HID and other energy-efficient lamps;
- Electrical switches, contacts and relays;
- Laboratory and educational uses.

208. Additional categories of mercury demand more prevalent in, but not exclusive to, lower income countries include:

- Vinyl chloride monomer (VCM) production using the acetylene process and a mercury catalyst;
- Artisanal and small-scale gold mining (ASM);
- Batteries;
- Cosmetics and skin-lightening creams;
- Cultural uses and traditional medicine;
- Paints and pesticides/agricultural chemicals.

209. While continuing its long-term decline in most of the higher income countries, there is evidence that demand for mercury remains relatively robust in many lower income economies, especially South and East Asia (especially mercury use in products, vinyl chloride monomer (VCM) production and artisanal gold mining), and Central and South America (especially mercury use in artisanal and small scale gold mining). At the same time, there are little detailed data pertaining to its end use in many nations. The main factors behind the decrease in mercury demand in the higher income countries are the substantial reduction or substitution of mercury content in regulated products and processes (paints, batteries, pesticides, chlor-alkali, etc.), and a general shift of mercury product manufacturing operations (thermometers, batteries, etc.) from higher income to lower income countries. The major mercury demand sectors are discussed individually below.

5.1.1 Chlor-alkali industry

210. As seen in Table 17 below, the European Union (EU-25) represented in 2005 over 60% of global mercury cell chlor-alkali plant (MCCAP) chlorine production capacity. Another 12% of global MCCAP capacity is based in the United States of America. The efficiency and emissions of the United States plants are roughly comparable to those in the European Union, and to some plants elsewhere. On the other hand, over two million metric tonnes[14]/ of MCCAP capacity are located in countries where management practices and environmental controls are, on average, not as rigorous. While undoubtedly a significant number of these plants have relatively low mercury consumption, there is evidence that average MCCAP mercury consumption and releases (per tonne of production capacity) in most countries are considerably higher than in Europe and the United States of America.

211. In comments to an earlier draft of this report, the World Chlorine Council (WCC) noted its recent work with other chlor-alkali industry associations in Brazil, India, Mexico and Russia, and put forward its calculation of global mercury consumption by the chlor-alkali sector, summarised in Table 17 below. This table presents the WCC position that net mercury consumption by the industry is on the order of 250 tonnes worldwide. "Net mercury consumption" is defined here as net mercury releases to products (chlorine, caustic, etc.), emissions to the air and water, disposal of mercury in wastes, and other mercury losses that are not fully explained (sometimes referred to in mercury balances as "difference-to-balance").

Table 17 World Chlorine Council position on MCCAP mercury consumption (2005)

Country/region	Mercury cell Cl_2 capacity (metric tonnes/year)	Percentage of global mercury cell chlorine production capacity	Mercury net consumption (g/tonne Cl_2 capacity)	Mercury net consumption total (metric tonnes)
Europe	5,824,000	62%	25.18	147
United States of America	1,108,000	12%	8.46	9
Brazil	341,000	4%	7.66	3
India	428,000	5%	33.81	14
Russia	430,000	5%	incl. in "other"	incl. in "other"
Other MCCAPs	1,251,000	13%	45.75	77
Total	**9,382,000**	**100%**		**250**

Source: WCC comments (2006).

212. The WCC provided documentation supporting its position, which included industry-generated plant-by-plant mercury consumption and emissions data for nearly all European and United States

[14]/ This refers to the plants' chlorine production capacity, not to a quantity of mercury.

plants, and considerably less (consolidated) industry-generated data with regard to the MCCAPs in other regions (WCC comments, 2006). The author subsequently consulted a number of independent assessments, contacted specialists in these different regions, and carried out an extensive analysis of the available information. While the author concedes that any characterization of the global industry is difficult, and any calculation of mercury consumption, even for a single MCCAP, involves a series of estimates and extrapolations, the following observations may be made.

213. It seems reasonable to accept the estimates of mercury consumption by **European** operators, although this an evolving industry, in that the number of MCCAPs and capacity at the beginning of 2005 are not the same as at the end of 2005. It is clear there are ongoing efforts to improve plant efficiencies and reduce mercury releases, and it is expected that 2006 will show further improvements. On the other hand, the "difference-to-balance" estimates of mercury releases are quite high relative to reported emissions, there is little independent scrutiny of reports, there is no publicly reported data on mercury recovered from wastes, adequate estimates of the quantities of mercury disposed of in waste are difficult to come by, and there are a number of concerns about the quality of some of the data reported by industry.

214. MCCAPs in the **United States of America** are legally obligated to recover most mercury from wastes, but the US EPA Toxics Release Inventory (TRI) reports[15]/ of mercury recovered ("retorted") from wastes are not credible for at least one of the eight USA plants,[16] and conflict with estimates provided by the US-based Chlorine Institute.[17]/ In several of the US MCCAPs, some of the reported emissions are legally defined estimates – neither measured nor controlled. Therefore estimates of total Hg consumption should preferably be based as well on other sources of information. Furthermore, on average the US industry routinely purchases three times the amount of mercury it claims to consume. Nevertheless, for purposes of this analysis, one must assume that overall US reports of Hg consumption and losses unaccounted for are the best available, and recognize that they should at least be averaged over several years.

215. **Russia** reportedly had three or four MCCAPs operating in 2005, of which one closed in 2005 or 2006. Russia deserves credit for agreeing to do mercury audits (for the first time in 2005), along the lines of those carried out in Europe, the US, India and Brazil. Russia has made a concerted effort to lower emissions and improve mercury balance accounting. Annual reports (if any) have not been made public in previous years, the present reports are not complete (purchases, consumption, etc. missing), and they are not independently verified, but the estimated industry consumption based on the Russian report for 2005, compared to an independent assessment in 2002 (Lassen *et al.*, 2004), suggests an approximate 50% decrease in (net) Hg consumption over three years. Averaging Hg consumption over several years is not possible due to lack of previous annual reporting.

216. **India** has, at the end of 2006, ten mostly small MCCAPs operating after another closed or converted earlier in 2006. There is reported to be an industry voluntary agreement for the rest of the MCCAPs to close by 2012, but there is no legal commitment. Indian industry has compiled consumption and emissions data for a number of years, apparently including most of the MCCAPs. An independent detailed study carried out a few years ago (CSE, 2002) showed high levels of mercury consumption, after which the industry has reported that consumption decreased by more than 60% in three years, 2002-2005. Lacking independent confirmation, and in light of the very large amounts of mercury releases unaccounted for during 2002-2005, the average reported mercury consumption during 2002-2005 is probably a reliable guide for estimating 2005 consumption.

217. **Brazil** has two plants with perhaps close to top-level performance, and three believed to have higher consumption and releases. As above, improved efforts among MCCAP operators are reliably reported by government and industry, but there is no independent assessment of emissions or mass balances, and reported mercury consumption for 2005, which shows greater than 75% decrease in three years (2002-5), is not credible as the total "unaccounted for" mercury losses during 2002-5 are about twice the reported 2002-5 consumption. By contrast, in Russia and India the "unaccounted for" mercury losses during 2002-5 are about one-half the reported 2002-5 consumption. Therefore, at present, it may reasonably be assumed that Brazil's MCCAP mercury consumption (per unit chlorine production capacity) is, on average, higher than that in Europe, although probably lower than that in India and Russia.

218. The World Chlorine Council preliminary list of **Other MCCAPs** reported 46 MCCAPs in other countries than those discussed above, with 1.25 million tonnes chlorine capacity (WCC comments, 2006), which WCC said they are in the process of trying to confirm. Separately, WCC (2006) has

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[15]/ Available at http://www.epa.gov/enviro/html/tris/
[16]/ PPG Industries, New Martinsville, West Virginia – TRI data accessed on 22 October 2006.
[17]/ Personal communication with Mr. Art Dungan, Chlorine Institute.

reported to UNEP an estimated 135 MCCAPs worldwide, which implies about 60 "other" MCCAPs. Independent sources such as SRIC (2005) have also identified about 60 “other” MCCAPs with a total estimated chlorine production capacity of 1.75 million tonnes. The operational status of some of these plants has not been confirmed, so we have estimated here about 1.6 million tonnes capacity for these “other” MCCAPs. This gives a global MCCAP capacity of 9.7 million tonnes, which is quite close to the WCC estimate of 9.5 million tonnes in 2005 (WCC comments, 2006). With some knowledge of the releases and emissions of a number of these MCCAPs that have undergone some independent assessment in the past, few of which do any mass balance reporting, and mercury release estimates are prepared with little independent oversight, it is estimated that (net) mercury consumption of these “other” MCCAPs averages better than the estimated Russian level of 2002 (over 150 g Hg/t Cl2 capacity), but probably not yet as good as the estimated Russian performance of 2005 (see “Russia” discussion above).

These observations and few alternative assumptions, in contrast to the WCC position presented in Table 17 above, suggest the MCCAP mercury consumption ranges shown in Table 18 below, which are used to derive industry mercury consumption numbers used elsewhere in this report. They suggest that the actual level of “net” mercury consumption by MCCAPs in 2005 was probably on the order of 350-400 tonnes. Beyond that figure, as in Table 18, there were an additional 90-140 tonnes of mercury in wastes that were recycled to recover the mercury, implying “gross” global mercury consumption by the chlor-alkali industry of 450-550 tonnes.

Table 18 Global chlorine production capacity and MCCAP mercury consumption (2005)

Country/region	Mercury cell Cl_2 capacity (metric tonnes/year)	Mercury net consumption (g/tonne Cl_2 capacity)	Mercury total net consumption (metric tonnes)	Mercury recycled and recovered from waste (metric tonnes)	Mercury total consumption (metric tonnes)
Europe	5,824,000	25.18	147	25-40	175-190
United States of America	1,108,000	8.46	9	35-60	45-70
Brazil	341,000	32-44	10-15	0-5	11-25
India	428,000	47-65	20-28	0-5	20-35
Russia	430,000	58-105	25-45	0-5	25-50
Other MCCAPs	1,600,000	75-113	120-180	10-40	140-210
Total	**9,731,000**		**350-430**	**90-140**	**450-550**

Sources: Calculations based on European industry reports to Euro Chlor (www.eurochlor.org), Chlorine Institute reports to the US EPA (www.chlorineinstitute.com), UNEP (2002), U.S. EPA Toxics Release Inventory reports, WCC comments (2006), SRIC (2005), Maxson (2004), Lassen *et al.* (2004) and CSE (2002), as cited in the text.

219. In order to put these numbers in context, now that the demand for mercury in batteries has dropped significantly, only VCM/PVC production, and the artisanal and small-scale gold mining (ASM) sector consume more mercury than the chlor-alkali industry.

5.1.2 Artisanal and small-scale gold mining

220. According to the UNIDO/UNDP/GEF Global Mercury Project (see report attached as Annex 3), at least 100 million people in over 55 countries depend on ASM for their livelihood, mainly in Africa, Asia and South America. ASM produces 20-30% of the world’s gold production, or approximately 500-800 tonnes per annum. It involves an estimated 10-15 million miners, including 4.5 million women and 1 million children. This type of mining relies on rudimentary methods and technologies and is often performed by miners with little or no economic capital who operate in the informal economic sector, often illegally and with little organization. As mercury amalgamation is an inexpensive, quick and simple way to extract gold particles, it is currently the method most commonly used in ASM.[18]/

221. As a consequence of poor practices, mercury amalgamation in ASM results in the consumption and release of an estimated 650 to 1000 tonnes of mercury per annum, equivalent to perhaps one-third of all global anthropogenic (human-caused) mercury releases into the environment. This makes ASM the single largest “intentional-use” source of mercury pollution in the world. In addition to the severe

[18]/ It should be noted that not all artisanal/small scale gold miners use mercury. Some use cyanide, permitting more gold to be recovered than when using mercury. Others use gravimetric methods without mercury or cyanide.

occupational hazards associated with mercury use, ASM has generated thousands of polluted sites with impacts extending far beyond localized ecological degradation, often presenting serious, long-term environmental health hazards to populations living near and downstream of mining regions. In addition to domestic pollution impacts, ASM air emissions contribute to the global atmospheric pool, while the discharge of tailings contaminates international waters (see Annex 3 and Veiga *et al.*, 2006).

222. Though large-scale gold mine operations have phased out mercury use by adopting alternative technologies, mercury demand in ASM continues to increase. With the spot market price of gold rising from US$260/oz in March 2001 to US$725 in May 2006, a gold rush involving poverty-driven miners is being observed in many countries. This increase in mining activity is compounded by escalating poverty due to factors such as the failure of subsistence economies, the displacement of populations in areas of conflict, and the ravages of diseases such as HIV/AIDS (see Annex 3).

223. The highest ASM mercury consumption levels appear to be in China (with 200 to 250 tonnes consumed and released), followed by Indonesia (100 to 150 tonnes), and between 10 and 30 tonnes in each of Brazil, Bolivia, Colombia (Colombia comments, 2006), Ecuador, Ghana, Peru, Philippines, Venezuela, Tanzania and Zimbabwe. Mercury may be used to varying degrees in as many as 40 other countries as well (see Annex 3).

224. According to its report, the GMP believes it could be possible to achieve at least a 50% reduction of mercury consumption in ASM by 2017. As called for by the GMP, this goal can be achieved if the main stakeholders support strategies that will help ASM communities to:

- eliminate amalgamation of "whole ore" by introducing a mercury-free concentration process prior to amalgamation;
- reduce mercury use in the amalgamation of concentrates through closed circuit process, so that mercury is always recycled;
- eliminate the burning of mercury without the use of a retort; the retort serves to contain emissions and thereby allow recycling;
- introduce completely mercury free techniques where feasible, beginning with "alluvial" ores, from which gold may be readily recovered without the use of mercury.

225. The GMP further stresses the primordial importance of economic signals in achieving the targeted reductions in ASM mercury consumption. A high mercury price, while not a magic solution to the mercury problem, has been observed to promote more efficient use of mercury at ASM sites – sometimes a complete shift to mercury-free techniques – and reduced emissions. Education campaigns about the health risks of mercury, and other initiatives, while important, have not been sufficient to broadly reduce mercury use in the face of growing numbers of miners.

226. Likewise, a drastic fall in the market price of gold would greatly reduce the extent of ASM activities as well as their consumption of mercury, because most ASM costs are for daily mining and smelting operations, and a significantly lower gold price would not provide the cash to cover these costs in many mining locations.

5.1.3 Batteries

227. Previous estimates (Maxson, 2004), based on trade data, of high mercury demand for batteries, especially in China, have recently been more closely investigated. While mercury use in Chinese batteries was confirmed to have been quite high through 2000, most Chinese manufacturers have now shifted to lower mercury designs, following commercial trends and customer demand in other parts of the world (NRDC, 2006). However, there are still vast quantities (tens of billions) of batteries with relatively low mercury content produced in China,[19]/ and probably other countries as well. Moreover, Comtrade statistics reveal that there continues to be a reduced, but still significant, trade in mercuric oxide batteries, some produced in China, and many more apparently produced in Customs-free trade zones on Chinese territory (NRDC, 2006). Therefore, the global consumption of mercury in batteries still appears to number in the hundreds of metric tonnes annually, and consideration should thus be given to collecting battery waste in all countries, to the extent possible, and making sure it goes to recycling or proper disposal.

228. It appears that there also remain a large number of button cell batteries manufactured in many different countries, containing typically 1-2% mercury. This manufacture will eventually be replaced by

[19]/ For just one type of battery, the D-size "paste battery," the known Chinese production in 2004 was 9.349 billion batteries. The authors (NRDC, 2006) estimated mercury chloride consumption for these batteries at 47.11 tonnes, with an estimated mercury content of 34.91 tonnes. The battery label claims less than 250 ppm mercury content.

mercury-free button cells,[20]/ but for the moment these batteries, also produced in the tens of billions, consume significant amounts of mercury.

5.1.4 Vinyl chloride monomer (VCM) production

229. The previously mentioned investigations in China (see Section 3.1.7.1) have confirmed (for 2004) the demand of more than 600 metric tonnes of mercury per year, in the form of a much greater quantity of mercuric chloride, for catalysts for vinyl chloride monomer (VCM) production. This use of mercury is visibly increasing as the Chinese economy booms, and as Chinese demand for PVC end-products increases (NRDC, 2006; Tsinghua, 2006). Meanwhile, the hospital use of PVC is declining in various parts of the world due to concerns about possible health effects, added softeners, etc. (HCWH, 2004; NRDC, 2006; WSJ, 2006).

5.1.5 Measuring and control devices

230. There is a rather wide selection of mercury containing measuring and control devices, including thermometers, barometers, manometers, etc., still manufactured in various parts of the world. Tsinghua University has calculated that China alone may still consume 180 tonnes of mercury annually in the production of measuring devices (Tsinghua, 2006), although most international suppliers now offer mercury-free alternatives as well. European legislation, among others, is being developed to phase out such mercury equipment, and to promote mercury-free alternatives.

5.1.6 Electrical and electronic devices

231. Due to the RoHS Directive in Europe, and similar initiatives in California and Japan, among others, mercury-free substitutes for mercury switches, relays, etc., are being actively promoted.[21]/ At the same time, the Interstate Mercury Education and Reduction Clearinghouse (IMERC) database[22]/ indicates that mercury use in these devices remains significant, as confirmed by NRDC comments (2006).

5.1.7 Dental uses

232. In many higher income countries, dental use of mercury is now declining (Finland comments, 2006; ADA comments, 2006). The main alternatives are composites (most common), glass ionomers and compomers (modified composites). However, the speed of decline varies widely, so that mercury use is still significant in most countries, while in some countries it has almost ceased. In many lower income countries, changing diets and better access to dental care may actually increase mercury use temporarily, especially where the cost of treatment is most critical.

233. Most dental practitioners charge less for mercury amalgams than for the alternatives, although there are “downstream” costs to society. For example, it has been estimated in the United States of America that dental mercury typically contributes 50% of the mercury load to wastewater (ADA, 2003; CCSD, 2006). Among others, Sweden, Japan, Denmark and Finland have implemented measures to greatly reduce the use of dental amalgams containing mercury. Most countries and water authorities do not yet require dental practices to install amalgam separators or other devices to keep mercury out of the wastewater stream, and even where they do, the results can sometimes be less than satisfactory (Hylander, 2006). In many countries, dental practitioners have been relatively slow to change long-standing methods of treatment, many of them perhaps not convinced of compelling reasons to do so.[23]/

5.1.8 Mercury lamps

234. Mercury containing (fluorescent tubes, compact fluorescent, etc.) lamps remain the standard for energy-efficient lamps, where ongoing industry efforts to reduce the amount of mercury in each lamp are countered, to some extent, by the ever-increasing number of energy-efficient lamps purchased and

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[20]/ The National Electrical Manufacturers’ Association in the USA has called for a phase-out of all mercury in button cell batteries in the USA by 2011.

[21]/ For California, see http://www.dtsc.ca.gov/HazardousWaste/EWaste/.
For Korea’s RoHS/WEEE/ELV-like legislation called "The Act for Resource Recycling of Electrical/Electronic Products and Automobiles,” see
http://www.europeanleadfree.net/pooled/articles/BF_NEWSART/view.asp?Q=BF_NEWSART_195645.
For Japan, see http://www.jeita.or.jp/index.htm;
also http://uk.farnell.com/jsp/bespoke/bespoke8.jsp?bespokepage=farnell/en/rohs/rohs/facts.jsp.

[22]/ All suppliers of mercury containing products to the northeastern United States are required to file annual reports, as described in http://www.newmoa.org.

[23]/ In the United States of America, most dentists rely on the American Dental Association (ADA) for professional advice. In comments submitted to a draft version of this report, the ADA repeated its core message to U.S. dentists – that dental amalgams are safe, and any environmental impact is small (ADA comments, 2006).

installed around the world. There are indications that mercury-free alternatives will become available in the coming years, but for most applications the alternatives are still quite limited and/or quite expensive.

5.2 Summary of global demand

235. In total, global demand for mercury is summarised in Table 19 below, together with estimated ranges of uncertainty.

Table 19 Global mercury demand by sector (2005)

Global mercury demand (2005)	**Metric tonnes**
Small-scale/artisanal gold mining	650-1,000
Vinyl chloride monomer (VCM) production	600-800
Chlor-alkali production	450-550
Batteries	300-600
Dental use	240-300
Measuring and control devices	150-350
Lighting	100-150
Electrical and electronic devices	150-350
Other (paints, laboratory, pharmaceutical, cultural/traditional uses, etc.)	30-60
Total	**3,000-3,900**
Note: “Demand” may also be termed “gross consumption,” and is here defined as total annual throughput of mercury for each of these sectors. In each of these sectors some mercury recycling takes place, involving the recovery of mercury from products or wastes. Therefore, “net consumption” of mercury in any of these sectors may be significantly lower than “gross consumption.”	

Sources: Euro Chlor (http://www.eurochlor.org/), Maxson (2004, 2005, 2006), NRDC comments (2006), GMP (2006).

236. Largely as a result of increasing awareness and regulation, the global demand for mercury has declined from more than 9,000 metric tonnes annual average in the 1960s, to just under 7,000 metric tonnes in the 1980s, and less than 4,000 metric tonnes since the late 1990s.[24]/ In 2005, global demand for mercury, on the strength of high gold prices and related strong mercury demand for artisanal and small-scale gold mining, remained in the vicinity of 3,000-3,900 metric tonnes per year, as seen in the table above. Global mercury demand (and estimated supply), broken down by geographical region, is estimated in Table 20 below.

237. It is evident from both of these tables, based on an extensive review of published and other sources, that any measures that might be taken by national and regional authorities to improve the accuracy of the information on mercury uses would significantly aid future policy development and monitoring.

[24]/ Historical mercury demand through the 1990s is based on mercury production data compiled by Hylander and Meili (2003).

Table 20 Global mercury demand (and supply) by region (2005)

Elemental mercury, 2005	**Regional demand** (metric tonnes)	**Regional supply** (metric tonnes)
East and Southeast Asia	1,600-1,900	900-1,300
South Asia	300-500	100-200
European Union (25 countries)	400-480	400-800
CIS and other European countries	150-230	800-1,200
Middle Eastern States	50-100	0-50
North Africa	30-50	0-50
Sub-Saharan Africa	50-120	0-50
North America	200-240	300-500
Central America and the Caribbean	40-80	20-100
South America	140-200	100-200
Australia, New Zealand and Oceania	20-40	0-50
TOTAL	**3,000-3,900**	**3,000-3,800**

Sources: Maxson (2004, 2006), NRDC (2006), UNDESA/SD Comtrade (2006) statistics.

5.3 Future demand

238. This section describes the possible evolution of global mercury demand over the next five to ten years. During the next five years, the rate of decline in mercury demand will depend primarily upon reductions in the battery, electrical product, and measuring device manufacturing sectors; dental use; and chlor-alkali facilities. These sectors represent the greatest potential for short-term declines because the alternative mercury-free technologies or products are readily available, and are of equal or better quality. For these sectors, the challenges are not technical, but rather related to the extent of encouragement offered by key countries or regions through financial assistance, and legal or voluntary mechanisms such as those discussed in Section 6. In comparison, small-scale gold mining presents a major challenge during the next 5-10 years, is more sensitive to the influence of higher mercury prices or supply constraints, and presents a further major challenge beyond that time-frame. Finally, VCM manufacturing is more appropriately a mid- to long-term challenge, with no easy solutions in sight, although mercury releases can likely be greatly reduced.

239. Due to the uncertainties in the type and extent of future incentives that may be put in place to encourage reductions in mercury supply and demand, two scenarios have been developed to assess possible reductions in mercury demand over the next ten years. The first scenario represents the "status quo," and assumes that few measures that are not already in place will be introduced during the next ten years. The second scenario represents a more "focused mercury reduction" strategy, in which the key countries and companies involved identify mercury demand reduction as a clear priority, and adopt the more obvious measures necessary to move significantly toward that objective. The basic assumptions comprising these two scenarios are presented in Table 21.

Table 21 Two scenarios of future mercury demand, 2005-2015

"Status quo" scenario	***"Focused mercury reduction" scenario***
Chlor-alkali production – As described in Section 3.3, around 10 million metric tonnes of chlorine capacity in 2005 may be expected to decrease to less than 4 million metric tonnes capacity by 2020. Therefore, 500+ metric tonnes of total mercury consumption during 2005 may be expected to decrease to some 350 metric tonnes of mercury by 2015, keeping in mind that the average plant that closes may well consume less mercury per tonne of production capacity than those that stay open. Note also that mercury "consumption" here represents all mercury pathways to emissions, chemical products, "unexplained" (or "difference-to-balance") releases and wastes; some of the wastes are later retorted or recycled to recover mercury.	**Chlor-alkali production** – The report elsewhere identifies financial incentives as an important ingredient to encouraging the transition of this sector. The broader introduction of such an incentive, expanded efforts to bring "best practice" to reducing mercury releases of facilities worldwide, and other measures could result in mercury consumption as low as 250 tonnes by 2015. In addition, an aggressive policy of mercury recycling and recovery, especially from wastes, as is mandated in the United States of America, would further reduce the net mercury consumption of the sector.
Batteries – Battery producers have shown a willingness to respond to market demands for batteries with a reduced mercury content. As described in NRDC (2006), implementation of Chinese and other legislation to further reduce the mercury content of batteries (despite a possible ongoing demand for mercuric oxide batteries from military or medical customers) may be expected to reduce mercury demand from an estimated 400 metric tonnes in 2005 to 200 metric tonnes or perhaps much less by 2015.	**Batteries** – The majority of the mercury now used in this sector is for button cell battery production, thus the pace of the transition to mercury free button cells will determine the extent of mercury demand reduction for this sector. With U.S.A. manufacturers already committed to producing only mercury free button cells by 2011, the major question is when manufacturers in the European Union, China, and Japan will follow suit. Given the highly competitive nature of battery manufacturing, the likely regulatory pressures that will be placed on this sector, and China's active consideration of new standards for this product, one might predict that the major battery manufacturers will make this transition by 2015, thus reducing annual mercury consumption for this sector to less than 100 tonnes.

"Status quo" scenario	*"Focused mercury reduction" scenario*
Dental uses – Composite and other materials are now widely available as substitutes for the increasingly controversial, mercury-containing "silver" amalgam dental filling. Advances in mercury free dental care, and reductions in mercury use in many countries will be offset by improved dental care in others, including likely increased use of low-priced mercury amalgam fillings, at least in the near to medium term. While aesthetic considerations may encourage whiter fillings, and new materials will gradually come on the market, it is possible there may be little or no reduction in dental mercury use by 2015. One must also keep in mind that diets are changing in much of Asia and Africa, accompanied by a greatly increased consumption of sugar, which could also bring an increasing number of citizens in search of dental treatment.	**Dental uses** – Even in the event of an increased number of people worldwide seeking dental care, it is possible to consider a range of incentives that may encourage a global reduction in dental mercury use during the next 10 years. However, there are presently no significant trends or international initiatives that point in that direction. Even lacking such concerted efforts, however, it is certain that the cost of alternative dental fillings will continue to decrease, and the aesthetic advantages of non-mercury fillings will become better recognized.
Measuring and control devices – Mercury-containing thermometers, one of the most visible uses of mercury, are being gradually replaced by digital thermometers, or thermometers using "galistan," an alloy of gallium, indium, and tin, etc. (Pennsylvania Department of Environmental Protection, 2004). Encouraged by such programs as Health Care Without Harm,[25]/ and a pending European Union Directive to phase out the sale and use of certain mercury containing measuring and control devices, the increasing trend is for users to request, and for producers to supply, mercury-free devices. A reduction in mercury use in this category of some 50% worldwide by 2015 might therefore be foreseen.	**Measuring and control devices** – In addition to the initiatives mentioned to the left, other measures being taken by many of the states in the United States of America, and the impact of activities worldwide aimed at reducing mercury use in the health care sector could lead one to predict a reduction in mercury use in this sector of 60-70% or more during the next ten years.
Lighting – Mercury-free alternatives to energy-efficient lamps are appearing, but the range of applications remains very limited. While the mercury content of the average lamp continues to decline, and the European Union's RoHS Directive has placed limits on the mercury content, the demand for energy-efficient lighting increases, especially as energy prices continue to climb. Overall, therefore, no noticeable reduction in mercury consumption for this application may be assumed by 2015.	**Lighting** – With other countries expected to adopt similar legislation to RoHS, the mercury limits imposed by the European Union could spread much more widely. In the event that a wide range of LED or similar energy-efficient mercury-free lamps also come onto the market rapidly at prices that consumers find acceptable, one could conceive of a 20%+ reduction in mercury use in this sector by 2015. However, there are presently no particular signs of a rapid influx of LED or other energy-efficient mercury-free lamps .

[25]/ Information on Health Care Without Harm (HCWH) activities to promote non-mercury alternatives in the health care sector may be found at http://www.noharm.org/europe/mercury/contents.

"Status quo" scenario	*"Focused mercury reduction" scenario*
Electrical and electronic equipment – The impact of the European Union and similar legislation banning the use of mercury in electrical and electronic devices after 1 July 2006 may be even more significant than the reductions of mercury in measuring and control devices, especially before 2010, with a continued, but more gradual, reduction likely after 2010. Therefore, one might anticipate a global reduction of 60% or more over 10 years.	**Electrical and electronic equipment** – If one assumes that the European Union RoHS Directive is influencing the global market, as key producers develop similar legislation over the next several years, an even greater reduction in worldwide mercury use in this sector could be conceivable. However, such a reduction would depend strongly on the extent to which China eventually implements RoHS legislation, which cannot be lightly assumed.[26]/
Other uses – General trends suggest that other demands for mercury might decrease gradually, but past experience suggests caution. New uses for mercury sometimes appear, especially when the mercury price is low, and other uses that may have been going on for many years are occasionally newly identified.	**Other uses** – This sector is too diverse to predict significant reductions over 10 years. However, one might assume that the more attention is devoted to mercury awareness and reduction in other sectors, the more reduction of mercury in these "other uses" might also be expected. Furthermore, legislation against selling newly developed products containing mercury has been introduced in Sweden, and will increasingly be implemented elsewhere as more nations move to eliminate most mercury uses.
Artisanal and small-scale gold mining – The use of mercury for artisanal gold mining in many parts of the world will continue. In the near term, high gold prices are expected to draw more miners into the ASM sector and increase mercury demand for use in artisanal mining. At the same time, high gold prices may also be expected to stimulate activities of larger mines and related by-product mercury production. Beyond that, the informal mining sector is very difficult to predict. While ASM activity appears to be increasing, there are signs that the high price of mercury has already encouraged some miners to seek ways to use mercury more efficiently, or not at all. Therefore, one might hope that total mercury use in ASM may not increase much above its present high level. Based upon experience during the last five years, if the mercury market price is above USD 25/kilogram, there will be further ASM efforts to use mercury more efficiently; if the mercury market price is below USD 10/kilogram, there will be far less attention devoted to such measures, in spite of the considerable efforts of UNIDO and other field programs.	**Artisanal and small-scale gold mining** – According to the Global Mercury Project report (Annex 3), global commitments are critically needed to address the major ASM challenges – from community-level issues such as technologies and gender inequities, to broader policies such as international mercury export controls and policies to improve regulation and assistance in the ASM sector. The GMP report has estimated that between 30% and 50% of the total amounts of mercury annually used in ASM are not necessary, and discontinued use would not adversely affect gold production by miners. They have concluded that, with appropriate supply restrictions and other measures in place, it could be possible to achieve at least a 50% reduction of mercury consumption (demand) in ASM by 2017. The GMP report stressed that economic signals remain, at least for now, the most effective means of changing ASM behavior with regard to mercury use.

[26]/ See footnote 21. China is expected to enact RoHS-type legislation in 2007 (see http://www.greensupplyline.com/howto/175803063), but there are some doubts about the speed and level of enforcement (see http://circuitsassembly.com/cms/content/view/4114/95/).

"Status quo" scenario	*"Focused mercury reduction" scenario*
Vinyl chloride monomer (VCM) production – China is the location of the vast majority of the industry capacity using the mercury process for VCM production. Economic conditions, combined with availability of appropriate raw materials in China suggest VCM production will continue to expand, and the mercury catalyst process will likely be used for much of that capacity. NRDC (2006) estimated that mercury demand could increase from about 700 metric tonnes at present to some 1,000 metric tonnes by 2010. At the same time, however, there will be increasing political pressure on China to improve recycling, not to mention the considerable economic incentive if the mercury price stays relatively high. Meanwhile, European competitors have voiced concern that China is producing VCM/PVC at a very low cost using a process that is no longer "accepted" in other regions of the world for environmental reasons. The impacts of such political pressures on the sector are impossible to predict at present.	**Vinyl chloride monomer (VCM) production** – An aggressive policy of recycling and removing the mercury from both waste catalyst and hydrochloric acid would greatly reduce the net mercury consumption and potential mercury releases from this sector. Much could be accomplished during the next ten years. However, there is at present no scenario that would prevent the overall capacity of this (mercury-catalyst VCM/PVC) sector from expanding.

240. Of course, any overall projection of global mercury demand is subject to a large number of regulatory and other variables. For example, if it were not for the large projected increase in mercury demand for vinyl chloride monomer (VCM) production, the total global demand for mercury would show a much greater decline between 2005 and 2015. Nevertheless, based on present information, the scenarios above provide a reasonable range of demand estimates for the next 10 years, as summarised in the following table.

Table 22 Global mercury demand projections, 2005-2015

Mercury demand projections, by sector (metric tonnes)	**Present (2005)**	**"Status quo" scenario (2015)**	**"Focused Hg reduction" scenario (2015)**
Small-scale/artisanal gold mining	650-1,000	650	400
Vinyl chloride monomer (VCM) production	600-800	1,000	1,000
Chlor-alkali production	450-550	350	250
Batteries	300-600	200	100
Dental use	240-300	270	230
Measuring and control devices	150-350	125	100
Lighting	100-150	125	100
Electrical and electronic devices	150-350	110	90
Other (paints, laboratory, pharmaceutical, cultural/traditional uses, etc.)	30-60	40	30
Total	**3,000-3,900**	**2,870**	**2,300**

241. It should also be noted here that disruptions in mercury supply can have a range of effects on demand. For example, the closure of the Almadén mercury mine in Spain resulted in a reduction in the European Union supply of mercury, which in turn resulted in a reduction in the quantities of mercury exported by the Spanish trading company MAYASA. Due to increased public awareness, European Union traders reportedly prefer to deal with buyers for whom the end use of mercury is clear and "legitimate" (i.e., they prefer not to knowingly sell mercury for ASM uses, skin lightening creams, etc.) Both of these changes have likely contributed to the decrease in mercury exports from the European Union, especially since 2003.

242. It goes without saying that in virtually all of the areas mentioned above, improved tracking and reporting of commercial mercury transfers would aid tremendously in understanding and dealing with a range of mercury issues – both national and global.

5.4 Evolution of mercury prices

243. The market price of mercury, and the trend in that price, are important for a number of reasons:

(a) Significant changes in the price of mercury generally reflect changes in supply and demand, or they could sometimes be related to other factors of interest to policy makers;

(b) According to economic theory (not always evident in the mercury market), mercury demand should soften if the price rises, and should strengthen as the price decreases;

(c) While not evident during the major price rise of 2004-2005, mercury mines that have been closed could view rising mercury prices as an encouragement to resume mining, as long as they can sell mercury at prices that exceed the cost of mining;

(d) Likewise, suppliers of by-product mercury, recyclers, metal traders and anyone else who may be holding mercury inventories or stocks may be expected to adapt their behaviour in relation to significant changes in mercury market prices.

5.4.1 Evolution of mercury supply versus price

244. As evident in the following figure, mercury prices have been declining for most of the past 40 years. From 1991-2003 mercury prices stabilized at their lowest real levels in 100 years (see Figure 14) – in the range of USD 4-5 per kilogram of mercury – before increasing rapidly from the middle of 2004. Adjusting for inflation, mercury at USD 5 per kilo was worth less than 5% of its peak price during the 1960s. The USD 5 price level reflected a plentiful supply of mercury coupled with an increasing cost of using or dealing with mercury due to regulatory pressures, e.g., to reduce industrial emissions, to organize separate collection of mercury products, and to deal with increasing restrictions and costs of mercury waste disposal by sending more wastes to recyclers.

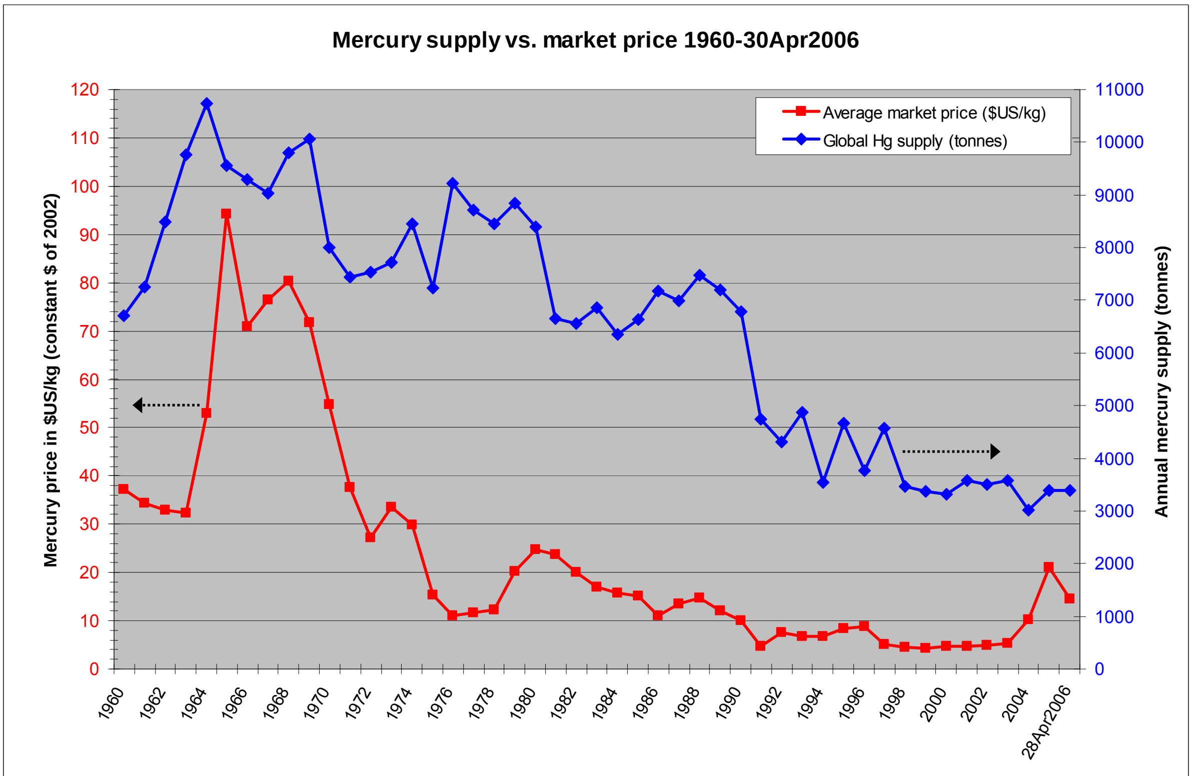
245. The subsequent and sudden 2004-2005 increase in the mercury price may be explained largely by the significant tightening of mercury supplies during 2004, mainly related to the closure of both the Spanish and Algerian mercury mines, as described in Section 3. The following are additional contributing factors that may have contributed to the rising prices:

- Rising gold prices stimulated artisanal and small scale gold mining demand for mercury, which increased by more than 300 metric tonnes during 2002-2005;
- China reduced its annual mercury imports by about 500 metric tonnes between 2000-2002, and subsequently increased domestic mercury production in 2002 and 2003, but not enough to meet its own needs, creating tight supplies in the large Chinese market as well;
- Mercury demand is relatively inelastic, at least over periods of 12 months or less, so that even a relatively small shortfall in supply can have a large impact;
- Uncertainty over the implications of the European Union Mercury Strategy may have led to some market speculation;
- The change in US dollar exchange rates against other major currencies inflated dollar prices of mercury that was coming from European Union and most other non-US sources;
- The Khaidarkan mine in Kyrgyzstan – the only mercury mine still exporting – has had difficulty, in the past, producing more than 600 metric tonnes per year, and it was already close to that level in 2004;

- Inventories (other than MAYASA) were limited, and MAYASA decided in 2004 to reduce its customer base somewhat, effectively reducing deliveries by some 30%;
- The resulting market "panic" may have led to further speculation and price increases, as:
    - o Mercury users wanted to secure supplies quickly;
    - o Speculators wanted to buy and hold supplies while waiting for further price increases.

246. Responding in part to the price rise, increased supplies of mercury appeared on the market in 2005 and 2006 , leading to a rapid fall-off in the mercury price, although still well above the levels of the last 10-15 years.

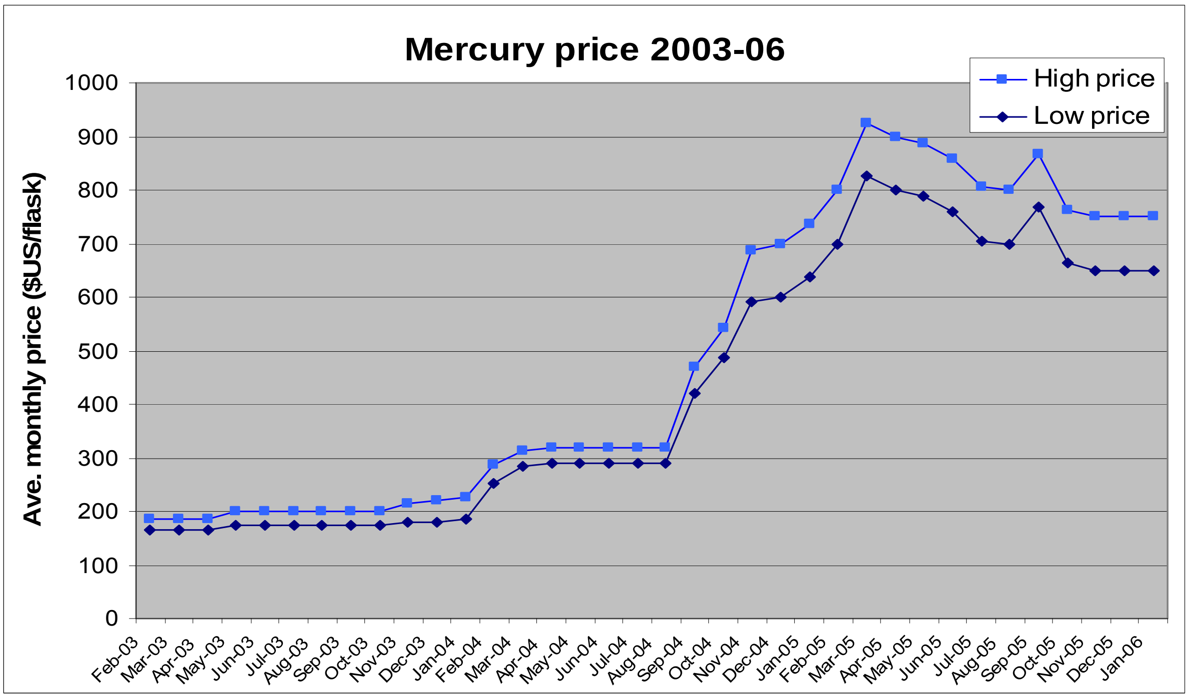
Figure 12 Global mercury supply and spot market price, 1960-2006



Sources: Hylander and Meili (2003), Maxson (2004, 2006).

247. The evolution of the 2003-2006 mercury price can be seen in more detail in the following figure.

Figure 13 Monthly evolution of the spot market price of mercury, 2003-2005

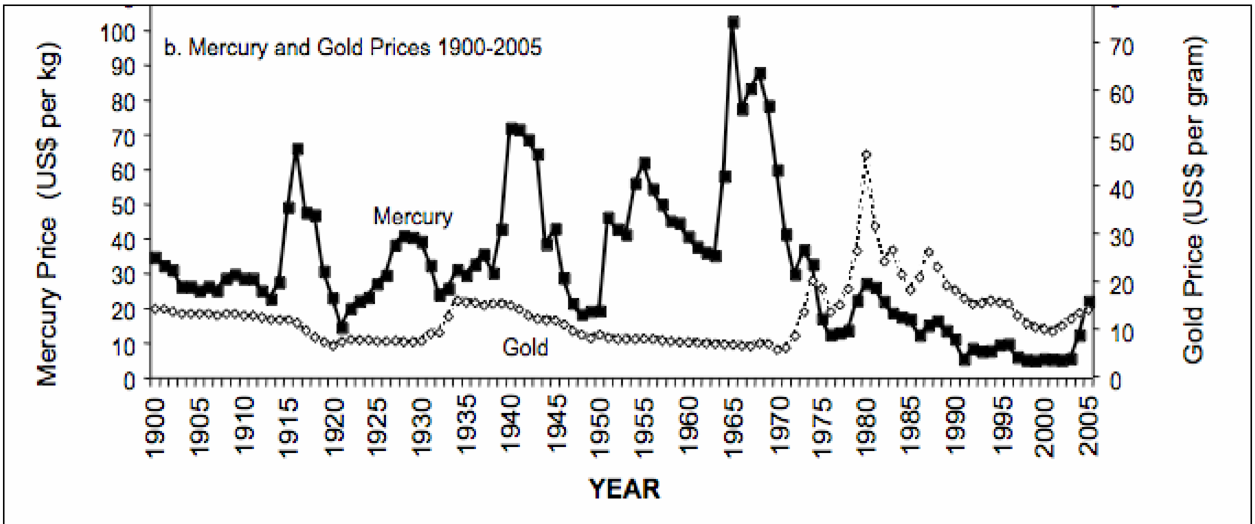


Source: Metal Bulletin (2006).

5.4.2 Trends in mercury and gold prices

248. The price of gold has increased significantly in recent years, leading to ever increasing artisanal and small scale gold mining (ASM) around the world, which so far has translated to increased demand for mercury. Meanwhile, the price of mercury increased much faster than gold in 2005, slowing somewhat the increase in consumption of mercury among gold miners. Despite the appearance of a correlation in recent years, it would be a mistake to look for a close correlation between gold prices and mercury prices, because there are other factors that play a much greater role in the mercury price (especially periods of tight mercury supply, the difficulty of getting mercury to remote areas, etc.). Nevertheless, there is no doubt that increasing gold prices are closely correlated with the number of ASM miners who are active, which is, in turn, correlated with demand for mercury, if not price. The following figure shows the relative movements of gold and mercury prices since 1900.

Figure 14 Relative movement of gold and mercury prices during the last century



Source: Swain *et al.* (submitted)

6 Relevant legislation and measures affecting supply and trade

249. The decision of the 23rd session of the UNEP Governing Council in 2005[27]/ requests *inter alia*, in paragraph 25, Governments and international organisations "to take immediate actions to reduce the risks to human health and the environment … by mercury in products and production processes, such as … considering curbing primary production and the introduction into commerce of excess mercury supply."

250. Therefore, measures aimed at restricting demand for products containing mercury (especially paints, pesticides, batteries, electrical and electronic equipment, thermometers, vehicles, etc.) are not addressed here in detail, although it must be stressed that such measures are extremely important as part of the overall strategy to reduce mercury supply and demand simultaneously. An extensive overview of product management measures was finalised in June 2006 by the Task Force on Heavy Metals, UNECE/LRTAP, and provides an essential reference for these measures.[28]/

251. There are a number of examples of legislation that has been implemented or is under discussion to restrict import and export of mercury. At the international level, three multilateral environmental agreements (MEAs) exist that are of relevance to mercury and mercury compounds. However, they do not deal directly with trade issues. Likewise, the most recently negotiated agreement relevant to chemicals, the Stockholm Convention on POPs, does not cover mercury, although there has been some discussion about the possibilities for adding mercury to the list of substances covered.

252. The Rotterdam Convention on the Prior Informed Consent Procedure (PIC) for Certain Chemicals and Pesticides in International Trade, and the Basel Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposal regulate trade in unwanted chemicals/pesticides

[27]/ UNEP GC Decision 23/9 IV.

[28]/ This overview is available at http://www.unece.org/env/tfhm/third%20meeting/PostOttawa/HMProtocol_Review_Products_final%20report_0615.pdf

or hazardous wastes. However, they do not contain specific commitments to reduce uses and releases of mercury.

Rotterdam Convention

253. The 1998 Rotterdam Convention (PIC Convention) has been implemented in the European Community through legislation that also bans the export of cosmetic soaps containing mercury, and requires prior notification for export of mercury compounds.

254. Mercury is already listed under the Rotterdam Convention, but only for use as a pesticide. In February 2006 Sweden notified mercury as a banned or severely restricted industrial chemical to the Rotterdam Convention Secretariat. However, an additional notification from a country in another region is required before the process to consider inclusion in the Convention can be initiated.

Basel Convention

255. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted on 22 March 1989, strictly regulates the transboundary movements of hazardous wastes and establishes obligations for its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner. The main principles of the Basel Convention are:

i. Transboundary movements of hazardous wastes should be reduced to a minimum consistent with their environmentally sound management;
ii. Hazardous waste generation should be reduced and minimised;
iii. Hazardous wastes should be treated and disposed of as close as possible to their source of generation; and
iv. Efforts should be made to assist developing countries, and countries with economies in transition, with the environmentally sound management of hazardous and other wastes they generate.

256. The imposed restrictions on transboundary waste movements include the prohibition of shipment with non-Parties, and the need to receive a written confirmation from the relevant authorities in the country of import accepting the import.

257. A decision to amend the Convention was adopted in September 1995 in order to ban exports of hazardous wastes for final disposal, recovery or recycling from countries listed in a new Annex VII (Parties and other States which are members of OECD, EC, Liechtenstein) to non-Annex VII countries.

European Union Strategy on mercury – export ban and storage

258. In January 2005 the European Commission published the Community Mercury Strategy (European Commission, 2005). The strategy set out a series of objectives and actions, which include:

v. Banning mercury exports by 2011;
vi. Global action – a series of measures to encourage international activities and cooperation with other countries, e.g. to control mercury trade, emissions, and use in activities like gold mining;
vii. Reducing European Union demand – restricting the marketing of measuring devices containing mercury (e.g. thermometers), and further investigation of remaining uses (e.g. dental amalgam);
viii. Addressing European Union surpluses – safe storage of mercury decommissioned by industry, and further study of mercury already circulating in society (e.g. in old products still in use);

259. On 24 June 2005, the Environment Council of the European Union adopted its Conclusions on the Community Mercury Strategy. The Environment Council underlined “the importance of the proposal to phase out the export of mercury from the Community.” It also invited the European Commission “to take action as soon as possible … to present appropriate proposals” on the issue of the “phasing out of the export of mercury from the Community and action to pursue the safe storage or disposal of mercury inter alia from the chlor-alkali industry to a timescale consistent with the intended phase out of mercury exports”.

260. As one of the early actions to implement the Community Strategy, in October 2006 the European Commission proposed legislation that bans the export from the Community of metallic mercury, and ensures that much of it does not re-enter the market. The latter will be assured by a requirement for

safe storage/disposal of mercury coming from the decommissioning of EU chlor-alkali facilities.[29]/ The fundamental purpose of both measures is to avoid further increasing the "global pool" of mercury.

261. The proposed European Union export ban and supporting analysis implies that there is a sort of "hierarchy" of mercury sources to be reduced, with priority reductions aimed at the sources that are most "environmentally damaging," from the point of view of quantities of mercury that could be put on the market and released to the biosphere, and also taking account of the ease of sequestering certain mercury sources. From this perspective, mercury mining would be the highest priority source to be reduced, followed by mercury recovered from decommissioned chlor-alkali plants, other mercury inventories, etc. By-product mercury and mercury recycled from waste and products would be "preferred" sources in this case because they are, at least for the moment, inadvertent mercury sources that are impossible to avoid. Without collection, much of this mercury would be immediately released into the environment.

262. According to action 16 of the European Union Mercury Strategy, the Community should promote an initiative to make elemental mercury subject to the Rotterdam Convention PIC procedure. It may be noted that Sweden has launched such an initiative.

National initiatives

263. **Sweden** – A legislated ban on mercury in specific products, and an export ban, were implemented by Sweden during the 1990's, combined with possibilities for exemptions on a general (or a case-by-case) basis, based on the principles of substitution and precaution. This approach has made the adjustment to mercury free alternatives easier for the industry.[30]/ Effective as of 1 January 1992 , the ordinance introduced a ban on the commercial manufacture or sale of certain products containing mercury. The ordinance imposed a further ban, effective as of 1 July 1997, on the export of mercury and chemical compounds and mixtures containing mercury.

264. In February 2006 Sweden published a proposal for a general ban on mercury. Under the proposal, the present ban on certain goods will be extended, and will also include amalgam and analytical chemicals, for example. Exemptions are suggested for applications covered by harmonised European legislation, for example button cell batteries and fluorescent lamps, and for certain other applications to provide time for development and transition to alternatives. The ban is to come into force on 1 January 2007.

265. **Philippines** – The Government passed in 1997 a Department of Environment and Natural Resources (DENR) Administrative Order known as the Chemical Control Order (CCO) for Mercury and Mercury Compounds." Using this and other legislation, the Government is obliged to control and monitor the entry of mercury and mercury compounds into the country, including the names of importers, distributors and users.

266. **Denmark** – Denmark has imposed similar bans with appropriate legislation. According to Danish legislation (Statutory Order No. 692 of 22 September 1998 from the Ministry of Environment and Energy on Prohibition of Sale and Export of Mercury and Mercury-Containing Products), it is prohibited to sell or export mercury and mercury-containing products. "Mercury" means the element mercury, both in its metallic form and in chemical compounds. "Mercury-containing products" means products in which mercury represents more than 0.005 percent of the weight. In comments during the development of the European Union Mercury Strategy, Denmark wrote, "We have had fine experience with a general ban (with exemptions)."[31]/

267. **The Netherlands** – The Dutch product policy concerning mercury is a sweeping prohibition, which took effect in 2000, against the production, trade or import of all mercury containing products. Exceptions from the prohibition may only be granted for products for which sufficient evidence is presented that the use of mercury is essential.

[29]/ See footnote 6.
[30]/ Consultation Document of an EU Mercury Strategy, Swedish Ministry of the Environment, 11 May 2004. See http://ec.europa.eu/environment/chemicals/mercury/pdf/sweden.pdf.
[31]/ Development of an EU Mercury Strategy (Comments), Danish Environmental Protection Agency, 6 May 2004. See http://ec.europa.eu/environment/chemicals/mercury/pdf/denmark.pdf.

Annex 1 – Discrepancies in trade statistics (1)

Examples of inconsistent or missing trade statistics

Mercury shipped from	To	Year	Quantity (kilograms)	Value (Euro/€ or USD/$)	Data source	Comments
Spain →	United Kingdom	2003	40,000	$227,330	COM & EUR	Spain reported that it exported twice as much mercury to the United Kingdom as the United Kingdom reported receiving from Spain. This inconsistency is also reported by Eurostat.
Spain →	**United Kingdom**	2003	20,000	$109,812	COM & EUR	
Russian Federation→	**Netherlands**	2003	4,875	$28,281	COM & EUR	The Russian Federation reported that it exported far more mercury to the Netherlands than the Netherlands reported receiving from the Russian Federation.
Russ. Federation→	Netherlands	2003	99,187	$259,872	COM	
USA →	**Mexico**	2003	328,687	$130,503	COM	Mexico reported that it imported far more mercury from the USA than the USA reported exporting to Mexico.
USA →	Mexico	2003	35,453	$398,720	COM & USI	
Spain →	Iran	2003	170,582	$896,862	COM	Spain reported that it exported more mercury to Iran than Iran reported receiving from Spain.
Spain →	Iran	2003	154,700	€703,192	EUR	
Spain →	**Iran**	2003	147,316	$756,360	COM	
Peru →	Spain	2003	52,835	$85,942	COM	Spain reported that it imported twice as much mercury from Peru as Peru reported exporting to Spain.
Peru →	**Spain**	2003	98,800	€193,626	EUR	
Peru →	**Spain**	2003	114,195	$249,353	COM	
USA →	Singapore	2003	21,940	$204,662	COM & USI	Singapore reported that it imported more than twice as much mercury from the USA as the USA reported exporting to Singapore.
USA →	**Singapore**	2003	56,445	$357,099	COM	
Spain →	France	2003	5,125	$36,618	COM & EUR	France reported that it imported much more mercury from Spain than Spain reported exporting to France.
Spain →	**France**	2003	19,898	$130,056	COM	
Spain →	**France**	2003	700	€8,050	EUR	
Netherlands →	Belgium	2003	4,000	$28,297	COM & EUR	Belgium reported that it imported much more mercury from the Netherlands than the Netherlands reported exporting to Belgium, according to Comtrade. Eurostat gives an even greater trade volume.
Netherlands →	**Belgium**	2003	18,523	$115,469	COM	
Netherlands →	**Belgium**	2003	34,600	€196,042	EUR	
Spain →	Australia	2003	44,851	$273,793	COM & EUR	Spain reported that it exported more mercury to Australia than Australia reported receiving from Spain.
Spain →	**Australia**	2003	30,949	$170,843	COM	
United Kingdom →	**Ireland**	2003	11,625	$684,338	COM	There is a large discrepancy between the value of Irish imports as published by Comtrade, compared to the value published by Eurostat.
United Kingdom →	**Ireland**	2003	11,300	€357,027	EUR	
Germany →	**Spain**	2003	180,941	$373,473	COM	There is a large discrepancy between the quantity of German exports as published by Comtrade, compared to the quantity published by Eurostat.
Germany →	**Spain**	2003	221,100	€401,633	EUR	
Spain →	Netherlands	2003	148,351	$741,483	COM	There is a large discrepancy between the quantity of Spanish exports as published by Comtrade, compared to the quantity published by Eurostat.
Spain →	Netherlands	2003	113,900	€508,022	EUR	

Bold = reporting country COM = Comtrade EUR = Eurostat USI = USITC

Note:
1) Note that in all cases above, mercury is shipped from the country in the first column to the country in the second. The major difference is only that the authorities of the first column reported the shipment as an export, and those of the second column reported the same shipment as an import.
2) In cases where Comtrade and Eurostat statistics are similar but not identical, the Comtrade statistics are presented – courtesy of, and copyright by, UN Statistics Division.
3) The UNSD is hereby credited as the source of all Comtrade statistics above marked as COM. Likewise, Eurostat and USITC statistics have been consulted.

Annex 2 – Discrepancies in trade statistics (2)

More examples of inconsistent or missing trade statistics

Mercury shipped from	**To**	**Year**	**Quantity** (kilograms)	**Value** (Euro/€ or USD/$)	**Data source**	**Comments**
United Kingdom→	**Netherlands**	2003	75,140	$375,575	COM & EUR	While the Netherlands, Brazil, India and Ireland reported receiving substantial imports from the United Kingdom, the United Kingdom did not report any of these exports.
United Kingdom→	**Brazil**	2003	31,222	$101,634	COM	
United Kingdom→	**India**	2003	35,500	$155,461	COM	
United Kingdom→	**Ireland**	2003	11,625	$684,338	COM	
Algeria →	Netherlands	2003	80,039	$363,292	COM	While Algeria, Spain, Finland, Japan, the USA, and Kazakhstan reported these exports to the Netherlands, the Netherlands reported none of these imports except 2,062 kilo from Japan (Comtrade) and 6,100 kilo from Japan (Eurostat).
Spain →	Netherlands	2003	148,351	$741,483	COM	
Spain →	Netherlands	2003	113,900	€508,022	EUR	
Finland →	Netherlands	2003	25,531	$101,484	COM & EUR	
Japan →	Netherlands	2003	102,328	$360,155	COM	
USA →	Netherlands	2003	57,159	$269,943	COM	
Germany →	**Netherlands**	2003	60,425	$260,187	COM & EUR	The Netherlands reported large imports from Germany, but Germany did not report any exports to the Netherlands.
Sweden →	**Indonesia**	2003	40,000	$47,199	COM	Indonesia reported significant imports from Sweden, but Sweden has not filed any report – either to Comtrade or to Eurostat - on mercury trade in 2003.
USA →	Viet Nam	2003	39,882	$171,500	COM & USI	The USA reported exports to Viet Nam, but Viet Nam has not filed any report on mercury trade in 2003.
Mexico →	USA	2003	18,714	$7,353	COM	Mexico reported exports to the USA, but the USA did not report any imports from Mexico – either to Comtrade or to USITC.
USA →	**Sri Lanka**	2003	19,050	$11,800	COM	Sri Lanka reported imports from the USA, but the USA did not report any exports to Sri Lanka – either to Comtrade or to USITC.
Germany →	**Spain**	2003	180,941	$373,473	COM	Spain reported large imports from Germany, but Germany did not report any exports to Spain - either to Comtrade or to Eurostat.
Germany →	**Spain**	2003	221,100	€401,633	EUR	
EU exporters→	EU importers	2003	266,800	€1354071	EUR	European Union countries reported exporting far less to each other than they all reported importing from each other
EU exporters→	**EU importers**	2003	542,800	€2630465	EUR	

Bold = reporting country COM = Comtrade EUR = Eurostat USI = USITC

Note:
1) Note that in all cases above, mercury is shipped from the country in the first column to the country in the second. The major difference is only that the authorities of the first column reported the shipment as an export, and those of the second column reported the same shipment as an import.
2) In cases where Comtrade and Eurostat statistics are similar but not identical, the Comtrade statistics are presented – courtesy of, and copyright by, UN Statistics Division.
3) The UNSD is hereby credited as the source of all Comtrade statistics above marked as COM. Likewise, Eurostat and USITC statistics have been consulted.

Annex 3 – Global Mercury Project report

Global Mercury Project

Report to the UNEP Governing Council Meeting
Nairobi, February 2007

GLOBAL IMPACTS OF MERCURY SUPPLY AND DEMAND IN SMALL-SCALE GOLD MINING

Prepared by UNIDO
United Nations Industrial Development Organization

requested by UNEP Governing Council decision 23/9 IV

October, 2006

Global Mercury Project

Project EG/GLO/01/G34
Removal of Barriers to the Introduction of Cleaner Artisanal and Small-Scale Gold Mining and Extraction Technologies

Report to the UNEP Governing Council Meeting

Nairobi, February 2007

GLOBAL IMPACTS OF MERCURY SUPPLY AND DEMAND IN SMALL-SCALE GOLD MINING

requested by UNEP Governing Council decision 23/9 IV

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Cover Photos: by AJ Gunson (China) and Marcello Veiga (Ecuador & Brazil)

Executive Summary

I. INTRODUCTION

The Global Mercury Project respectfully submits this report in response to the UNEP Governing Council's request (*decision 23/9 IV*) for information on mercury supply, trade and demand in artisanal and small-scale gold mining (ASM). This report highlights some of the Global Mercury Project's findings 2002-2007 and outlines some major policy implications for nations worldwide — particularly nations exporting, importing and/or using mercury, as well as all countries affected by global pollution and/or involved in providing capacity assistance to populations involved in ASM.

The Global Mercury Project (GMP) is an initiative of the U.N. Industrial Development Organization, launched in 2002 with financial support from the U.N. Development Program and the Global Environment Facility, co-financed by partner countries and civil society. The GMP works with governments, NGOs, industry and community stakeholders, building capacity to monitor factors related to mercury use and pollution in ASM and developing policy and institutional capacities to remove barriers to the adoption of cleaner technologies of mineral extraction. Several countries are participating in this pilot program, with primary field activities during the first phase taking place in Brazil, Indonesia, Lao People's Democratic Republic, Sudan, Tanzania and Zimbabwe.

II. GLOBAL MERCURY USE & POLLUTION IN SMALL-SCALE GOLD MINING

At least 100 million people in over 55 countries depend on ASM for their livelihood, mainly in Africa, Asia and South America. ASM produces 20-30% of the world's gold production, or approximately 500-800 tonnes per annum. It involves an estimated 10-15 million miners, including 4.5 million women and 1 million children. This type of mining relies on rudimentary methods and technologies and is often performed by miners with little or no economic capital who operate in the informal economic sector, often illegally and with little organization. **As mercury amalgamation is an inexpensive, quick and simple way to extract gold particles, it is currently the method most commonly used in ASM.**

As a consequence of poor practices, **mercury amalgamation in ASM results in the discharge of at least 650 to 1000 tonnes of mercury per annum, equivalent to 1/3 (one-third) of all global anthropogenic (human-caused) mercury releases into the environment. This makes ASM the single largest intentional-use source of**

mercury pollution in the world. In addition to the severe occupational hazards associated with mercury use, ASM has generated thousands of polluted sites with impacts extending far beyond localized ecological degradation, often presenting serious, long-term environmental health hazards to populations living near and downstream of mining regions. **It is estimated that as much as 300 tonnes of mercury per annum are volatilized directly to the atmosphere, while 700 tonnes are discharged in mine tailings into soil, rivers and lakes. In addition to domestic pollution impacts, both air emissions and tailings discharge contaminate both international waters and air.**

III. ECONOMIC AND SOCIAL DETERMINANTS OF MERCURY CONSUMPTION

Though large-scale gold mine operations have phased out mercury use by adopting alternative technologies, mercury demand in ASM continues to increase. With gold rising from US$260/oz in March 2001 to US$725 in May 2006, a gold rush involving poverty-driven miners is being observed in many countries. This increase in mining activity is compounded by escalating poverty due to factors such the failure of subsistence economies, conflict causing displacement of populations, and diseases such as HIV/AIDS. **Due to the increase in ASM, and based on evidence of mercury use in country-by-country and regional reporting, mercury consumption and demand in ASM may be growing to a historically unprecedented level on the global scale.**

The highest consumption levels are from China (with 200 to 250 tonnes released), followed by Indonesia (100 to 150 tonnes) and between 10 and 30 tonnes in each of Brazil, Bolivia, Colombia, Ecuador, Ghana, Peru, Philippines, Venezuela, Tanzania and Zimbabwe. Mercury may be used in as many as 40 other countries, to varying degrees. Because some mercury used is recycled, the amount of additional mercury demanded is equivalent to the amount of mercury consumed (assuming constant ASM production levels and constant technologies over time). On average, it is conservatively estimated that **at least 1 to 3 grams of mercury is lost to the environment for every gram of gold produced by ASM. Mercury releases primarily depend on the nature of mining technology employed, which is influenced by both social and economic factors.**

While there are numerous social and economic factors that affect technology use, the focus of this report is on how mercury supply and demand relate with respect to available technologies. **Various location-specific GMP training programs and assessments demonstrate that when mercury is less available and/or more expensive, less**

mercury is consumed due to transfers to more efficient practices, or in some cases, to practices that eliminate mercury use. GMP assessments emphasize these four critical determinants of mercury reduction:

1) *Whole ore amalgamation* is the largest point source of mercury pollution in ASM (contributing more than 50% of mercury lost in ASM). Substantial differences in mercury consumption are observed between whole ore amalgamation (i.e. mercury is added to all ore being processed during crushing, grinding or sluicing) and amalgamation of only heavy mineral concentrates. Although amalgamation of the whole ore is an inexpensive way to quickly extract gold, several cost-efficient alternative mercury-free pre-concentration technologies exist as viable options. However, the practice of whole ore amalgamation often persists in many regions due to factors such as: availability of inexpensive mercury, lack of technical knowledge/expertise, lack of organizational support, and lack of environmental health awareness. **GMP assessments in various locations indicate that a rising mercury price is a significant added incentive to eliminate this hazardous and economically inefficient practice.**

2) *Burning amalgam in open air* is the second largest source of mercury loss to the environment (contributing 20-30% of mercury losses in ASM); however it is the main health problem for miners and nearby communities. The price and availability of mercury also influences whether miners use retorts to contain mercury vapor during the burning stage of amalgamation. GMP field assessments found that effective retorts could be made cheaply (e.g. as little as US$3.20 in some cases), and that these retorts could contain mercury vapor in such a way that allows over 95% of the mercury to be recycled and re-used. Numerous community training programs and assessments have concluded that the mercury price and economic benefits of re-using mercury have a significant impact on whether miners will adopt the retorts, in addition to health and environmental considerations.

3) *Loss of mercury in amalgamation of concentrates* has also been identified by the GMP as a source of mercury pollution (10-15% of mercury losses). Amalgamation of only gravity concentrates is an improvement when compared to whole ore amalgamation. However, even amalgamating the gravity concentration, some mercury is lost. Higher prices of mercury could encourage miners to adopt better techniques to prevent these losses.

4) *Complete phase-out of mercury use* in mining may be a viable option for many miners, though such alternative technologies generally require a higher order of economic investment, organization, and technical expertise. Assessments indicate that a high price of mercury, coupled with capacity-building, may contribute to the transfer to such technologies. The most promising technology to replace completely the use of mercury in any type of gold ore is cyanidation, but this is not quite affordable and technically available to all artisanal miners. Cyanidation methods must be carefully assessed so that cyanide and mercury are not used in any way together, which can exacerbate pollution. Other gravity separation methods have great potential to reduce and in some specific situations eliminate the use of mercury but many of these cannot be adopted worldwide because ores vary significantly. **In approximately 10% of current ASM cases, gold sources are alluvial ore (free gold) and completely mercury-free-alternatives could be locally available at a very low cost.**

IV. GLOBAL SOURCES OF MERCURY

As mercury is readily available in most countries, it tends to be inexpensive and easily accessible to gold miners. Mercury usually enters developing countries legally, i.e. for use in dental amalgams or the chlor-alkali industry. However, evidence indicates that in many developing countries and countries with economies in transition, by far the majority of mercury imported ends up being used in ASM. Estimates have been undertaken concerning the amount of mercury diverted for use in ASM using import statistics and anticipated consumption for legitimate uses, focussing in the 6 GMP pilot countries and neighbouring countries.

GMP assessments reveal that in 2005, Kenya imported almost 14 tonnes of mercury from German, followed by Georgia (9.5 tonnes) and Japan (4.1 tonnes). **Evidence suggests that most of Kenya's imported mercury is then exported, legally and illegally, to Tanzania, Uganda and the Democratic Republic of Congo, where it is primarily used in ASM. In Tanzania, in 2005, the United States exported approximately 30% of Tanzania's official imports of 3 tonnes, followed by the Netherlands with another 30%.** It is unclear how much of this mercury is used in ASM since the price of imported mercury varies from US$0.18/kg to US$31.2/kg. Officials noted that differences could be attributed to mercury quality variance as well as reporting-related problems.

OECD countries are the main source of mercury to Sub-Saharan Africa, where mercury imports increased from 34 metric tons in 2000 to 57 tons in 2002. In 2000, the Netherlands shipped 245 tonnes of mercury to at least 18 countries, most in the Latin American-Caribbean region. Indonesia imported in 2000 24 tonnes from Spain, 17 tonnes from the Netherlands, 3 tonnes from Australia and 3 tonnes from Japan.

In 2005, official import data from Zimbabwe indicated 21.8 tonnes of mercury imported in which South Africa contributes with 13.8 tonnes, the Netherlands with 2.7 tonnes, Switzerland with 4.6 tonnes, and Germany with 0.7 tonnes. However, results from interviewing in 2003 indicated that one single mercury dealer in Zimbabwe unofficially declared importing 20 tonnes of mercury. In the same year, the Zimbabwe official data indicated that the Netherlands accounted for 15.7 tonnes. Given these facts, **it is unlikely that import statistics adequately capture the cross-border trafficking of mercury and the extent of diversion from legal sectors.**

In 2005, Brazil officially imported 43.3 tonnes of mercury, in which 26.9 tonnes came from Spain, 6.9 from UK, 3.4 from Hong Kong, and 3.3 from Kazakhstan, among others. Most of the mercury used in ASM in Brazil is labelled for use in dentistry.

The unregulated trading of mercury from industrialized countries to developing countries makes mercury easily available at the mine sites. **In most countries with ASM, mercury is readily available to miners at ASM sites. In some cases it is given for free, contingent on gold being sold to the mercury provider. Stockpiling of mercury by gold dealers has been identified as a concern. GMP assessments find that monitoring and regulating imports and domestic trade in many developing countries and countries with economies in transition is generally significantly more difficult than regulating mercury supply at the export stage, particularly exports from developed countries.**

V. HEALTH AND ENVIRONMENTAL IMPACTS

The misuse of mercury in ASM produces severe health and environmental hazards. The mobilization of **mercury from mine sites into aquatic systems presents a major risk. The major effects of mercury in aquatic life, soils and sediments, were found in Brazil, Zimbabwe and Indonesia. This was attributed to excessive use of mercury (whole ore amalgamation) as well as combined use of mercury with cyanidation. This combined use exacerbates the methylation of mercury. Once methylated, mercury can rapidly move through the food chain, leading to impacts downstream.**

Inhalation of mercury during handling, as a result of spills and during amalgamation, which is often undertaken by women and children, also represents a major health concern. Typically, this is conducted with **no protection and often takes place in the home.** Results of the health surveys have been alarmingly similar across GMP sites. Symptoms of mercury intoxication are widespread, with some people experiencing **levels of intoxication that exceed 50 times the WHO maximum public exposure limit**. Neurological disturbances such as ataxia, tremors and coordination problems are common. At one project site, almost 50 percent of miners showed an unintentional tremor, which is a typical symptom for mercury-induced damage of the central nervous system. With extremely high mercury concentrations in breast-milk of nursing mothers in GMP communities, infants are especially at risk.

VI. IMPLICATIONS FOR POLICY AND GOVERNANCE

The Global Mercury Project has been working mainly in six countries, and has acquired key lessons in its *Policy and Governance Initiative*. This initiative recognizes that effectively addressing mercury problems in ASM requires an integrated approach that targets capacities of local institutions in the removal of technical, social, economic and political barriers to the improvement in ASM practices. The GMP emphasizes that local participation and locally-driven processes of policy development are of critical value. **Since 2005, the GMP has been working with governments and communities on developing and implementing various new policies such as**: **mercury trade and management laws in Indonesia, national mercury and mining labour laws in Zimbabwe, policies to legalize and assist indigenous miners in Sudan, and microfinance policy in Tanzania.**

In selected sites, the GMP has been focussing on capacity-building pilot programs to remove barriers to the adoption of cleaner technologies. These programs involve **mobile training units that can reach miners in rural areas to engage local priorities**. **This community assistance model is receiving widespread support, and the GMP has already certified teams of local trainers.** Yet, the regions benefiting from the GMP constitute only a fraction of the global population impacted by ASM. **Further commitment is needed in these and other regions, including additional resources.**

Global commitments are critically needed, from community-level issues such as technologies and gender inequities, to broader policies such as international mercury export controls and policies to improve regulation and assistance in the ASM sector. **<u>The GMP asserts that it could be possible to achieve at least a 50% reduction of mercury consumption (demand) in ASM by 2017</u>. As called for by the GMP, this goal must be achieved by fostering commitments of diverse stakeholders** to development strategies that will empower populations to:

1. **eliminate amalgamation of whole ore** by replacing by introducing mercury-free concentration process prior to amalgamation
2. reduce mercury use in the amalgamation of concentrates through closed circuit process (mercury is always recycled)
3. eliminate the burning of mercury without the use of a retort to contain emissions and thereby allow recycling

4. introduce completely mercury free techniques where feasible, particularly for ores which preclude the use of mercury.

The 10-year goal of reducing mercury consumption in ASM by over 50% is ambitious but achievable. Given the urgency of the mercury problem in ASM, such an effort cannot be considered a choice – rather it must be seen as a global obligation. The GMP calls on nations around the world to achieve the above goal by reducing mercury supply through export controls and other mechanisms that will encourage the transition to alternative technologies, as well as by pledging commitments to programs to help build community capacities. Further information on the activities of the Global Mercury Project can be obtained at the project website: www.globalmercuryproject.org

Annex 4 – UNEP questionnaire
UNEP request for information

UNEP Mercury Trade letter of 15 March 2006 – Annex to the letter

(Responses to this letter can be found at http://www.chem.unep.ch/mercury/Trade-information.htm)

SUBMISSION OF SUPPLY, TRADE AND DEMAND INFORMATION

Background

Please indicate the country submitting the information and provide a contact institution and person, if possible (with full contact details) for eventual follow-up questions.

Timeframe and Units for the data

Amounts must be given with unit clearly defined, preferably in metric tons.

If available, data are requested for the period 1995-2005.
The time period for the data should be clearly indicated.

1. SUPPLY OF MERCURY

Please provide national data for the following:

- Production of primary mercury (extracted from ores within the earth's crust):
  - either as the main product of the mining activity,
  - or as by-product of mining or refining of other metals (such as zinc, gold, silver) or minerals;
- Recovered mercury from refining of natural gas;
- Mercury recovered from spent products, catalysts and wastes from industrial production processes (excluding any mercury recovered on-site from chlor-alkali wastes);
- Mercury in government reserve stocks or inventories;
- Other stocks or sources of mercury, such as mercury recovered from a chlor-alkali factory that has closed or converted to a mercury-free process.

Are there national systems in place to collect and periodically publish data such as those above on mercury supply, and if so, how complete are the data?

2. TRADE IN MERCURY

Trade statistics

Comprehensive trade statistics for mercury for United Nations member states are publicly available through the United Nations Commodity Trade Statistics Database (Comtrade). Comtrade contains detailed import and export statistics reported by statistical authorities of close to 200 countries and areas. These data are processed into a standard format with consistent coding and valuation. The data are then stored in a computerized data base system, called UN Comtrade. For many countries the data coverage starts as far back as 1962 and goes up to the most recent completed year. The data can be accessed at http://unstats.un.org/unsd/comtrade/.

In addition, there are a few other commercial statistical databases maintained by key organizations that provide trade data on mercury. These include, among others, Eurostat (the Statistical Office of the European Communities) and the United States International Trade Commission, which focus on statistics for trade between their own region/country and other countries.

The range of commodity mercury, products and compounds that are routinely reported by national authorities are listed in annex 1 together with the corresponding entries from the main commodity classification systems.

Additional information

Publicly available data from the above mentioned databases will be used as background data for summarizing global trade (import and export) in mercury. This request is not intended to generate new data about mercury movements – only to clarify and substantiate trade statistics that are publicly available through the UN Statistics Division or other agencies. A very few additional questions/issues are formulated below in order to supplement these data.

Please provide information on the following:

Do you have any reason to believe that the data reported to Comtrade or other statistical agencies about mercury movements in and out of your country may be incomplete or inaccurate? If so, in what way? (Responses to these questions will assist UNEP in assessing the viability of the statistics presently available through Comtrade and other databases.)

During the collection and reporting of these mercury statistics in your country, is there any requirement to identify the final destination or use of the mercury being transported?

3. DEMAND FOR MERCURY

Some additional questions/issues are given below in order to supplement data available through the databases. Please provide data on the following:

- Production of mercury containing batteries – annual domestic production and use and export
- Fluorescent, high-intensity discharge (HID) and other lamps containing mercury – annual domestic production (total quantity of lamps and amounts of mercury used in production), domestic consumption, export and import.
- Any other mercury containing products (especially mercury for dental use, thermometers, barometers, manometers, medical devices, paints, cosmetics) - annual domestic production (total quantity and amounts of mercury used in production), domestic consumption, export and import.
- Mercury based chlor-alkali facilities – annual mercury demand, number of facilities, total production capacity (chlorine or caustic soda), any plans during the next five years to close facilities or convert them to a mercury-free process.
- Any facilities (such as for production of vinyl chloride monomer) that use mercury or a mercury compound as a catalyst, and total yearly demand for mercury.

4. ARTISANAL AND SMALL-SCALE GOLD MINING (ASM)

Do artisanal and small-scale gold mining activities (ASM activities) using mercury occur in your country?

If yes, please respond to the additional questions/issues given below:

Do you have estimates of the production quantities and estimated amounts of mercury used in such activities in the country, by year? How accurate are these estimates?

It is said that in most countries, mercury is generally imported through legal channels for legitimate uses, such as dental amalgam. In some cases, however, there is evidence that mercury is later diverted to ASM activities. Is the use of mercury in ASM activities regulated in your country, and if so, how? What are the major difficulties, if any, in controlling the use of mercury in these activities?

What are the sources (mining, recycling, import, etc.) for the mercury used in ASM activities, and approximately how much mercury comes from each source, if known?

Import of mercury – Does your country have any system to register the intended use of mercury at the time it is imported?

Does your country have any system for registration of sale of mercury for ASM activities?

Any views or suggestions on measures that could be implemented at national or global level to better understand this mercury trade, and to take steps to reduce the potential health effects of mercury on ASM miners, their families and communities?

Annex 5 – Regional mercury trade flows

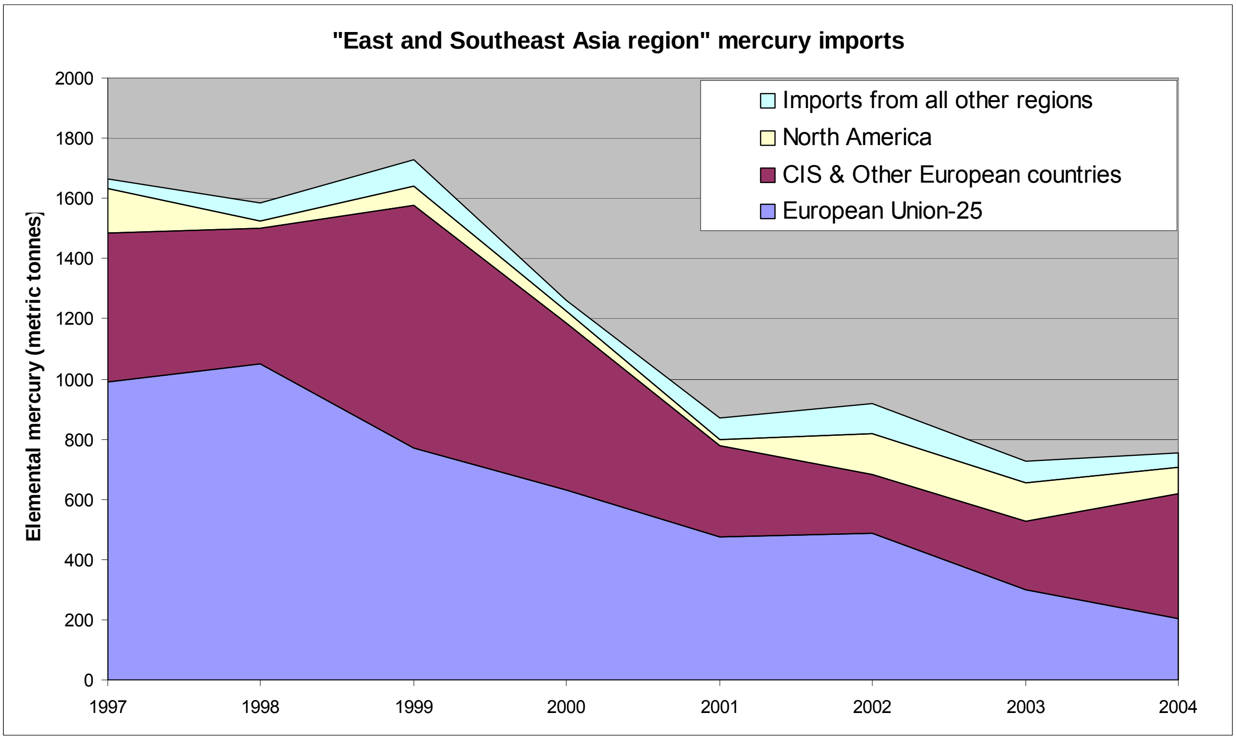
The following figures present trade flows of elemental mercury between different regions of the world for the years 1997-2004, according to the statistics held in the Comtrade database (UNDESA/SD Comtrade, 2006).

As noted in the main report, in order to determine the commercial flow of mercury between any two regions, these figures combine the reports of both exporters and importers, while taking care not to count the same trade flow between any two countries more than once. In the few cases where the statistics did not give quantities traded, estimates have been made. In a few other cases where the statistics made no sense and could not be verified, they have either been revised to correspond to other relevant data, or they have been omitted if there was no basis for revision.

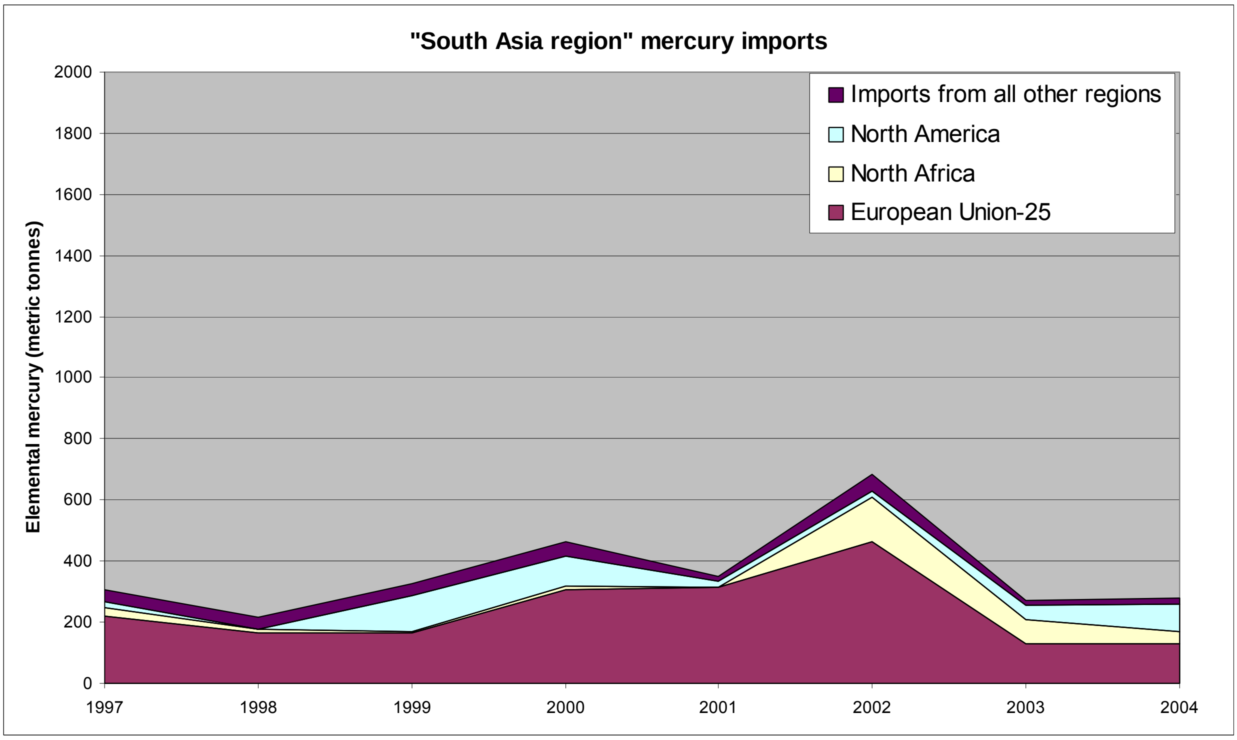
As noted in the main report, since the same mercury may be traded more than once in a given year, since different countries may use somewhat different reporting guidelines, since the data is not comprehensive for all countries in each region, etc., it should be stressed again that these figures show the general evolution of trade flows during these years, which cannot necessarily be directly converted to definitive regional imports or exports. Nevertheless, for the sake of convention, the figures refer to outgoing mercury flows as "exports," and to incoming flows as "imports."

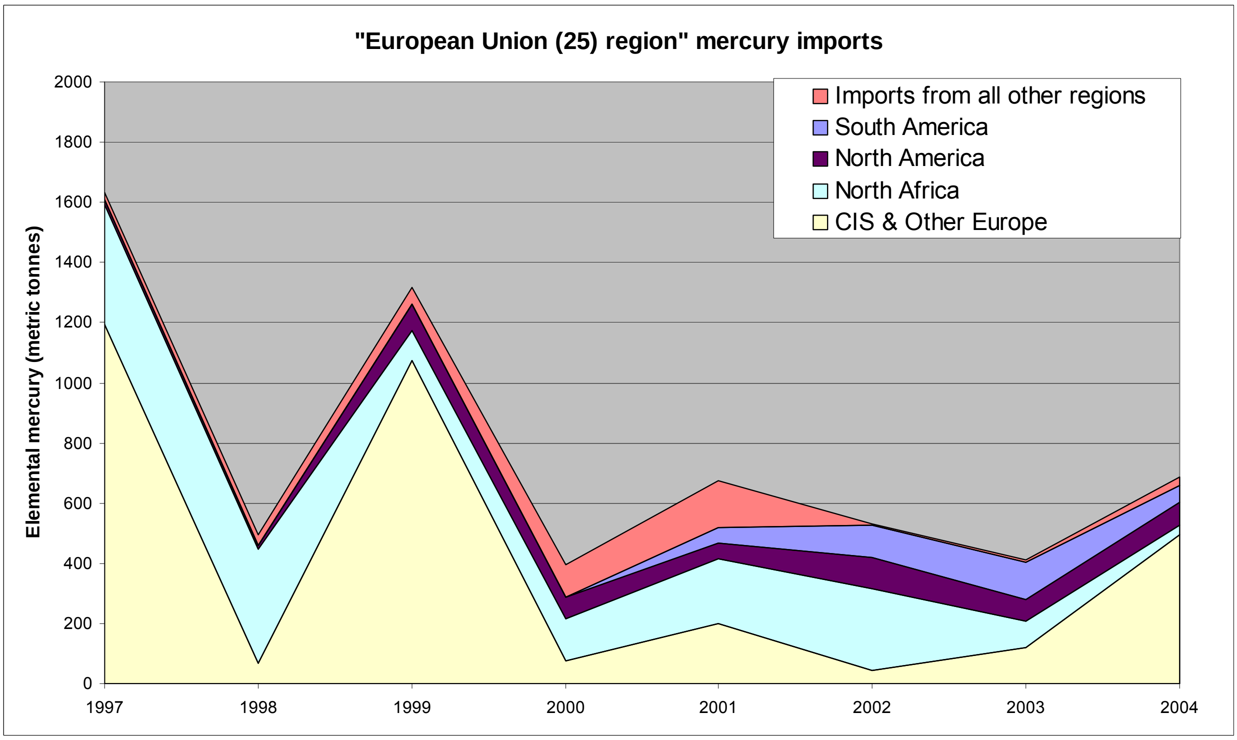
The following figures show first regional imports, then regional exports, and finally, imports compared to exports, or "regional trade." It should be noted that the scale of the figures varies. Larger flows are presented on a scale of 0-2000 tonnes per year, while smaller flows are presented on a scale of 0-600 tonnes per year. No further analysis is provided here.

IMPORT FLOWS OF MERCURY INTO VARIOUS REGIONS OF THE WORLD



IMPORT FLOWS OF MERCURY INTO VARIOUS REGIONS OF THE WORLD





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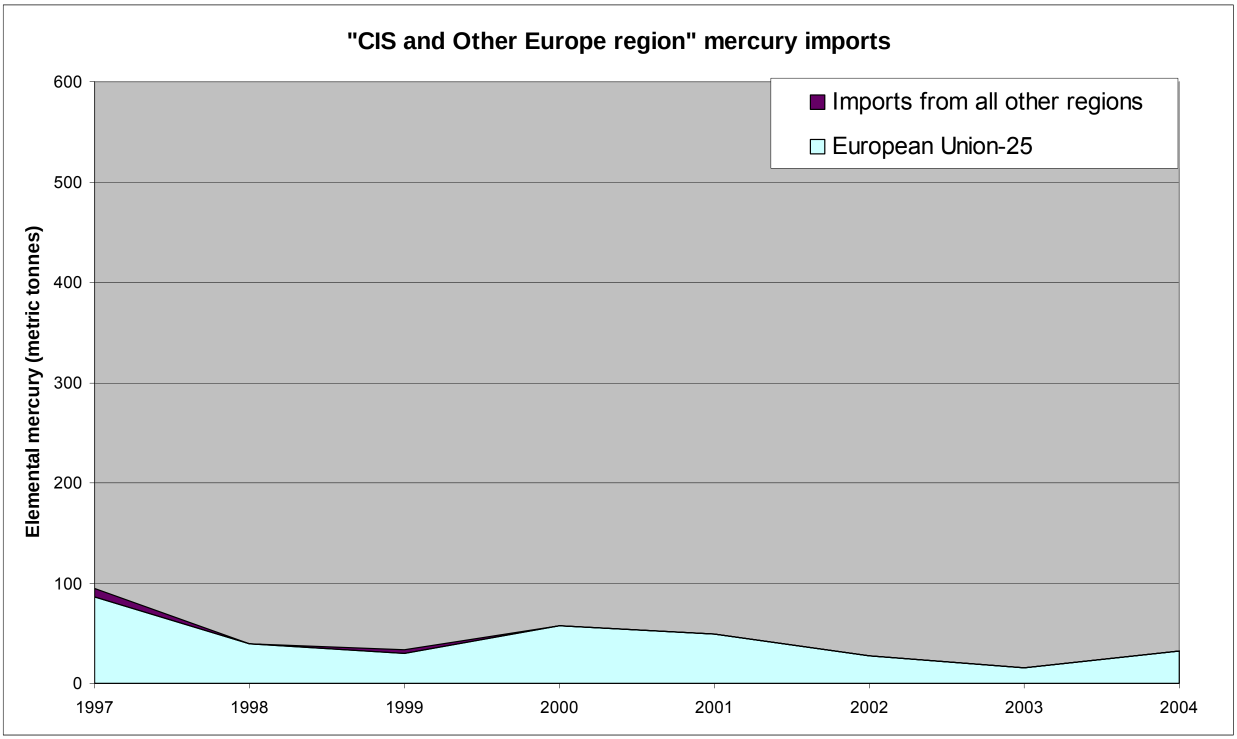

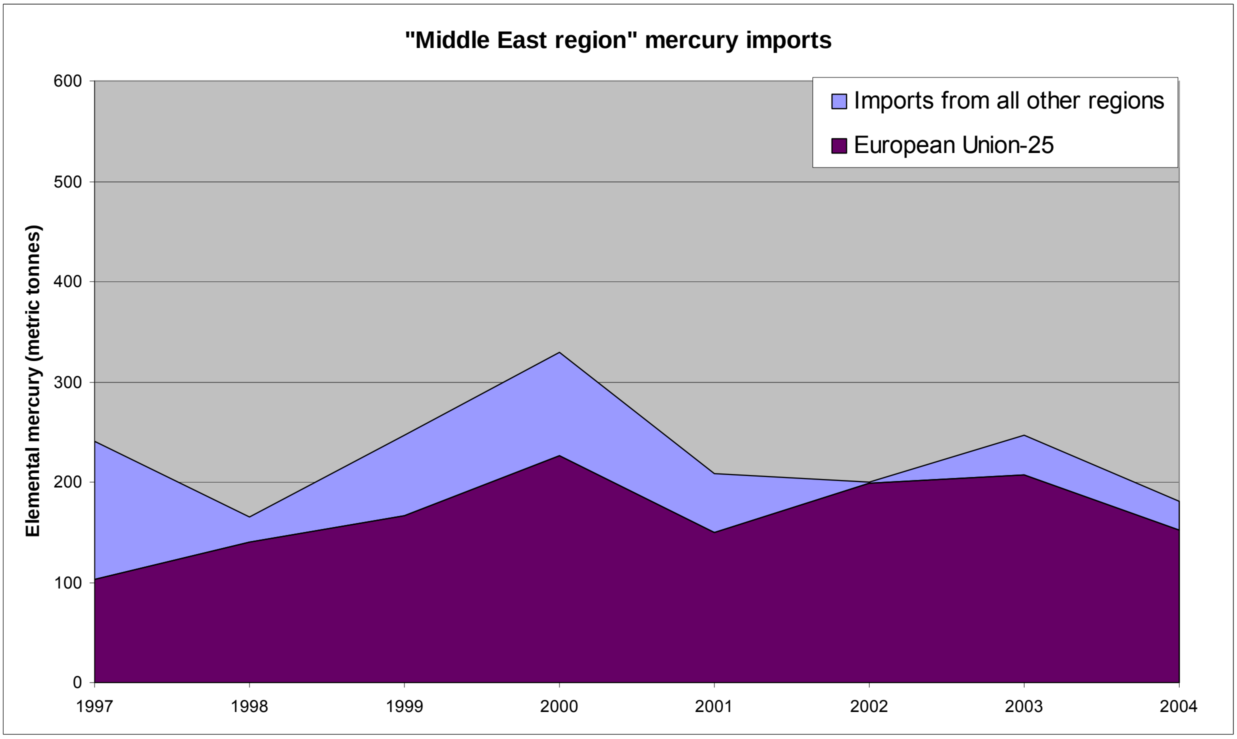

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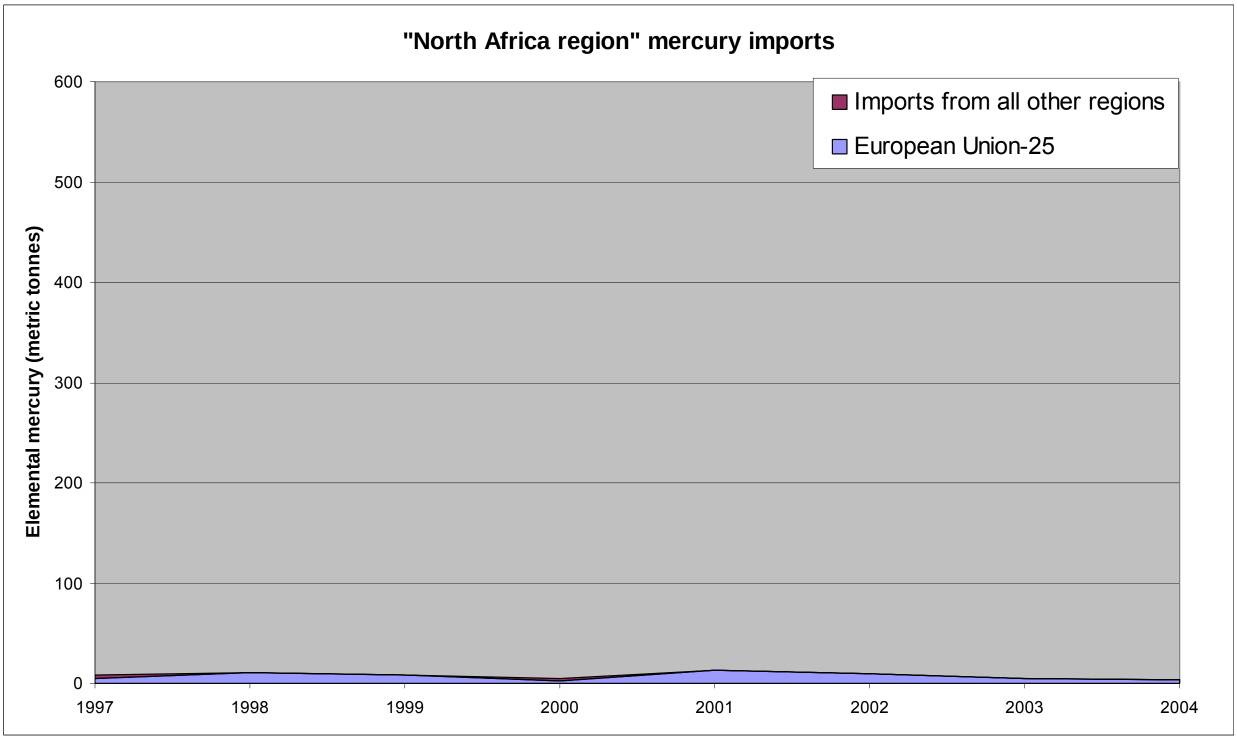

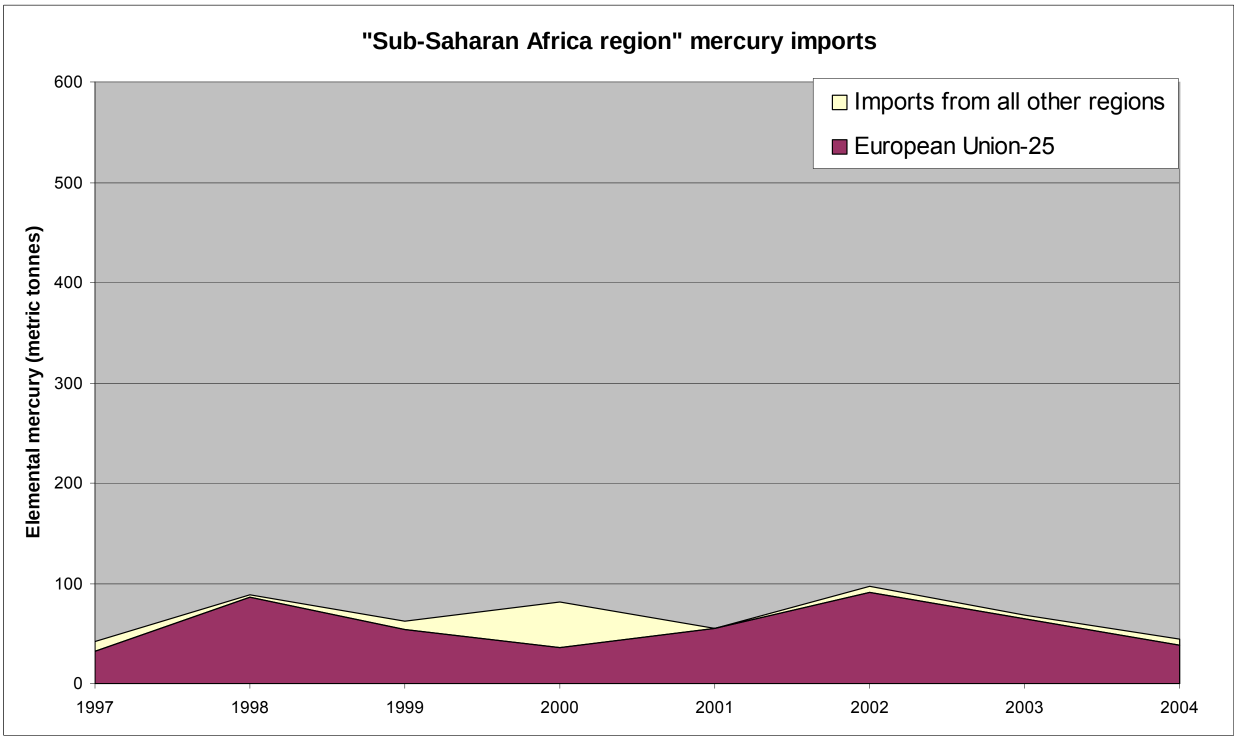

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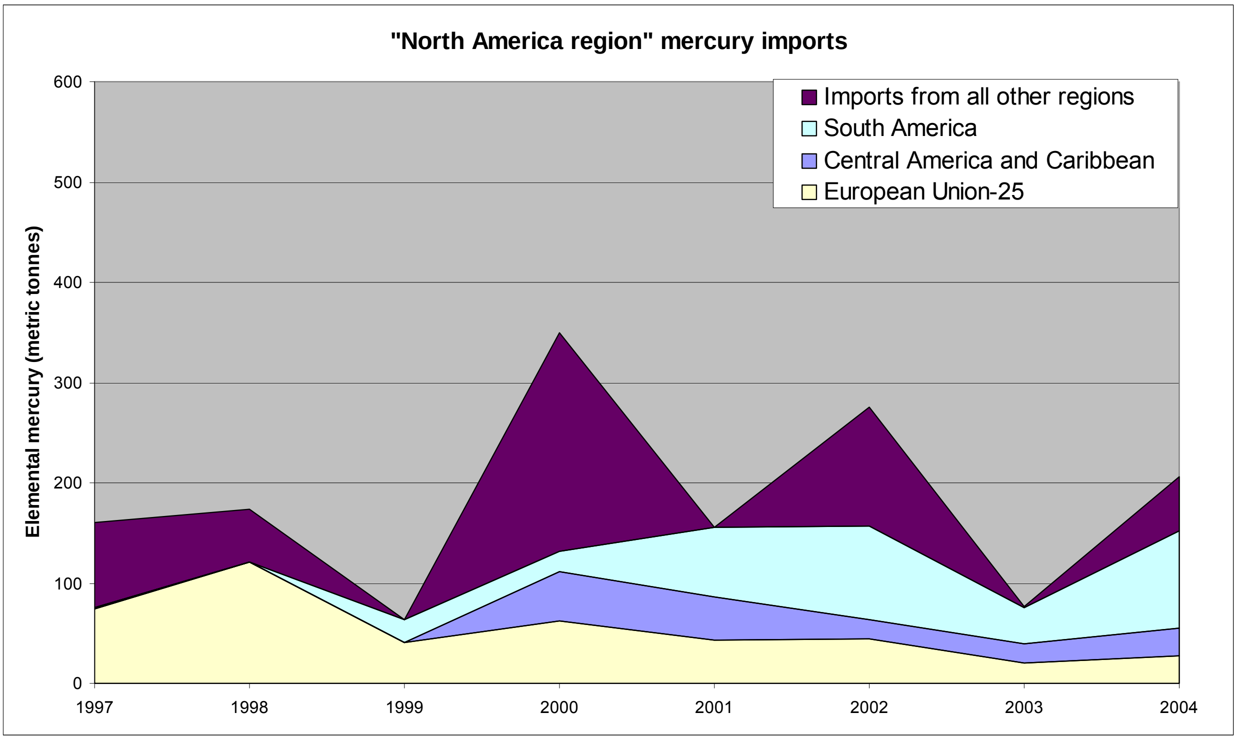

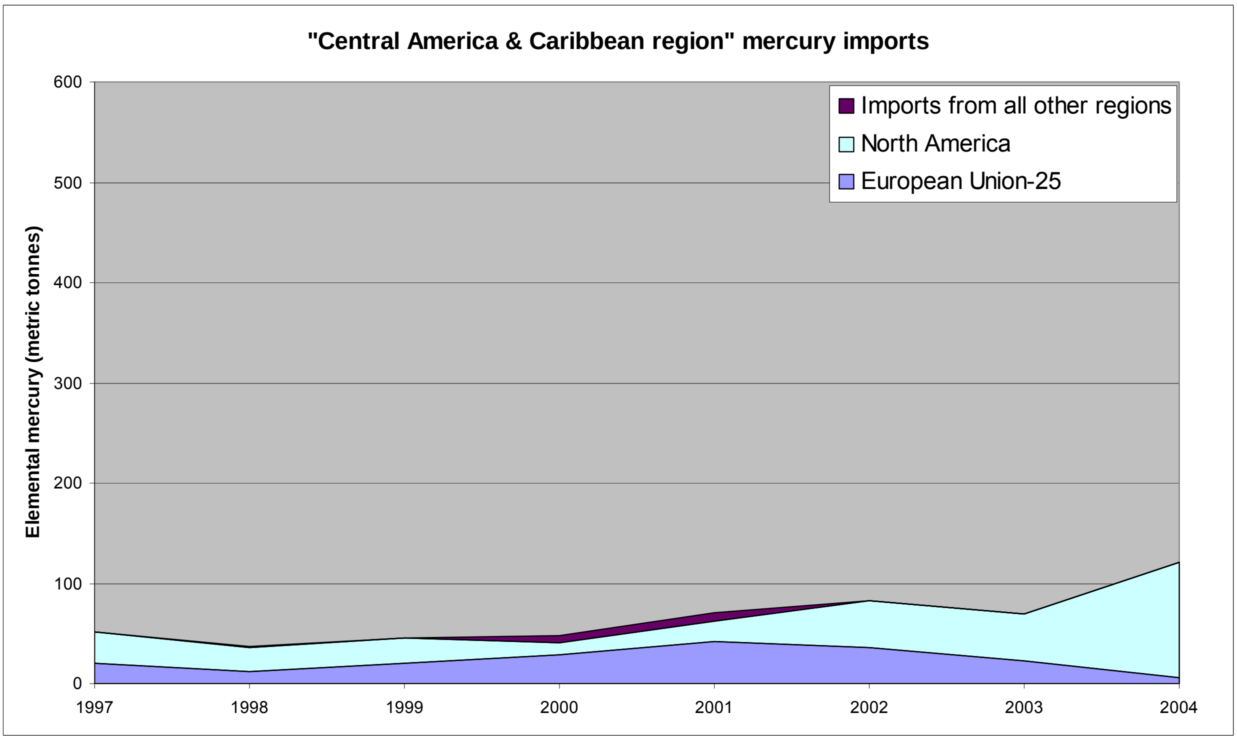

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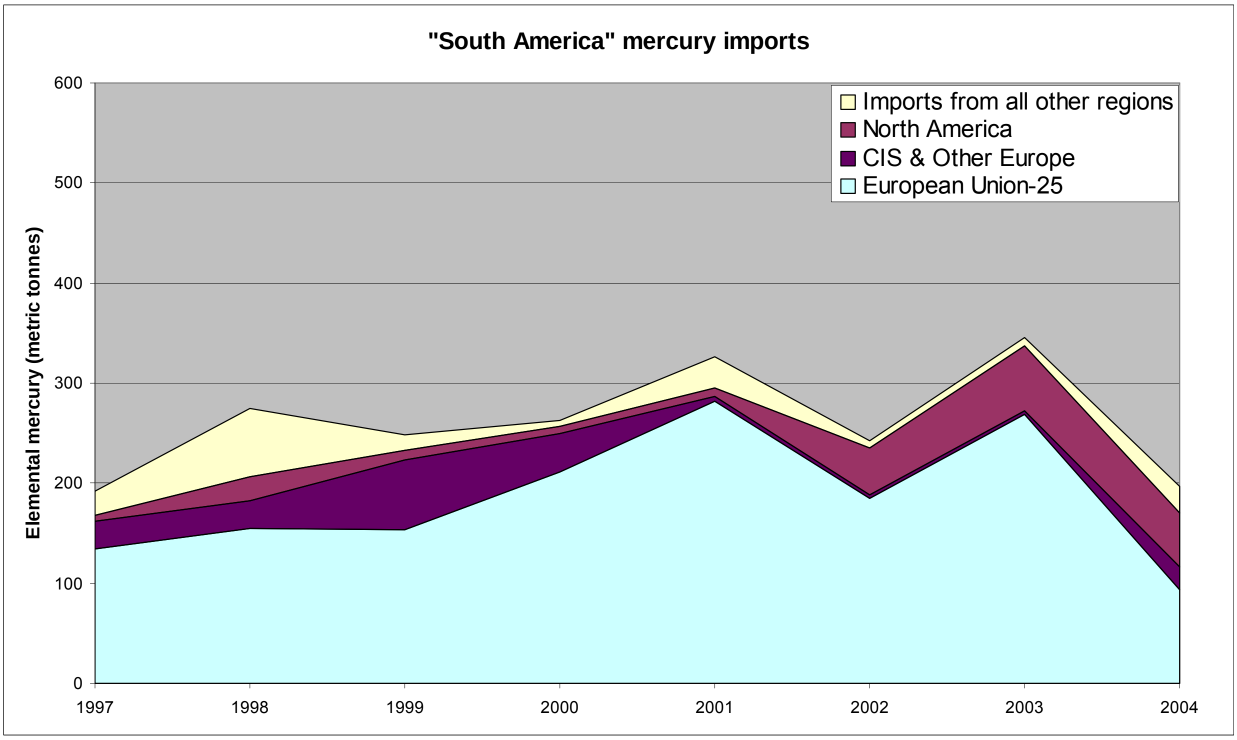
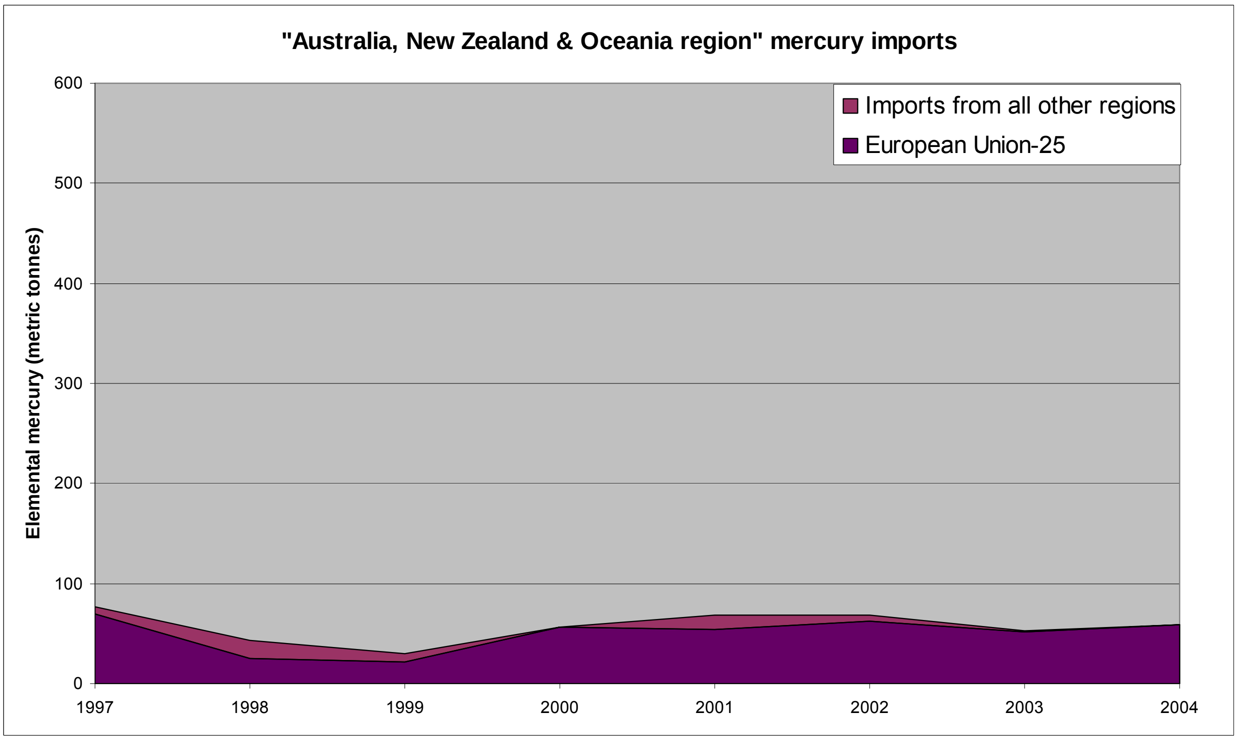
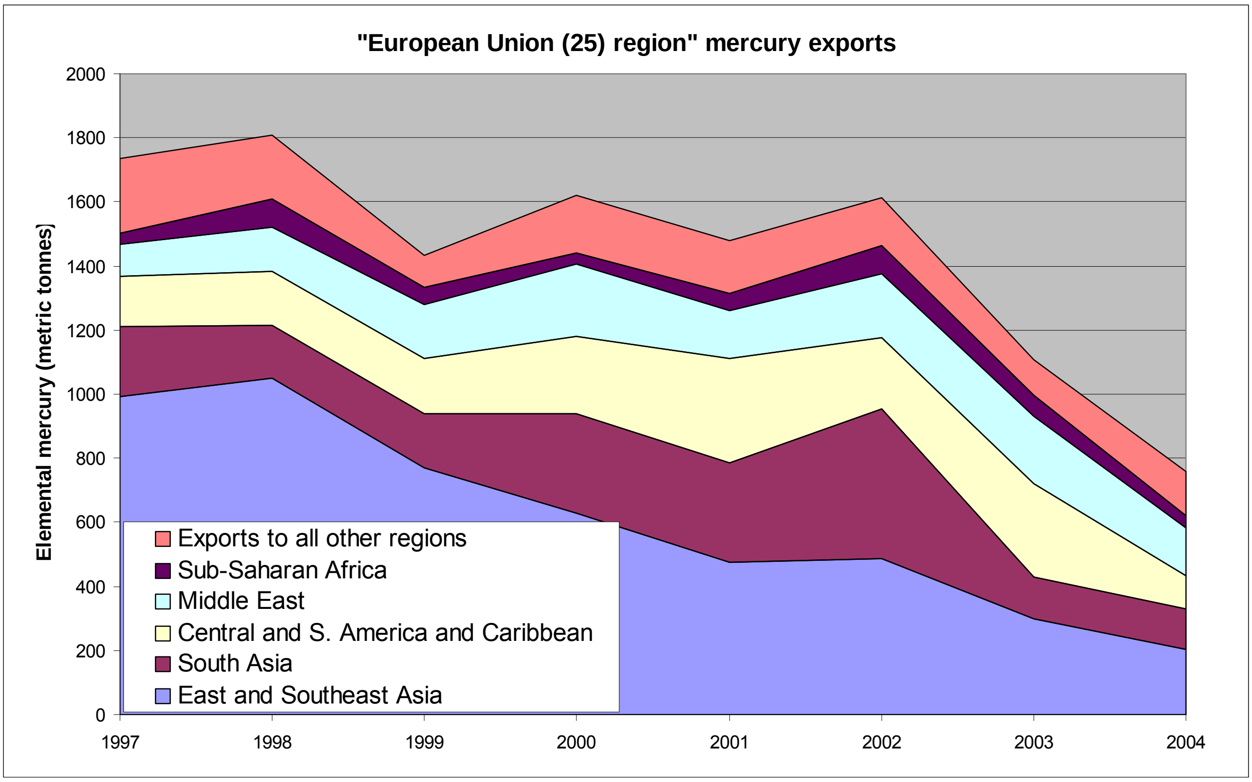
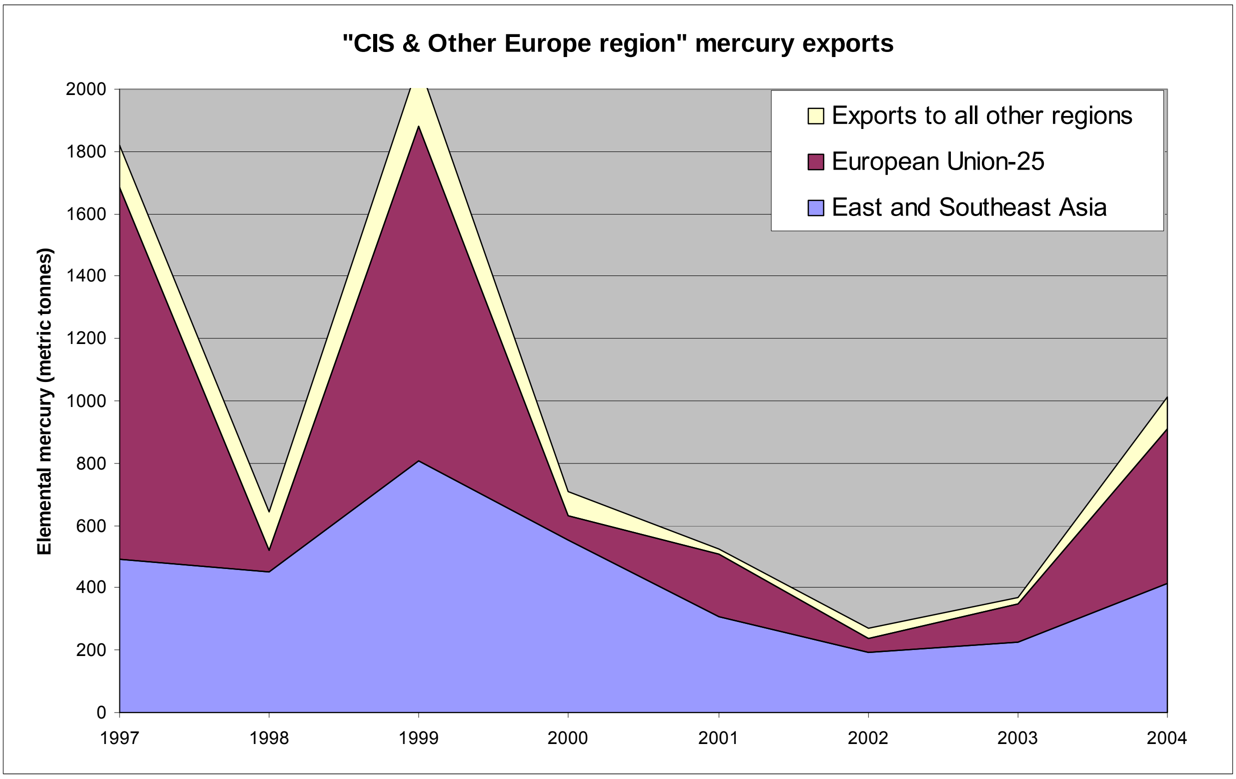




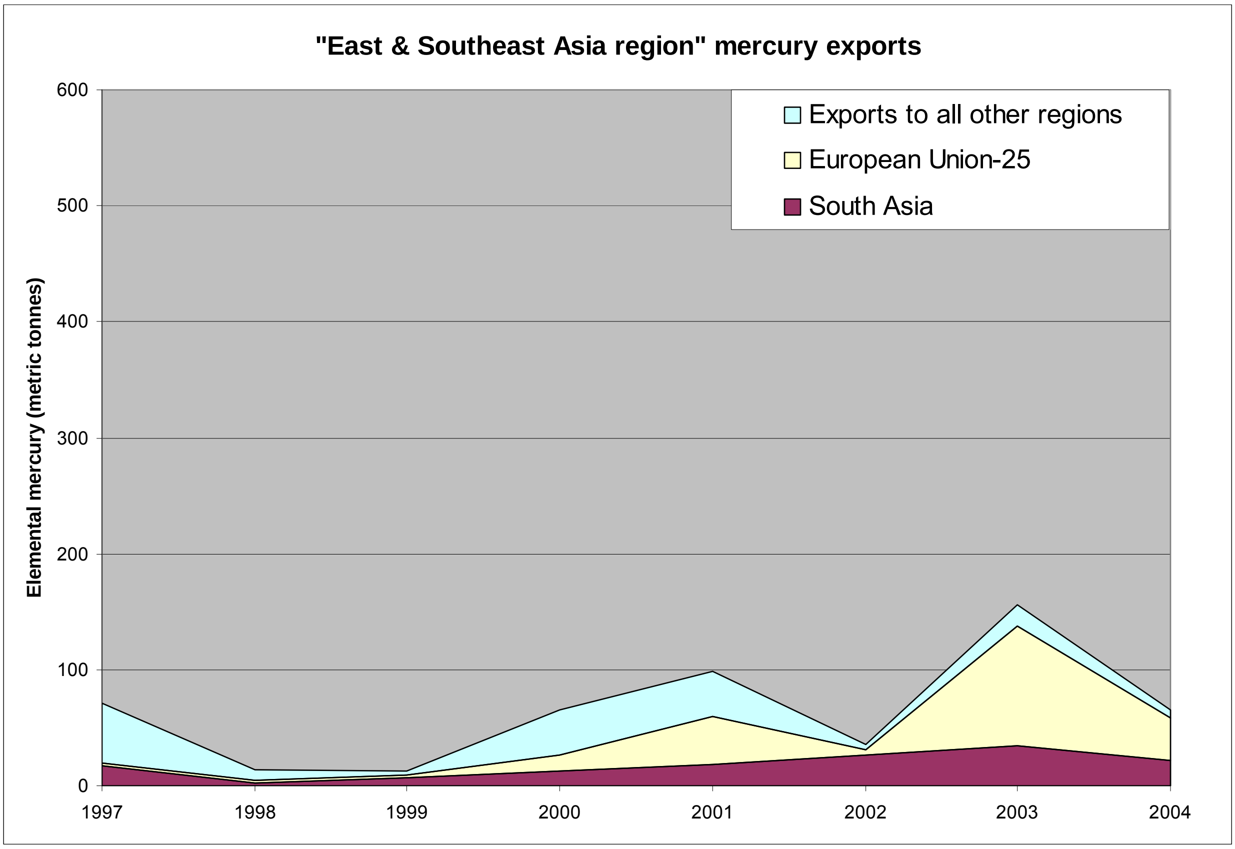
EXPORT FLOWS OF MERCURY INTO VARIOUS REGIONS OF THE WORLD

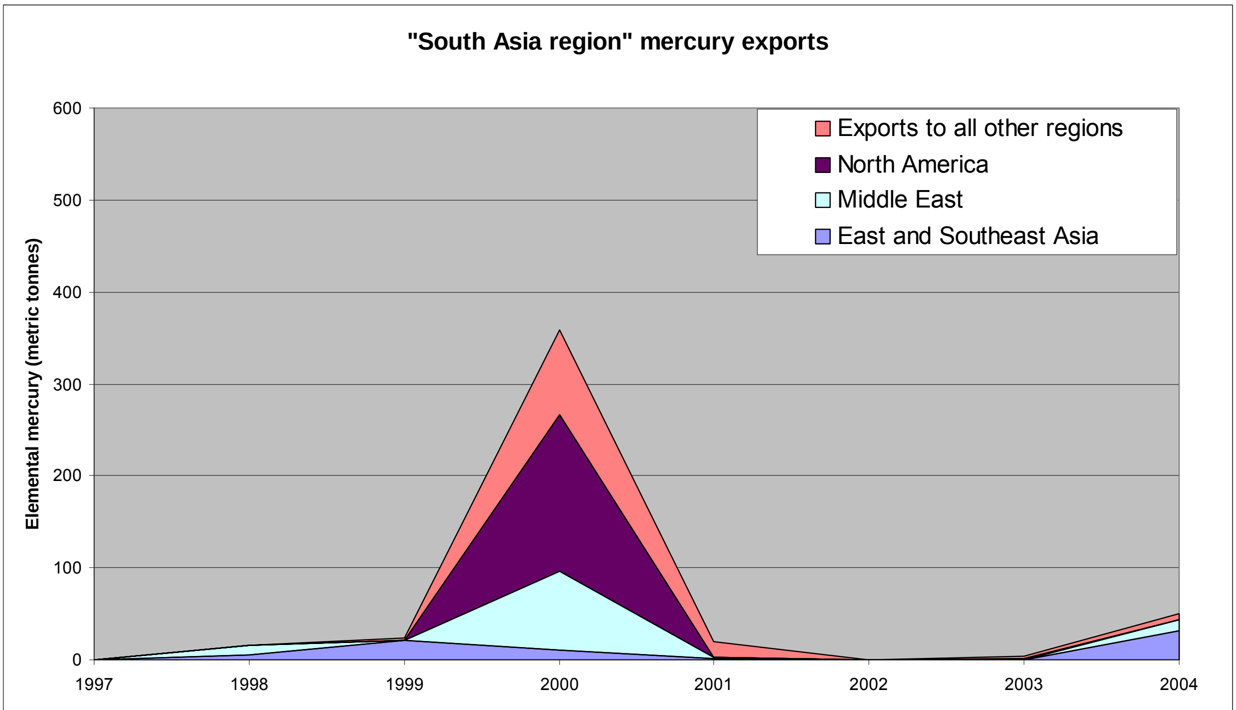




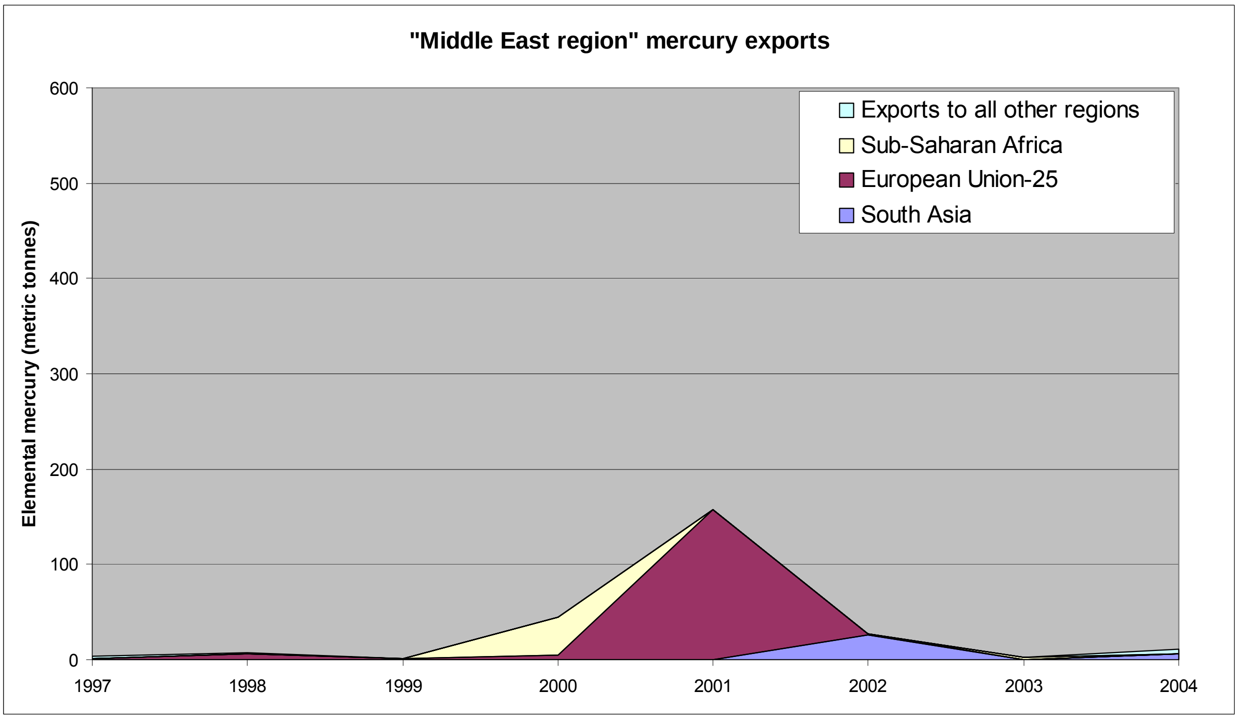
Note: The large "CIS and Other Europe" exports in 2004 (and to a lesser extent, in 2003) are heavily influenced by exports from Switzerland (considered "Other Europe" here) into the European Union.

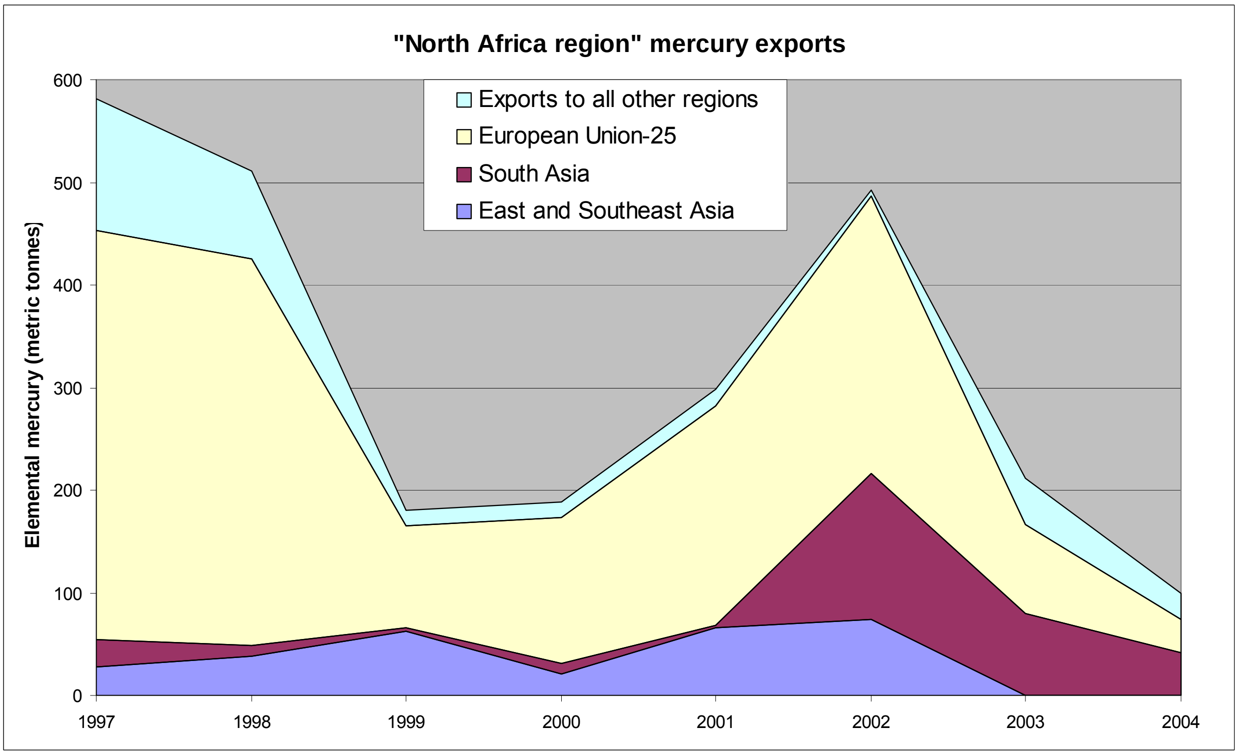
EXPORT FLOWS OF MERCURY INTO VARIOUS REGIONS OF THE WORLD





EXPORT FLOWS OF MERCURY INTO VARIOUS REGIONS OF THE WORLD





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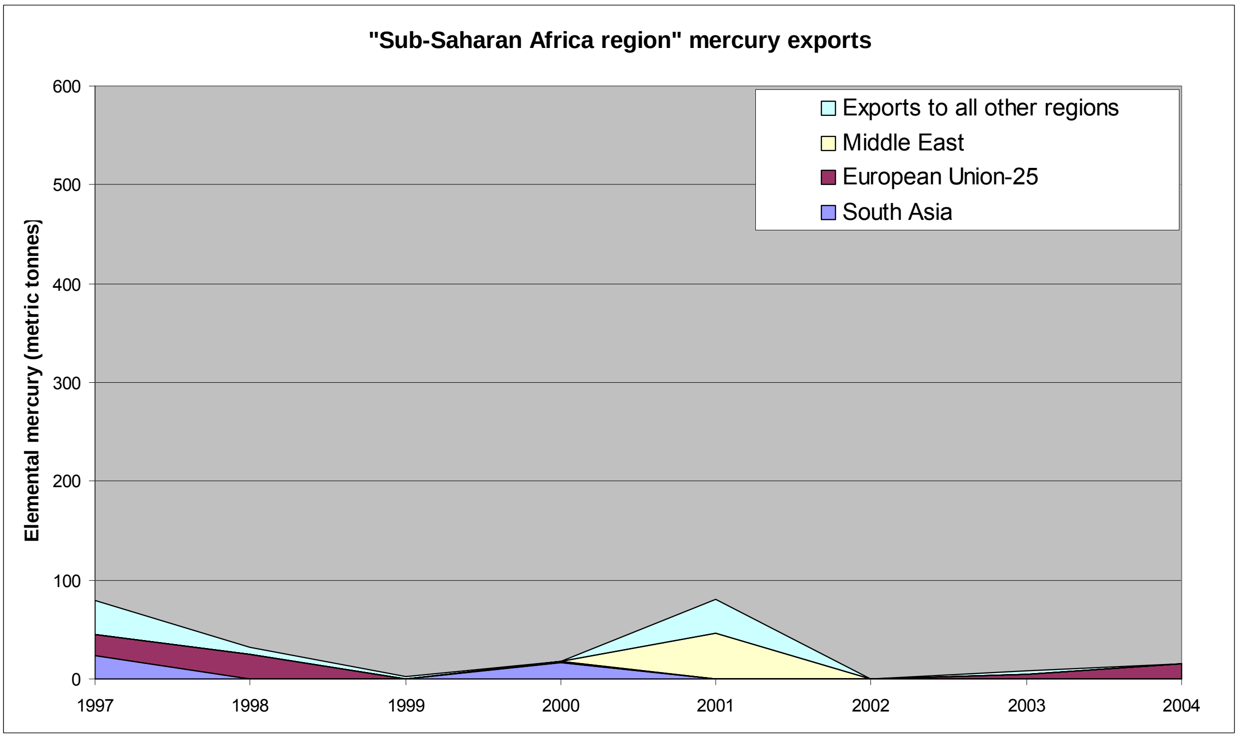

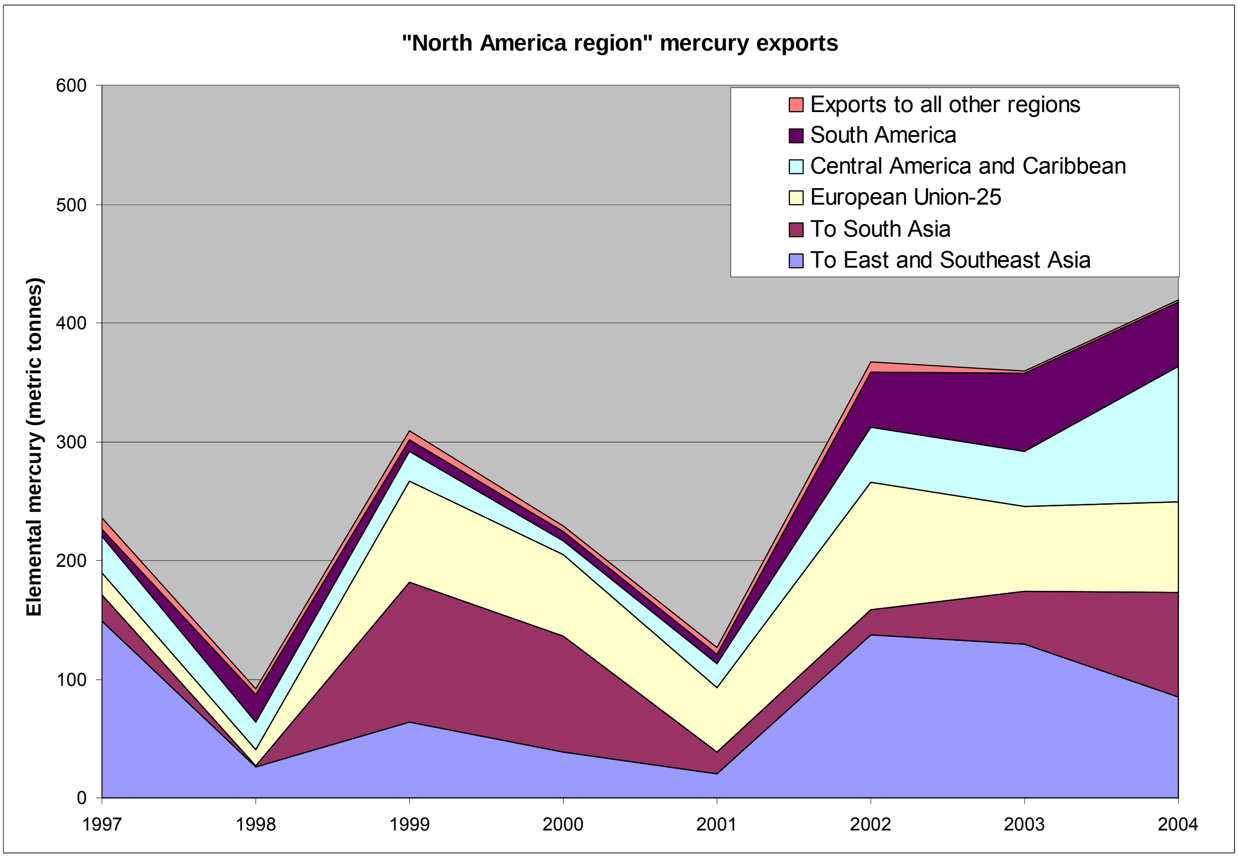

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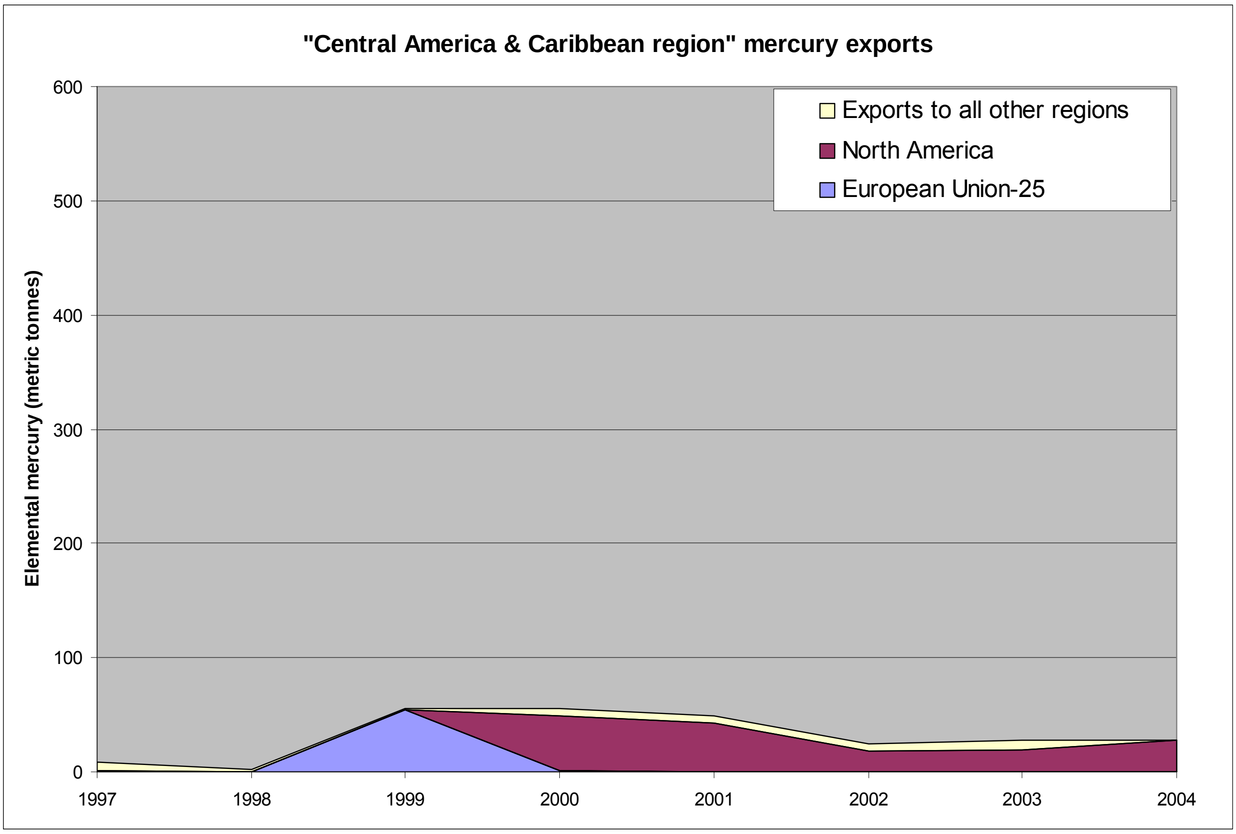
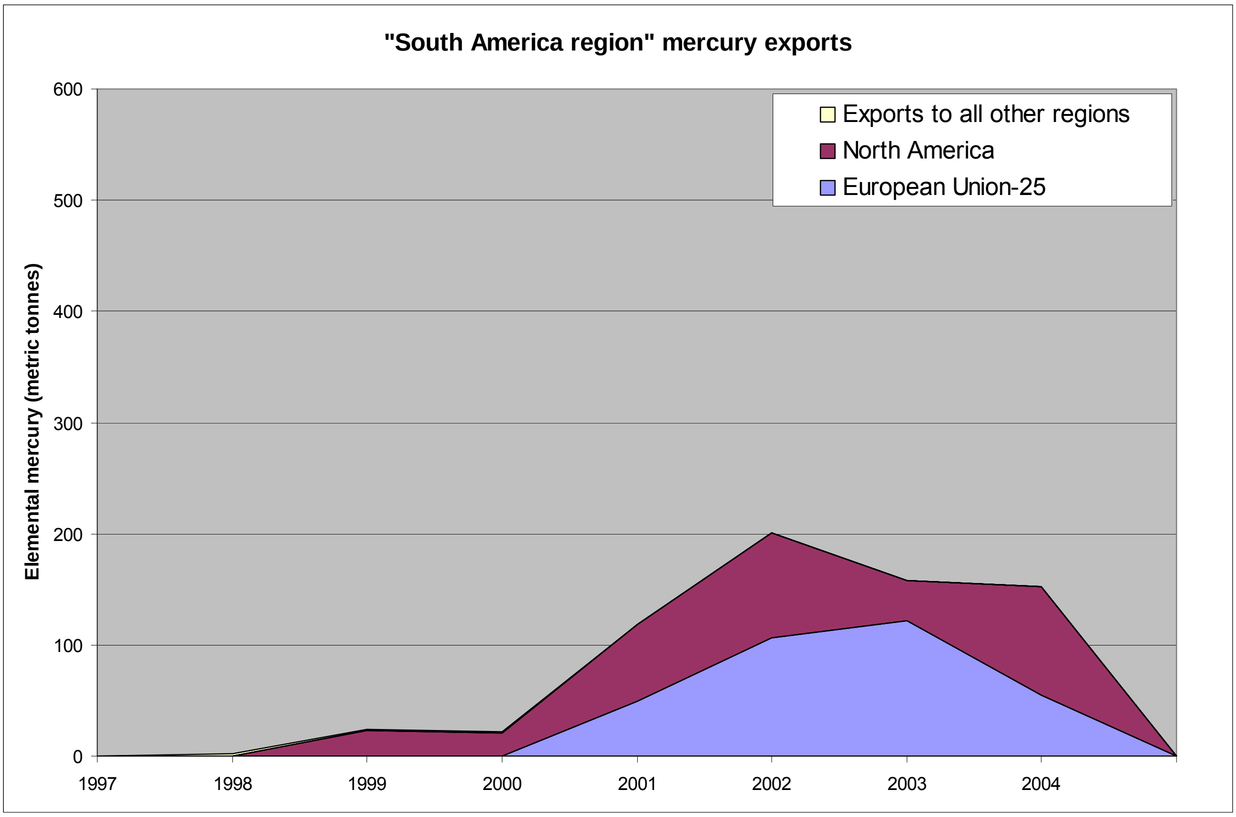
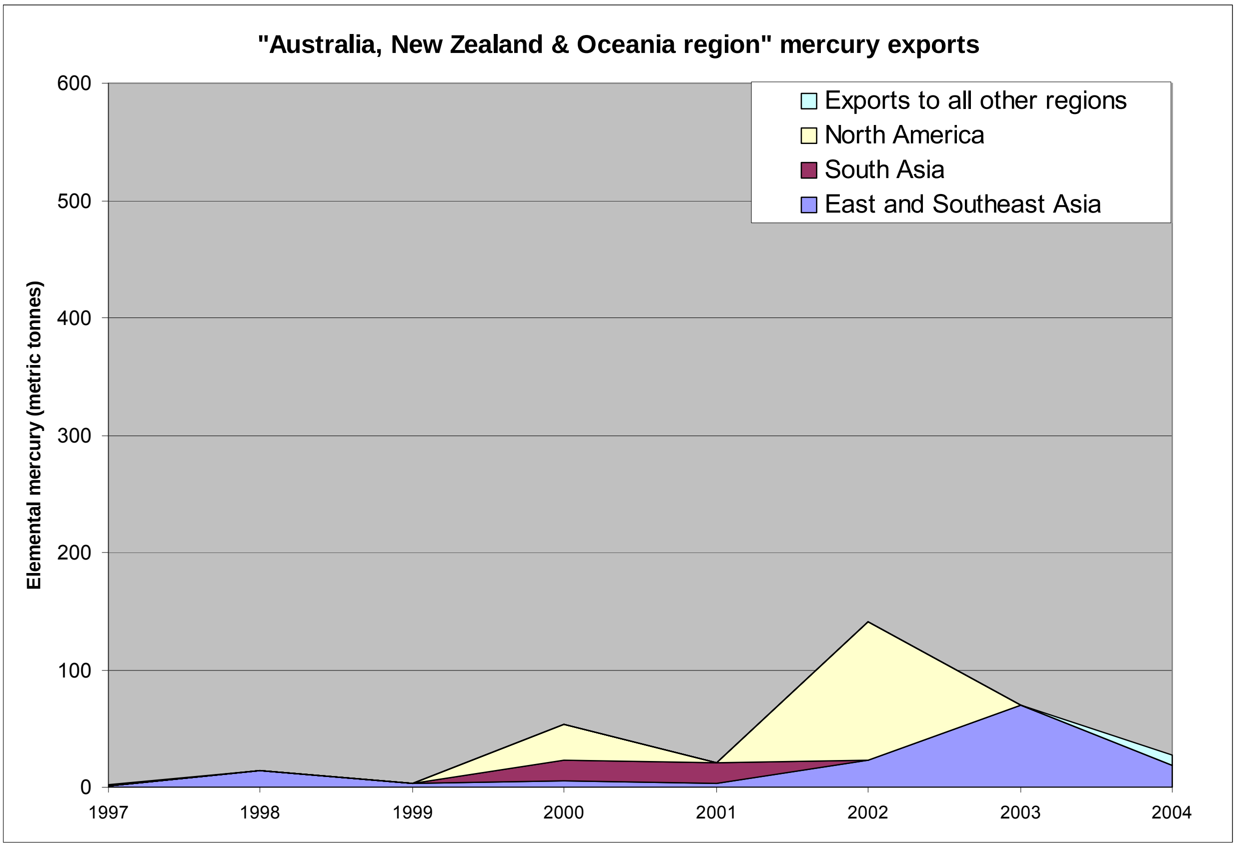
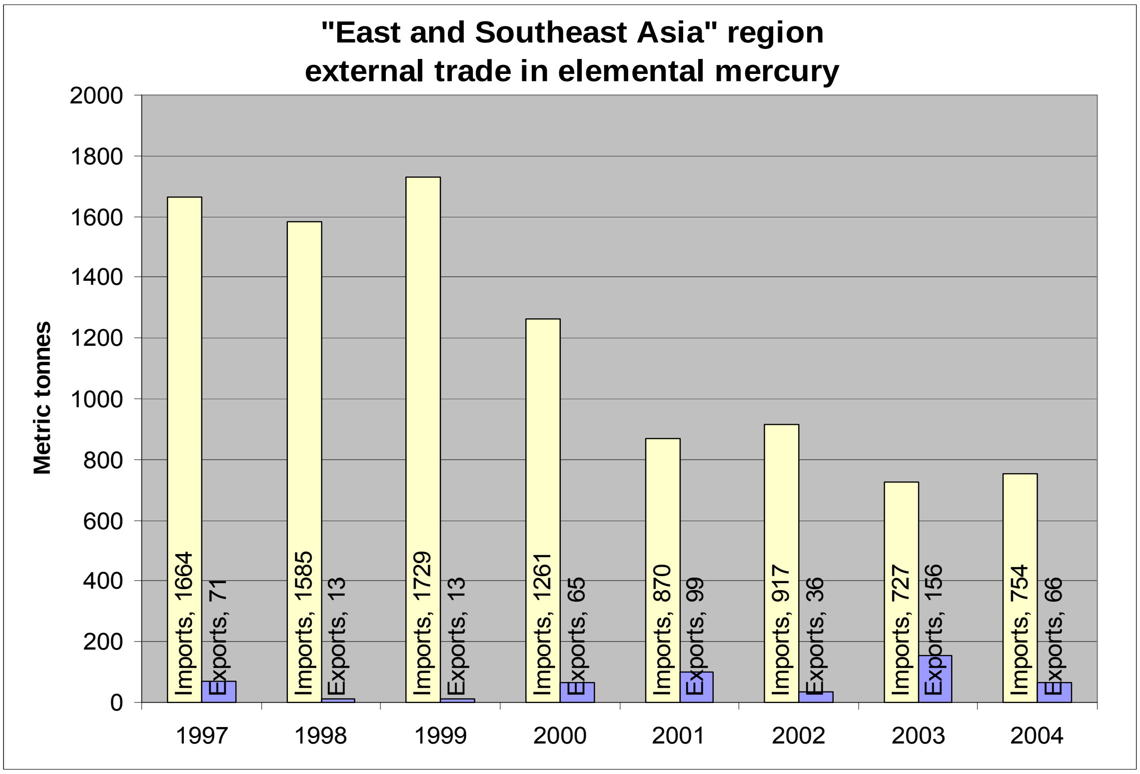


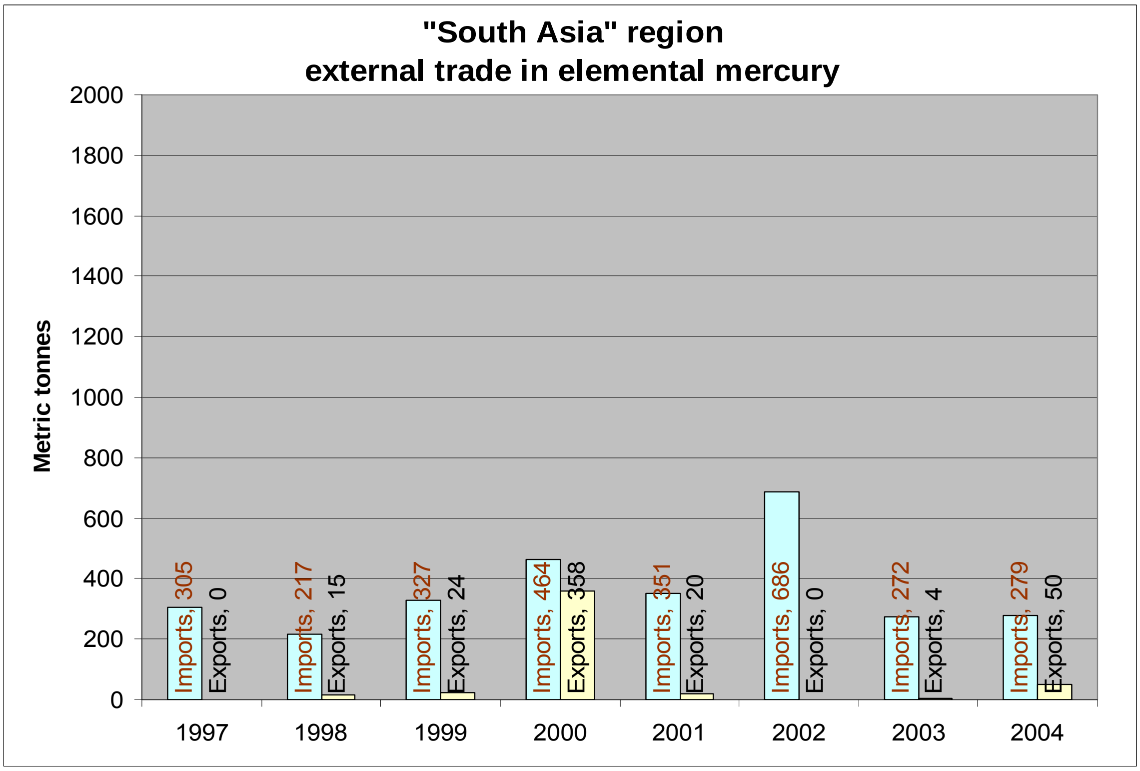


EXPORT FLOWS OF MERCURY INTO VARIOUS REGIONS OF THE WORLD



REGIONAL EXTERNAL TRADE FLOWS OF MERCURY





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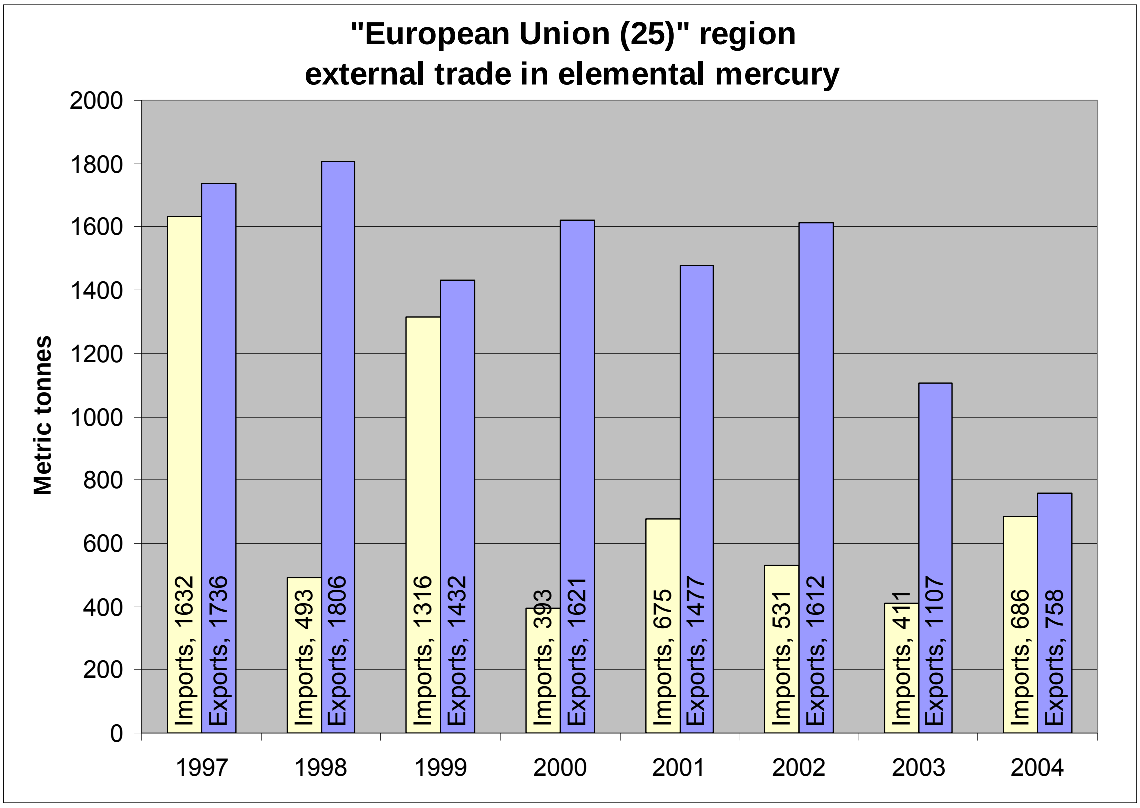

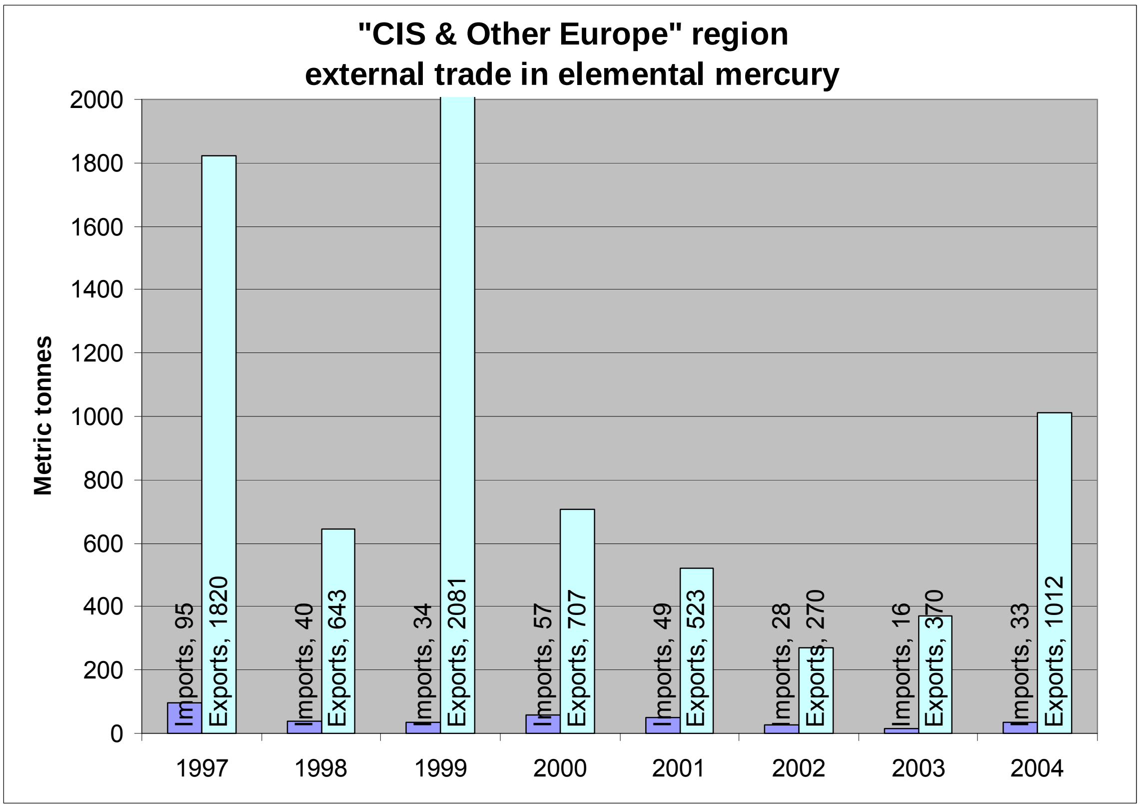

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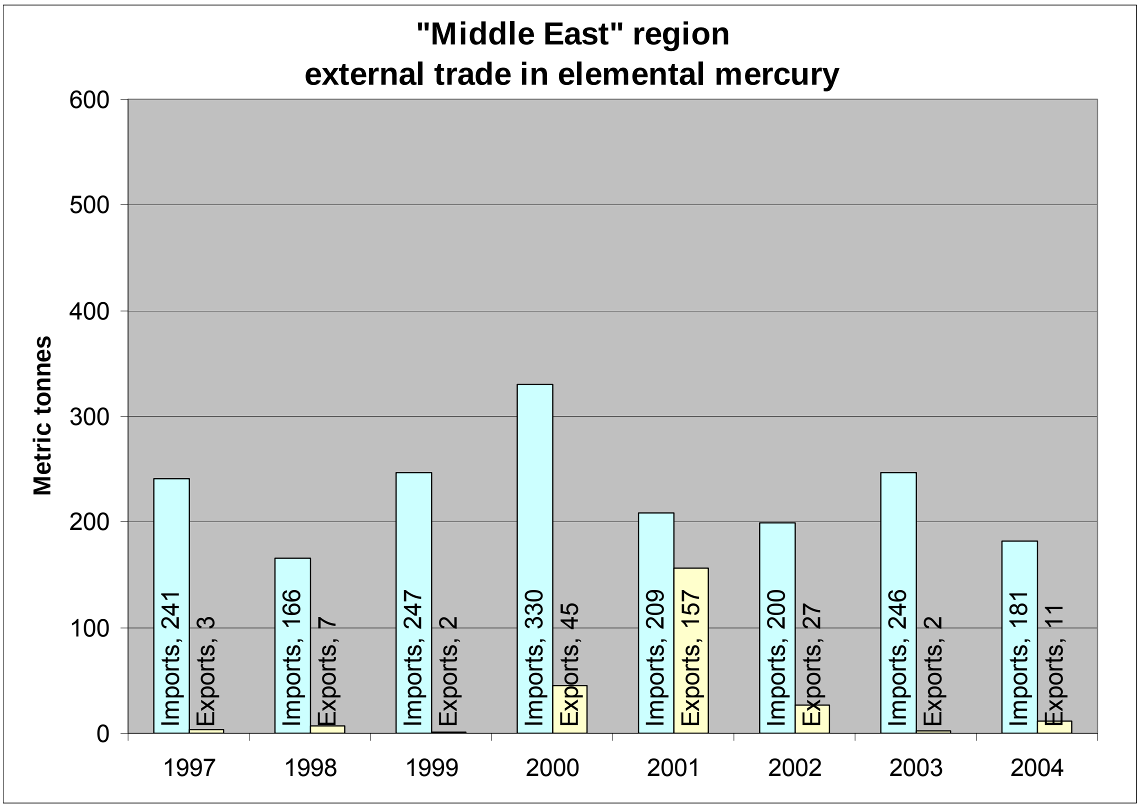

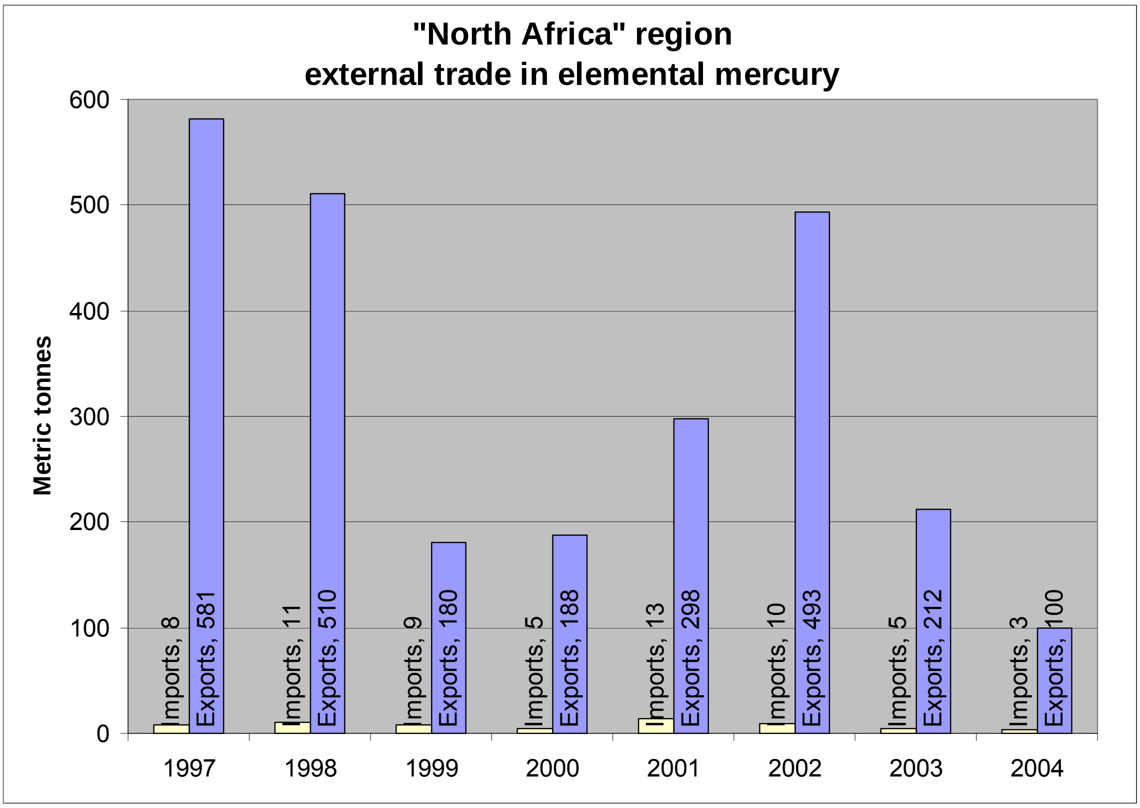

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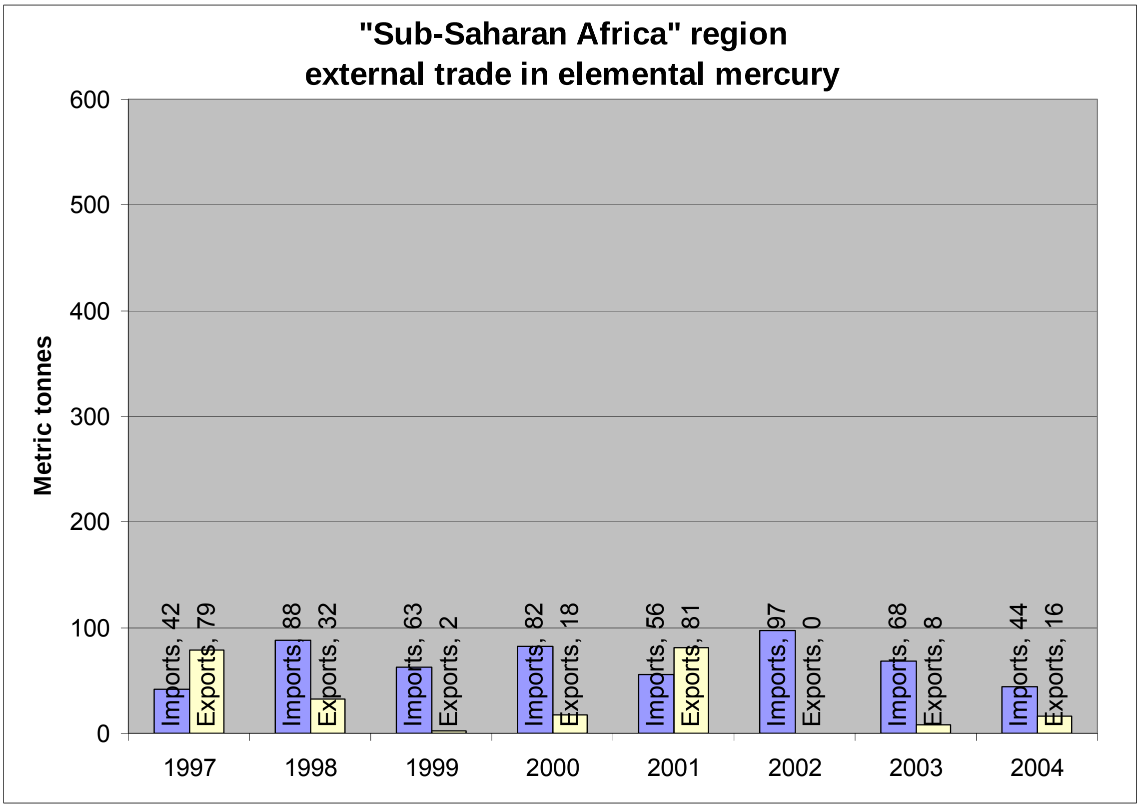

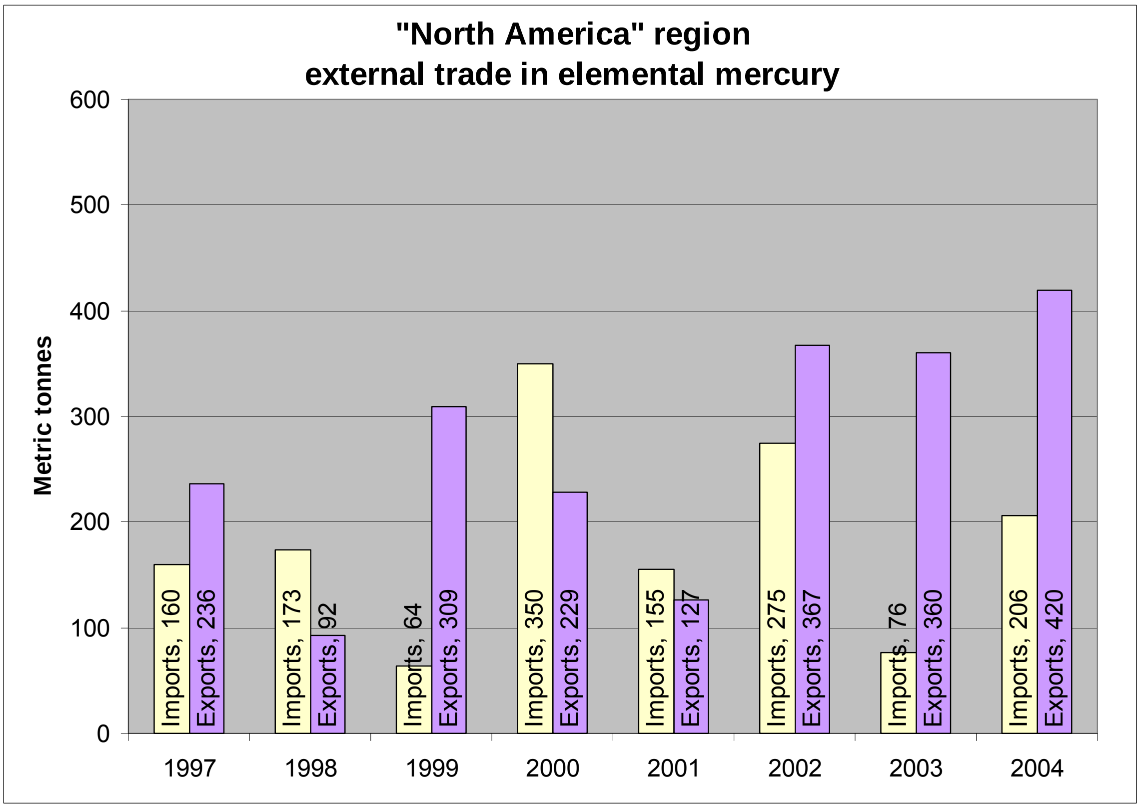

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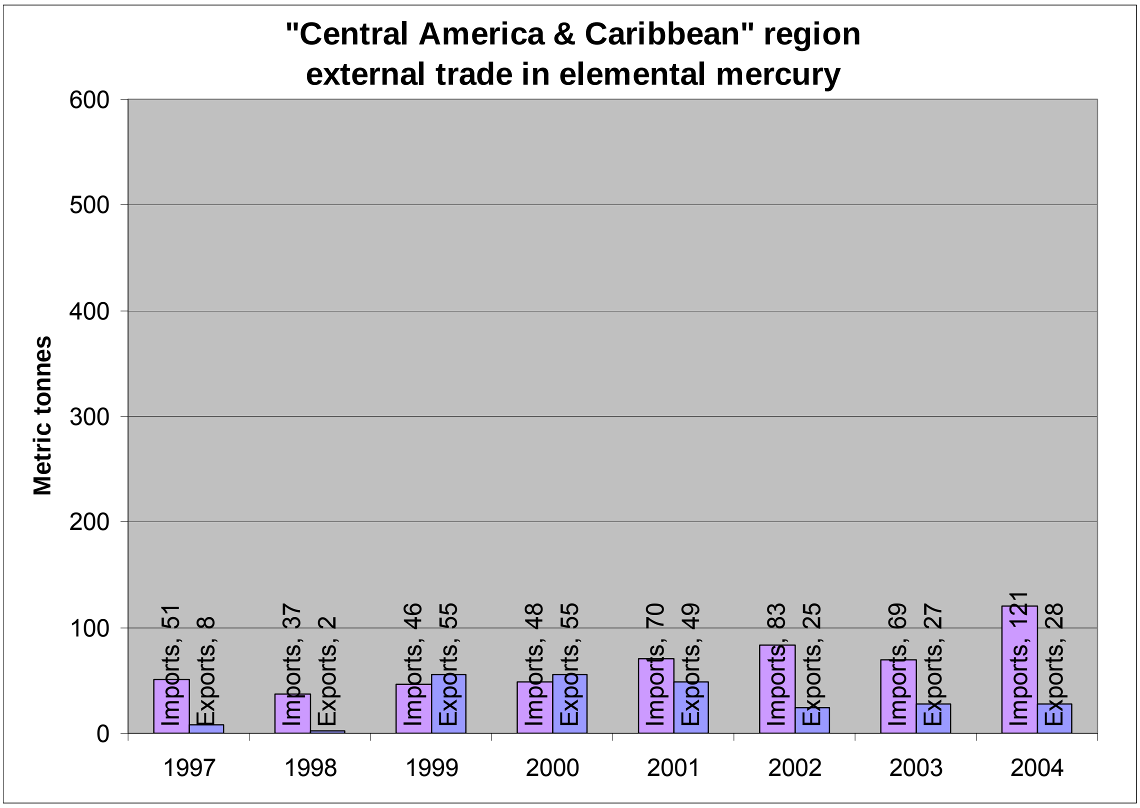

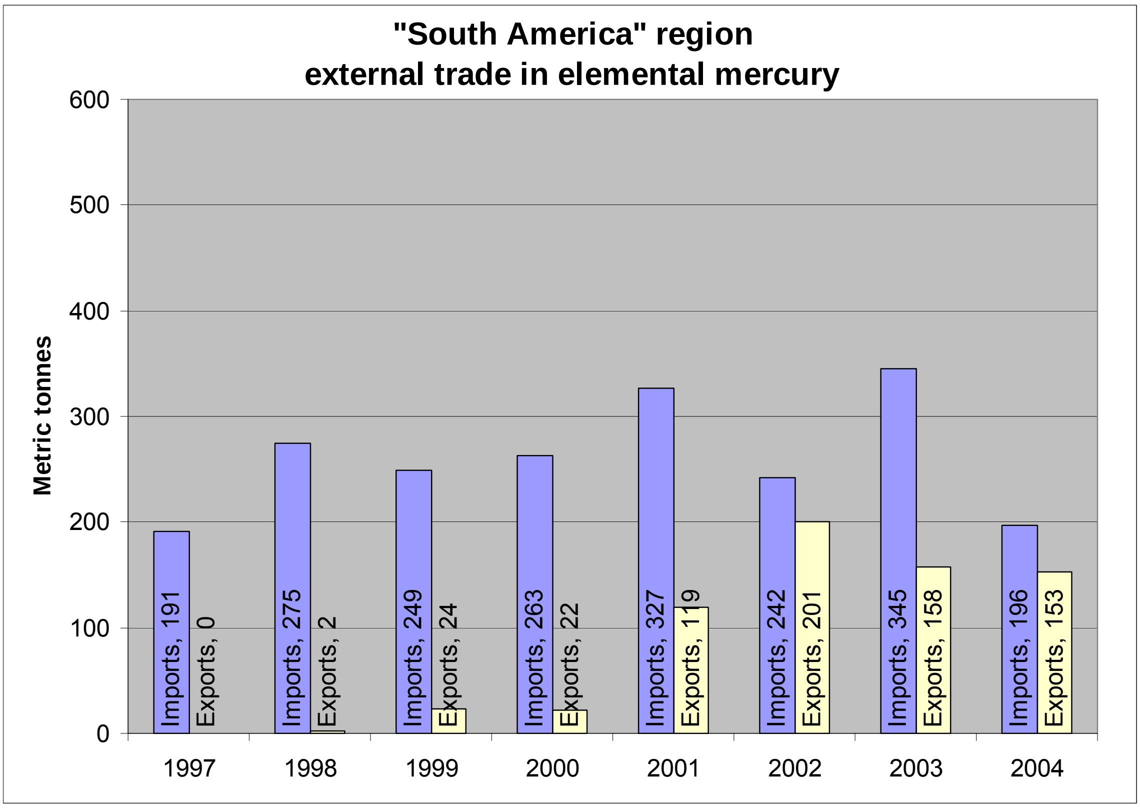

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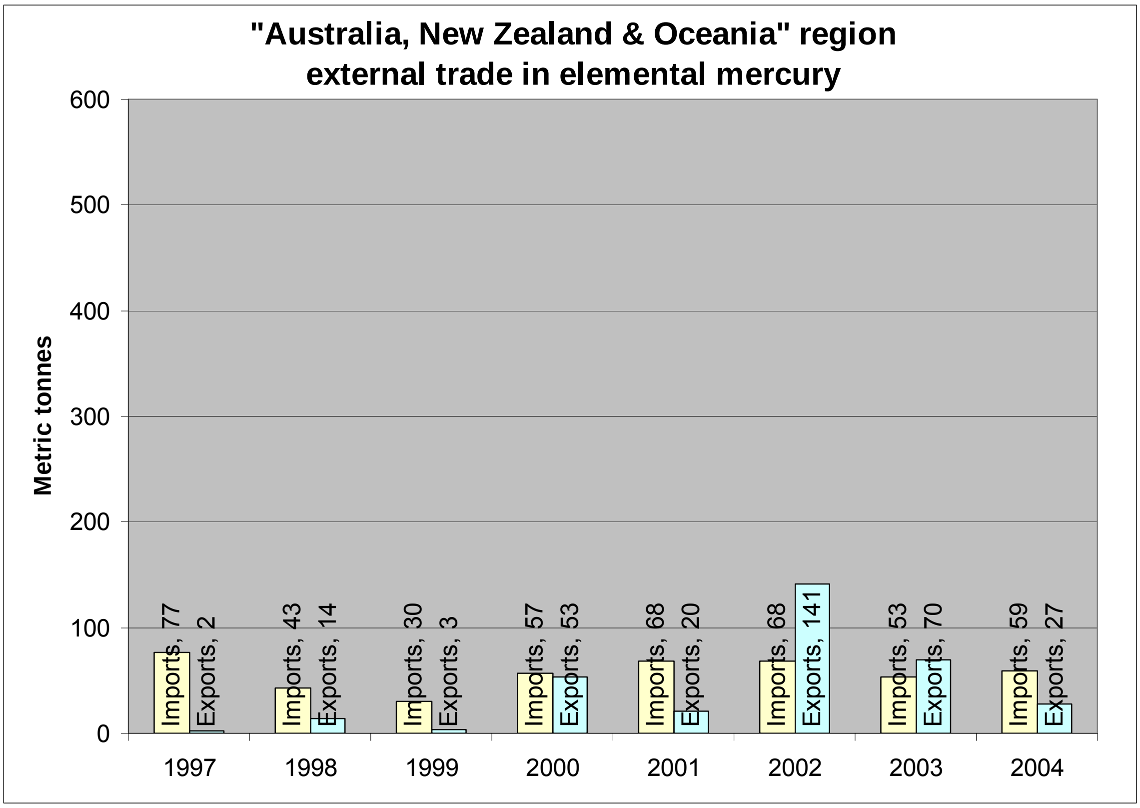

References

1. ACAP (2005) – *Assessment of Mercury Releases from the Russian Federation*. Arctic Council Action Plan to Eliminate Pollution of the Arctic (ACAP), Russian Federal Service for Environmental, Technological and Atomic Supervision & Danish Environmental Protection Agency. Danish EPA, Copenhagen. See http://www.mst.dk/homepage/default.asp?Sub=http://www.mst.dk/udgiv/Publications/2005/87-7614-539-5/html/helepubl_eng.htm
2. ADA (2003) – Draft ADA Assessment of Mercury in the Form of Amalgam in Dental Wastewater in the United States, Environ report to the American Dental Association, November 2003.
3. ADA comments (2006) – Comments submitted by the American Dental Association to the 1 September 2006 draft report, "Summarizing Supply, Trade and Demand Information on Mercury." Available at http://www.chem.unep.ch/mercury/Trade-information.htm
4. Algeria (2000-2005) – Annual statistical reports of Algerian mercury production and exports published as "Résultats du secteur de l'énergie et des mines," available at http://www.mem-algeria.org/fr/statistiques/
5. Boliden (2006) – Extensive information is available about the company and its operations at http://www.boliden.com
6. Brooks and Matos (2005) – W Brooks and G Matos, Mercury Recycling in the United States in 2000, U.S. Geological Survey, 2005.
7. CCCSD (2006) – Dental Offices and Mercury Pollution, Central Contra Costa Sanitary District, Contra Costa, California, USA, 2006.
8. Chlorine Institute (2006) – Ninth Annual Report to EPA – For the Year 2005, The Chlorine Institute, Inc. 15 May 2006, available at www.chlorineinstitute.org.
9. Colombia comments (2006) – Comments submitted by Colombia to the 1 September 2006 draft report, "Summarizing Supply, Trade and Demand Information on Mercury." Available at http://www.chem.unep.ch/mercury/Trade-information.htm
10. CSE (2002) – S Narain, Down to Earth, *Science and Environment Fortnightly*, Centre for Science and Environment, 15 September 2002.
11. DNSC (2003) – *Draft Mercury Management Environmental Impact Statement*, Defense National Stockpile Center (DNSC), Defense Logistics Agency (DLA), Department of Defense, Washington DC, 2003.
12. DNSC (2004) – See Record of Decision at www.mercuryeis.com.
13. Echeverria *et al.* (2006) – D Echeverria, JS Woods, NJ Heyer, D Rohlman, FM Farin, T Li and CE Garabedian. The association between a genetic polymorphism of coproporphyrinogen oxidase, dental mercury exposure and neurobehavioral response in humans. *Neurotoxicol Teratol* 2006; 28: 39-48.
14. ENS (2005) – Italian Chlorine Producers Funded to Replace Mercury Process, Environmental News Service, Brussels, Belgium, March 21, 2005.
15. Euro Chlor (2005) – Chlorine Industry Review 2004-2005, Euro Chlor, Brussels, August 2005. See www.eurochlor.org.
16. European Commission (2001) – Integrated pollution prevention and control (IPPC) - Reference document on best available techniques in the non ferrous metals industry. European IPPC Bureau, Sevilla. Available at: http://eippcb.jrc.es/pages/Fmembers.htm.
17. European Commission (2005) – Communication on the Community Strategy Concerning Mercury. Brussels, 28.01.2005 COM(2005) 20 final {SEC(2005) 101}.
18. FDA (2006) – Joint Meeting of the Dental Products Panel (CDRH) and the Peripheral and Central Nervous System Drugs Advisory Committee (CDER) - September 6-7, 2006, Gaithersburg, Maryland, USA. A complete transcript is available at: http://www.fda.gov/ohrms/dockets/ac/cdrh05.html#DentalProducts
19. Feng (2004) – X Feng, *Mercury Pollution in China – An Overview*, State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, People's Republic of China, 2004.
20. Fialka (2006) – J Fialka, "Backfire: How Mercury Rules Designed for Safety End Up Polluting," *Wall Street Journal*, New York, NY, 20 Apr 2006.
21. Finland comments (2006) – Comments submitted by Finland to the 1 September 2006 draft report, "Summarizing Supply, Trade and Demand Information on Mercury." Available at http://www.chem.unep.ch/mercury/Trade-information.htm
22. Global Village (2006) – Executive Finding of Mercury Investigation in Guizhou, Global Village of Beijing, Beijing, People's Republic of China, 2006.
23. GMP (2006) – Global Impacts of Mercury Supply and Demand in Small-Scale Gold Mining, Report to the UNEP Governing Council Meeting to take place in Nairobi in February 2007, GEF/UNDP/UNIDO Global Mercury Project EG/GLO/01/G34, October 2006.

24. HCWH (2004) – Health Care Without Harm. Comments on the Consultation Document: Development of an EU Mercury Strategy from 15 March 2004. Health Care Without Harm Europe. See http://www.noharm.org/mercury/mercuryFree for a list of pharmacies no longer selling mercury, or http://www.sustainablehospitals.org, www.inform.org, and www.h2e-online.org

25. Hylander and Meili (2003) – LD Hylander and M Meili, "500 years of mercury production: global annual inventory by region until 2000 and associated emissions," *The Science of the Total Environment*, 304 (2003) 13–27.

26. Hylander (2005) – LD Hylander and M Meili, "The Rise and Fall of Mercury: Converting a Resource to Refuse After 500 Years of Mining and Pollution," *Critical Reviews in Environmental Science and Technology*, vol. 34.

27. Hylander (2006) – LD Hylander, A Lindvall and L Gahnberg, High mercury emissions from dental clinics despite amalgam separators. *Sci. Total Environ*. 362:74-84.

28. ILZSG (2006) – "Lead and Zinc Statistics," International Lead and Zinc Study Group, Geneva. http://www.ilzsg.org/ilzsgframe.htm

29. Jones and Miller (2006) – G Jones and G Miller, Mercury and Modern Gold Mining in Nevada, report to U.S. Environmental Protection Agency, Region IX, by the Department of Natural Resources and Environmental Sciences, University of Nevada, Reno, Nevada, U.S.A., 24 October 2005.

30. Lassen *et al.* (2004) – C Lassen (Ed.), YA Treger, EP Yanin, BA Revich, BE Shenfeld, SV Dutchak, NA Ozorova, TG Laperdina and VL Kubasov. "Assessment of mercury releases from the Russian Federation." Ministry of Natural Resources of the Russian Federation, Danish Environment Protection agency, Arctic Council. Draft, 2004.

31. Lawrence (2002) – B Lawrence, Director, Bethlehem Apparatus, presentation at Mercury Conference, Boston, May 2002.

32. Lebanon comments (2006) – Comments submitted by Lebanon to the 1 September 2006 draft report, "Summarizing Supply, Trade and Demand Information on Mercury." Available at http://www.chem.unep.ch/mercury/Trade-information.htm

33. Masters (2006) – Personal communications between H Masters, Mng. Director, Lambert Metals, and P Maxson.

34. Maxson (2004) – *Mercury flows in Europe and the world: The impact of decommissioned chlor-alkali plants*, report for the European Commission – DG Environment (Brussels: February 2004).

35. Maxson (2005) – "Global mercury production, use and trade." Chapter in: Dynamics of Mercury Pollution on Regional and Global Scales – Atmospheric Processes and Human Exposures around the World (eds.: Pirrone and Mahaffey), Kluwer Academic Publishers.

36. Maxson (2006) – "Mercury flows and safe storage of surplus mercury," Concorde East/West Sprl for the European Commission – Environment Directorate, August 2006. Available at http://ec.europa.eu/environment/chemicals/mercury/pdf/hg_flows_safe_storage.pdf

37. Mergler *et al.* (submitted). D Mergler *et al.* Exposure and effects of methylmercury in humans. Paper (first presented at the International Conference on Mercury as a Global Pollutant in Madison, Wisconsin, August 2006) submitted to *Ambio* for publication early in 2007.

38. Metal Bulletin (2006) – Subscriber information and databases accessed at http://www1.metalbulletin.com

39. Minco (2006) – The company's description of the Laguna Zacatecana Silver Tailings Project is available at: http://www.minco.ie/default.php?category=Mining%20Projects&pageName=Project%20Overview&sub=Laguna%20Tailings%20Project.

40. Mukherjee *et al.* (2004) – Mukherjee AB, R Zevenhoven, J Brodersen, LD Hylander & P Bhattacharya. Mercury in waste in the European Union: sources, disposal methods and risks. *Resour. Conserv. Recycl. 42*:155-182.

41. NGO (2004) – Environmental NGO comments to UNEP on further measures for addressing global mercury contamination, available at http://www.chem.unep.ch/mercury/

42. Ninomiya *et al.* (2005) – T Ninomiya, K Imamura, M Kuwahata, M Kindaichi, M Susa and S Ekino. Reappraisal of somatosensory disorders in methylmercury poisoning. *Neurotoxicol. Teratol.* 27(4): 643-653.

43. Noruzbaev (2004) – Personal communication with KM Noruzbaev, Head of Division of Nature Management, Department of Ecology and Nature, Bishkek, Kyrgyz Republic, at the Regional awareness raising workshop on mercury pollution, Kiev, Ukraine (see UNEP, 2004).

44. NRDC (2006) – "NRDC submission to UNEP in response to March 2006 request for information on mercury supply, demand, and trade," Natural Resources Defense Council, Washington, DC, May 2006. http://www.chem.unep.ch/mercury/Trade-information.htm

45. NRDC comments (2006) – Comments submitted by the Natural Resources Defense Council to the 1 September 2006 draft report, "Summarizing Supply, Trade and Demand Information on Mercury." Available at http://www.chem.unep.ch/mercury/Trade-information.htm

46. Openshaw and Woodward (2001) – P Openshaw and C Woodward, "New Developments in Mercury Removal," AIChE Spring National Meeting, April 22-26, 2001, Houston, Texas.

47. Pirrone *et al.* (2001) – N Pirrone, J Munthe, L Barregård, HC Ehrlich, G Petersen, R Fernandez, JC Hansen, P Grandjean, M Horvat, E Steinnes, R Ahrens, JM Pacyna, A Borowiak, P Boffetta and M Wichmann-Fiebig. *EU Ambient Air Pollution by Mercury (Hg) - Position Paper*. Office for Official Publications of the European Communities, 2001. Available on http://europa.eu.int/comm/environment/air/background.htm#mercury).
48. Scheuhammer *et al.* (submitted). A Scheuhammer *et al.* Exposure and effects of methylmercury in wildlife. Paper (first presented at the International Conference on Mercury as a Global Pollutant in Madison, Wisconsin, August 2006) submitted to *Ambio* for publication early in 2007.
49. SRIC (2005) – Chlorine/Sodium Hydroxide, E Linak, S Schlag and K Yokose, CEH Marketing Research Report, SRI Consulting, Zurich, August 2005.
50. Swain *et al.* (submitted) – E Swain *et al.* Socioeconomic consequences of mercury use and pollution. Paper (first presented at the International Conference on Mercury as a Global Pollutant in Madison, Wisconsin, August 2006) submitted to *Ambio* for publication early in 2007.
51. Toxics Link (2004) – Mercury in India, 2004, Usage and releases, URL http://toxicslink.org
52. Tsinghua (2006) – "Improve the Estimates of Anthropogenic Mercury Emissions in China," Tsinghua University, October 2006.
53. UNDESA/SD Comtrade (2006) export statistics – UN Commodity Trade Statistics Database, United Nations Department of Economic and Social Affairs—Statistics Division, at http://www.unstats.un.org/unsd/comtrade.
54. UNEP (2002) – Global Mercury Assessment. United Nations Environment Programme, Chemicals Branch, Geneva, December 2002. Available in English, French and Spanish at http://www.chem.unep.ch/mercury/.
55. UNEP (2004) – Regional Awareness raising workshop on mercury pollution, Kiev, Ukraine, 20-23 July 2004. Available at http://www.chem.unep.ch/mercury/workshops.htm.
56. UNEP (2005) – Toolkit for identification and quantification of mercury releases - pilot draft of November 2005. United Nations Environment Programme, Chemicals Branch, Geneva, 2005. Available in English at http://www.chem.unep.ch/mercury/Guidance-training-materials.htm. (Under translation to other UN languages).
57. UNIDO (2005) – Pilot Project for the Reduction of Mercury Contamination Resulting from Artisanal Gold Mining Fields in the Manica District of Mozambique. Report to the United Nations Industrial Development Organization (UNIDO) and Blacksmith Institute, June 2005. See also http://www.globalmercury.org.
58. UNSD (2003) – *National practices in compilation and dissemination of external trade index numbers: a technical report*, Statistical Papers Series F No. 86 (St/Esa/Stat/Ser.F/86), Department of Economic and Social Affairs - Statistics Division, United Nations, New York, 2003.
59. US comments (2006) – Comments submitted by the United States of America to the 1 September 2006 draft report, "Summarizing Supply, Trade and Demand Information on Mercury." Available at http://www.chem.unep.ch/mercury/Trade-information.htm
60. US EPA (1997) – *Locating and estimating air emissions from sources of mercury and mercury compounds.* Report EPA-454/R-97-012, (NTIS PB98- 117054), Office of Air Quality Planning and Standards, Research Triangle Park, NC. Available at: http://www.epa.gov/ttn/chief/le/index.html.
61. USGS (2005) – "Mercury," U.S. Geological Survey, Mineral Commodity Summaries, January 2005
62. USGS (2006) – 2005 Minerals Yearbook: Mercury, US Geological Survey, US Department of the Interior, August 2006.
63. US ITC trade statistics – United States International Trade Commission database, accessed at http://dataweb.usitc.gov.
64. Veiga and Baker (2004) – Veiga M.M. and R. Baker, *Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small Scale Miners*, Report to the Global Mercury Project: removal of barriers to introduction of cleaner artisanal gold mining and extraction technologies, GEF/UNDP/UNIDO, 170 p. http://www.globalmercury.org
65. Veiga *et al.* (2006) – M Veiga, P Maxson and L Hylander. "Origin of mercury in artisanal and small-scale gold mining." *J. of Cleaner Production. 14:* 436-447.
66. WCC (2006) – World Chlorine Council Submission [to UNEP] on Global Mercury Partnership for the Reduction of Mercury in the Chlor-alkali Sector, World Chlorine Council, undated, no address, see http://www.worldchlorine.com
67. WCC comments (2006) – Comments submitted by the World Chlorine Council to the 1 September 2006 draft report, "Summarizing Supply, Trade and Demand Information on Mercury," and personal communications between P. Maxson, Euro Chlor, and the Chlorine Institute. Available at http://www.chem.unep.ch/mercury/Trade-information.htm
68. WSJ (2006). – L Landro, Hospitals go "green" to cut toxins, improve patient environment, *The Wall Street Journal*, 4 October 2006.
69. Wu *et al.* (2006) – Y Wu, S Wang, D Streets, J Hao, M Chan, and J Jiang, Trends in Anthropogenic Mercury Emissions in China from 1995 to 2003, *Environ. Sci. Technol.* 2006, 40, 5312-5318.