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Chapter 3

MERCURY TRADE IN A GLOBALIZING WORLD

Satya P. Mohapatra and Anne Mitchell
Canadian Institute for Environmental law and Policy,
130 Spadina Avenue #305, Toronto, M5V 2L4, Canada

ABSTRACT

Globalization has facilitated free trade and free market mechanism in the world today. However, unrestricted trade in toxic substances like mercury has caused serious environmental and health hazard and needs to be curtailed and terminated in the long run.

Mercury is a toxic metal known to have several deleterious effects on human health, not withstanding its usefulness for industrial, medical and household applications. A broad range of products and processes consume mercury around the world. The major applications of mercury include chlor-alkali production, batteries, fluorescent light bulbs, electrical switches, catalysts, thermometer, blood pressure monitor, dental amalgam, preservatives, cosmetics, fungicides, and other laboratory/educational uses besides artisanal and small-scale gold mining.

While the global supply of mercury mainly comes from the developed countries, such as the European Union and the United States where the demand of mercury has decreased, its demand in developing countries has greatly increased in recent years. Major sources of mercury are primary mined mercury, secondary mercury recovered as a by-product of mining of other ores and from recycling or waste processing, residual mercury recovered from decommissioned chlor-alkali plants, and mercury released from government stockpiles.

There are a few international treaties, such as the *Rotterdam Convention* on the prior informed consent procedure for certain hazardous chemicals and pesticides including mercury compounds in international trade that aims to control the trade in these hazardous chemicals. However, countries have so far failed to formalize a treaty to curb the production and export of mercury.

A cooperative international effort is required to effectively regulate world trade of mercury. This will include monitoring of trade and movement of mercury, reduction in both demand and supply, sharing of information among countries as well as financial and technical assistance to developing countries to replace mercury based technology.

1. INTRODUCTION

Free trade and globalization are essential and inevitable components of present world economic system; they make trade easier by allowing the market to balance supply and demand. Political leaders and economists have been pushing free trade and free market mechanism to facilitate international trade. The World Trade Organization (WTO), was founded in 1995 to help promote free trade by drawing up the rules of international trade. Consequently, a number of binational and regional free trade agreements have been signed during the past decade.

Free trade is characterized by unrestricted flow of goods and services between trading nations and results in increased productivity and increasing total domestic output of goods and services. However, free trade unconstrained by environmental protection could lead to serious disasters. Free trade in toxic chemicals allows these chemicals to be embedded into consumer products and finally find way into water and air causing environmental pollution. When national laws are formulated to restrict trade in order to protect human health and the environment, governments are sued for compensation or to get the law overturned. This free trade also encourages corporations to take their operations to places where environmental regulations are sloppy. As a result, developing nations get discouraged to invest in environmental protection regulations and to develop environment friendly products or technology (Sands, 2003).

International trade rules can also have a severe impact on environmental policies and there have been constant conflicts between national environmental protection measures with international legal obligations which prohibit restrictions to international trade (Sands, 2003). It is, however, evident that free trade in goods and services that create deleterious effect on the environment may result in short term trade benefits to nations but would result in significant cost to environment and to the society as a whole. Trade in toxic substances like mercury is, therefore, undesirable and deserves serious attention of national and international leaders.

2. MERCURY

2. 1 Use of Mercury

Mercury is a unique metal that exists in the liquid state at nearly all temperatures on earth. It is used for many industrial, medical and household purposes and functions as a catalyst in several chemical reactions, and is used in medical science to measure temperature and pressure as well as in dentistry. Spread as a thin film over a sheet of glass, mercury makes an excellent reflecting surface. Besides mirror making and gilding, it is also used in the extraction of gold and silver.

2. 1 Health Effects of Mercury

Notwithstanding its usefulness, mercury is a highly toxic metal that affects the nervous and cardiovascular system (Tchounwou *et al*. 2003). Nausea, vomiting, diarrhoea and severe kidney damage may occur due to exposure to high doses of mercury over a short period of time. Hallucinations, memory loss, nerve damage and the inability to concentrate can occur. Symptoms also include tremors, loss of dermal sensitivity, slurred speech and, in rare cases, even paralysis and death (Nierenberg *et al*., 1998)). Chronic degenerative diseases of the nervous system such as Alzheimer's disease are likely caused or exacerbated by mercury released from amalgam (Clarkson, 2002). Researchers have presented evidence that amalgam fillings in human teeth contribute to mercury contamination of breast milk (Drexler and Schaller, 1998). However, fish consumption is the principal route through which mercury enters the body of persons eating fish (Mahaffey, 2004). Children of women who are exposed to mercury during pregnancy are particularly affected by consumption of mercury-contaminated fish (Grandjean *et al*., 1998). Mercury could also increase the blood pressure level (Vupputuri *et al*., 2005) or result in the loss of colour vision (Cavalleri and Gobba, 1998). As mercury remains bioavailable for some time in the environment, it has lasting effects on the environmental quality affecting even future generations (Grandjean and Weihe, 1998).

2.3 Mercury as an Environmental Pollutant

Mercury is now found at many locations around the world at levels that adversely affect humans and wildlife according to the Global Mercury Assessment (UNEP, 2002). Although earth's ecosystem, including air, soils, sediments, vegetation, and water contains some mercury due to natural degassing or volatilization of mercury from the earth's crust, but the concentration of natural mercury emissions in any given locality is usually quite low. Human-related mercury emissions, however, result in higher than normal localized levels (Jasinski, 1994).

Important anthropogenic mercury sources are fuel combustion and industries, including electric power plants and general heating plants burning coal and oil, primary and secondary non-ferrous metal smelters, iron and steel production plants, cement plants, and waste incinerators (Pacyna *et al*. 2003). The use in amalgam fillings in dentistry causes mercury emissions both to air during cremation and to water systems as a result of dental practices as well as from human faeces from people with amalgam fillings (Drummond *et al*., 2003). The use of mercury in gold and silver mining causes mercury pollution (Nriagu, 1994; Lacerda, 1997; Pirrone *et al*., 1998; Veiga *et al*., 2006). Chlor-alkali plants and paper pulp factories have been major industrial sources that discharged mercury as waste into water bodies (Clarkson, 2002; Hylander and Meili, 2005). Mercury is also released to surface waters as a result of discharges of wastewater from wastewater treatment plants (Sang and Lourie, 1997). Other sources of mercury emission are municipal landfill operations (Lindberg and Price, 1999; Lindberg *et al*., 2005), consumer products such as batteries (Lindqvist, 1995) and fluorescent light bulbs (Aucott *et al*., 2003), emission from soil and plant surfaces (Frescholtz and Gustin, 2004; Zhang and Lindberg, 1999), and mine wastes (Gustin *et al*., 2003). Some mines in U.S.A. and Canada may still be emitting mercury to the atmosphere (Lacerda, 1997).

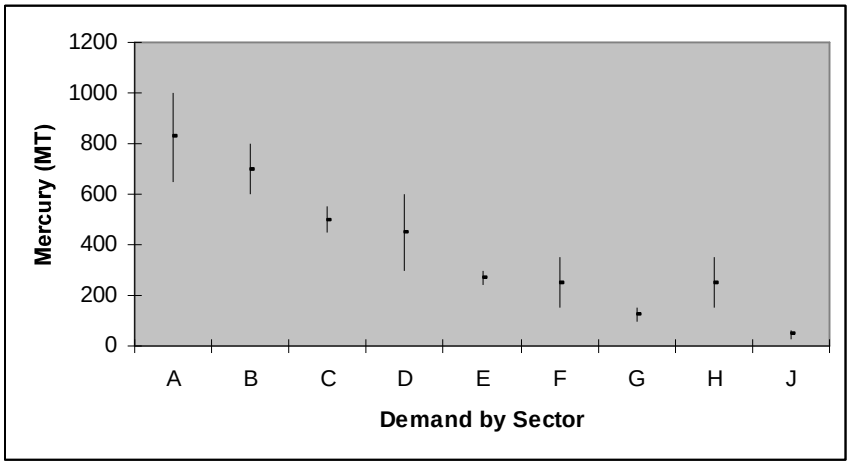
Once released to the atmosphere, mercury can transport to long distances and is subjected to various physical, chemical or photochemical processes. Ultimately, mercury is removed from atmosphere through both dry and wet deposition on soil, water and vegetation (Schroeder and Munthe, 1998).

Environmental cost of mercury is high. It is estimated that remediation costs of mercury from global sources of point pollution ranges between 2,500-1.1 million US Dollar per kg of mercury (Hylander and Goodsite, 2006).

3. MERCURY TRADE

3.1 Demand and Supply of Mercury

Although the use of mercury is reduced in recent years, the major categories of mercury demand in higher income countries include: (1) Chlor-alkali production; (2) Dental amalgams; (3) Fever and other thermometers; (4) Other measuring and control equipment; (5) Neon, fluorescent tubes, compact fluorescent, HID and other energy-efficient lamps; (6) Electrical switches, contacts and relays; and (7) Laboratory and educational uses. Additional categories of mercury demand more prevalent mostly in developing countries and countries with economies in transition include: (1) Vinyl chloride monomer (VCM) production using the acetylene process and a mercury catalyst; (2) Artisanal and small-scale gold mining (ASM); (3) Batteries; (4) Cosmetics and skin-lightening creams; (5) Cultural uses and traditional medicine; and (6) Paints and pesticides/agricultural chemicals (UNEP, 2006).



A - Small-scale/artisanal gold mining, B - Vinyl chloride monomer (VCM) production
C - Chlor-alkali production, D - Batteries, E - Dental use,
F - Measuring and control devices, G – Lighting, H - Electrical and electronic devices
J - Other (paints, laboratory, pharmaceutical, cultural/traditional uses, etc.)

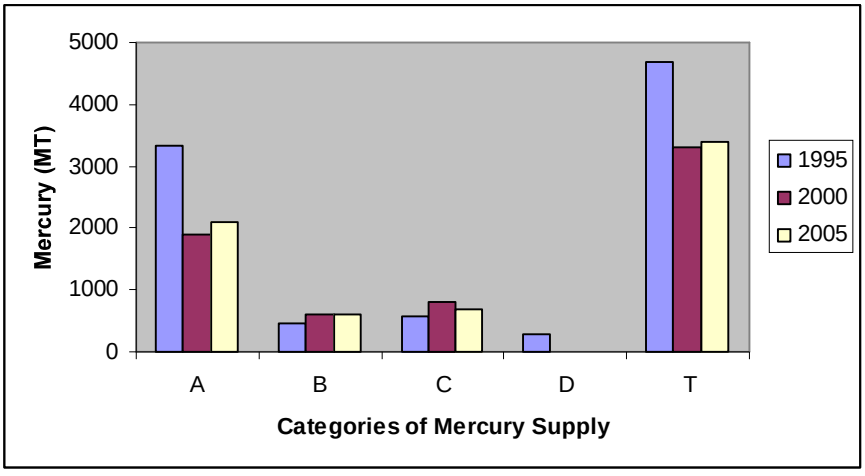
Figure 1. Global Mercury Demand in 2005 (Data Source: UNEP, 2006)

Fig. 1 shows the global mercury demand for 2005. A range of mercury demand is shown due to uncertainty in estimation. At present, artisanal and small-scale gold mining remains the

largest global user of mercury and is still increasing, mostly in developing countries (Viega et al., 2006). Another large and increasing use of mercury is in the production of vinyl chloride monomer (VCM), particularly in China. Aside this, a considerable quantity of mercury is used in chlor-alkali industry and in battery, although these uses are declining. Government regulations in several countries coupled with the public awareness have resulted in decline of mercury use in many sectors. However, there has been considerable increase in the use of mercury in artisanal and small-scale gold mining activities, and in vinyl chloride monomer (VCM) production. Global mercury demand was about 3,000-3,900 MT in 2005 and is estimated to hover around 2,870-2,300 MT by 2015 depending on two different scenarios of 15% and 30% reduction in mercury demand (UNEP, 2006).

In recent years, supply of mercury for global trade has come from five common sources: (1) Mining and processing of primary mercury ores; (2) By-product mercury recovered from the refining of some ferrous and most non-ferrous metals, and from the cleaning of natural gas; (3) 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); (4) 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; and (5) 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).

Change in the patterns of mercury supply during 1995-2005 is shown in Fig.2. While total mercury supply declined till 2000, it slightly increased in 2005. It is notable that there has been no supply of mercury from the national stockpiles in the last decade. There would be further reductions of mercury supply and demand if appropriate restrictions are implemented, such as phasing out the use of various mercury containing products and storing the residual mercury from decommissioned chlor-alkali facilities.



A - Mining and byproduct mercury, B - Recycled mercury, C - Mercury recovered from Decommissioned MCCAPs, D - Mercury from stockpiles, T - Total

Figure 2. Global Mercury Supply (1995-2005) (Data Source: UNEP, 2006)

3.2 Mercury Price

There has been a constant decrease in the mercury prices for almost 40 years till the beginning of 21st century when the price ranged USD 4-5 per kg of mercury. This price reduction was due to an abundant supply of mercury and reduced consumption because of the increasing cost of dealing with mercury due to regulatory pressures. Unfortunately, the low price of mercury stimulated its use in gold mining and other dissipative uses and reduced any economic incentive for recycling mercury after use (Hylander and Meili, 2005).

Significant tightening of mercury supplies during 2004, mainly related to the closure of both the Spanish and Algerian mercury mines resulted in sudden increase in the mercury price in 2004-2005. Increased demand for mercury by a growing number of artisanal and small scale gold miners also contributed to this rise in mercury price. 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 (UNEP, 2006).

3.3 Mercury Trade Statistics

Mercury market, previously dominated by North America and European Union, has been recently overtaken by South and East Asia (Maxon, 2004). Yet, the EU continues to play a predominant role in the global trade of mercury. Global movement of elemental mercury was over 8000 tonnes in 2000. On an average, some two to three tonnes of elemental mercury appear in international trade statistics for each tonne of mercury consumed during the same year (Maxon, 2004).

In most cases, the details of domestic trade inside individual countries are not very well known. A few countries have systems to collect and centralize information on domestic commercial transactions of mercury. Mercury transactions between countries are tracked through tariff codes by Customs authorities and are reported to centralized databases such as the UN Statistics Division's (UNSD) "Comtrade" database (UNEP, 2006).

Global mercury trade is, in fact, very fluid making it difficult to trace the flow of mercury. Mercury could be recovered from a Western European mercury cell chlor-alkali plant, sold to the Spanish mercury mining and trading company, shipped from Spain to Germany for further conversion into mercuric oxide, sold to mainland China for the manufacture of button-cell batteries, and the batteries exported to Hong Kong for incorporation into mass-produced watches for export to the European Union and the US (Maxon, 2004).

Mercury trade data are relatively less transparent. 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 or 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 1995-2004, or an average of

approximately 6,000 metric tonnes per year. The trend since 2000 has clearly been below that average. 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."(UNEP, 2006). The Comtrade data may be considered to provide a low-end approximation of the global market in elemental mercury as some countries do not report their trade statistics routinely to UNSD. More standardised, comprehensive and timely reporting of international and domestic trades would improve the quality and value of future assessments (UNEP, 2006).

3.4 International Agreements Governing Mercury Trade

Mercury can travel easily from one part of the globe to another through transcontinental transport of mercury. This underscores the necessity of an international approach to negotiate reduction of mercury in all parts of the world.

The Basel Convention on control of transboundary movements of hazardous wastes including mercury-containing wastes and their disposal, which came into force in May 1992, aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous wastes by ensuring that the generation of hazardous waste is reduced; hazardous wastes are disposed in an environmentally sound manner within the country of their generation and by enhancing controls on export and import of hazardous waste, among others.

The Rotterdam Convention on the prior informed consent procedure for certain chemicals and pesticides in international trade aims to limit or control the trade in hazardous chemicals. Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, entered into force on 24 February 2004. The convention is a legally binding procedure that requires exporters trading in a list of hazardous substances including mercury and mercury compounds to obtain the prior informed consent of importers before proceeding with the trade.

The United Nations Environment Programme (UNEP) undertook a global assessment of mercury and mercury compounds in 2002. Later it announced a new mercury programme with a long-term objective to facilitate national, regional, and global actions to reduce or eliminate the uses and releases of mercury as far as possible. However, at its meeting in Kenya in February 2005, the proposal for a treaty to curb the production and export of mercury was rejected and instead, it was agreed to adopt voluntary actions to improve mercury management (Khamsi, 2005). UNEP emphasized on such an international agreement on mercury in its meeting in November 2007.

4. DISCUSSION AND CONCLUSION

Mercury emissions in many developing countries and newly industrialized countries have increased substantially in the last two decades (Hylander, 2001; Pirrone *et al*., 1996). After introduction of stricter environmental rules for mercury use, many U.S.A. companies sold mercury-based technologies to developing countries with less stringent environmental regulations. The Chlor-alkali industry is still a globally dominating mercury consumer (Hylander and Meili, 2005) and moving the mercury cell technology for Chlor-alkali production to developing countries will not reduce health or pollution risks on a global scale. A ban on the mercury trade would significantly diminish mercury pollution (Hylander, 2001). Large stockpiles of mercury in several industrialized countries need to be decommissioned to avoid transfer of mercury and related risks to other countries (Hylander and Meili, 2005). This will not only avoid unnecessary poisoning of the poor population in developing countries but also minimize mercury pollution of water bodies around the world. The failure of the UNEP meeting in February 2005 to reach a global treaty banning mercury trade raises doubt on the commitment of some countries to resolve the mercury threat. An international agreement on mercury, particularly curbing both its demand and supply is essential, as advocated by the UNEP. Zero mercury trade and an efficient mercury management can only be achieved through strong political will and public involvement in addition to international cooperation.

REFERENCES

Aucott, M., McLinden, M., Winka, M., 2003. Release of mercury from broken fluorescent bulbs. Journal of the Air and Waste Management Association 53, 143-151.

Cavalleri, A., Gobba, F., 1998. Reversible color vision loss on occupational exposure to metallic mercury. Environmental Research 77A, 173-177.

Clarkson, T.W., 2002. The three modern faces of mercury. Environmental Health Perspective Supplements 110:11-23

Drexler, H., Schaller, K., 1998. The mercury concentration in breast milk resulting from amalgam fillings and dietary habits. Environmental Research 77A, 124-129.

Drummond, J.L., Cailas M.D., Croke, K., 2003. Mercury generation potential from dental waste amalgam. Journal of Dentistry 31, 493-501.

Frescholtz, T.F., Gustin, M.S., 2004. Soil and foliar mercury emission as a function of soil concentration. Water, Air, and Soil Pollution 155, 223-237.

Grandjean, P., Weihe, P., 1998. A new era of mercury hazards. Environmental Research 77A, 67.

Grandjean, P., Weihe, P., White, R., Debes, F., 1998. Cognitive performance of children prenatally exposed to “safe” levels of methylmercury. Environmental Research 77A, 165-172.

Gustin, M.S., Coolbaugh, M., Engle, M.A., Fitzgerald, B.C., Keislar, R.E., Lindberg, S.E., Nacht, D.M., Quashnick, J., Rytuba, J.J., Sladek C., Zhang, H., Zehner, R.E., 2003. Atmospheric mercury emissions from mine wastes and surrounding geologically enriched terrains. Environmental Geology 43, 339-351.

Hylander, L.D., 2001. Global mercury pollution and its expected decrease after a mercury trade ban. Water, Air, and Soil Pollution 125, 331-344.

Hylander, L.D., Goodsite, M.E. 2006. Environmental costs of mercury pollution. Science of the Total Environment 368, 352-370

Hylander, L., Meili, M., 2005. 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 35, 1-36.

Jasinski, S.M., 1994. The materials flow of mercury in the United States. United States Bureau of Mines, 1994.

http://pubs.usgs.gov/usbmic/ic-9412/mercury.pdf

Khamsi, R., 2005. Countries reject global mercury treaty: UN meeting decides on voluntary actions rather than export bans. Nature News, 28 February 2005.

http://www.nature.com/news/2005/050228/full/050228-2.html

Lacerda, L.D., 1997. Global mercury emissions from gold and silver mining. Water, Air and Soil Pollution 97, 209-221.

Lindberg, S.E., Price, J.L., 1999. Airborne emissions of mercury from municipal landfill operations: a short-term study in Florida. Journal of the Air and Waste Management Association 49, 174-185

Lindberg, S.E., Southworth, G., Prestbo, E.M., Wallschlager, D., Bogle, M.A., Price, J., 2005. Gaseous methyl- and inorganic mercury in landfill gas from landfills in Florida, Minnesota, Delaware, and California. Atmospheric Environment 39, 249-258.

Lindqvist, O., 1995. Environmental impact of mercury and other heavy metals. Journal of Power Sources 57, 3-7.

Mahaffey, K.R., 2004. Fish and shellfish as dietary sources of methylmercury and the ω-3 fatty acids, eicosahexaenoic acid and docosahexaenoic acid: risks and benefits. Environmental Research 95, 414-428

Maxon P.A. 2005. Global Mercury Production, Use and Trade In Pirrone N. and Mahaffey K.R. Eds. Dynamics of Mercury Pollution on Regional and Global Scales. Springer, US.

Nierenberg, D.W., Nordgren, R.E., Chang, M.B., Siegler, R.W., Blayney, M.B., Hochberg, F., Toribara, E.C., Clarkson, T., 1998. Delayed cerebellar disease and death after accidental exposure to dimethylmercury. The New England Journal of Medicine 338, 1672-1676.

Nriagu, J.O., 1994. Mercury pollution from the past mining of gold and silver in the Americas. Science of the Total Environment 149, 167-181.

Pacyna, J.M., Pacyna, E.G., Steenhuisen, F., Wilson, S., 2003. Mapping 1995 global anthropogenic emission of mercury. Atmospheric Environment 37, S109-S117.

Pirrone, N., Keeler, G.J., Nriagu, J.O., 1996. Regional differences in worldwide emissions of mercury to the atmosphere. Atmospheric Environment 30, 2981-2987.

Pirrone, N., Allegrini, I., Keeler, G.J., Nriagu, J.O., Rossmann, R., Robbins, J.A. 1998. Historical atmospheric emissions and depositions in North America compared to mercury accumulations in sedimentary records. Atmospheric Environment 32, 929-940.

Sands P. (2003) Principles of International Environmental Law. Cambridge University Press

Sang, S., Lourie, B., 1997. Mercury emission inventory in Ontario. Environmental Monitoring and Assessment 47, 79-88.

Schroeder, W.H., Munthe J., 1998. Atmospheric mercury – an overview. Atmospheric Environment 32, 809-822.

Tchounwou, P.B., Ayensu, W.K., Ninashvili, N., Sutton, D., 2003. Environmental exposure to mercury and its toxicopathologic implications for public health. Environmental toxicology 18, 149-175.

UNEP, 2002. Global Mercury Assessment. United Nations Environment Programme, Chemicals, Geneva, Switzerland, December 2002.

http://www.chem.unep.ch/mercury/Report/Final%20report/final-assessment-report-25nov02.pdf

UNEP 2006. Summary of supply, trade and demand information on mercury. United Nations Environment Programme, Chemicals, Geneva, Switzerland, November 2006

http://www.chem.unep.ch/mercury/HgSupplyTradeDemandJM.pdf

Veiga, M.M., Maxson, P.A., Hylander, L.D. 2006. Origin and consumption of mercury in small-scale gold mining. Journal of Cleaner Production 14, 436-447

Vupputuri, S., Longnecker, M.P., Daniels, J.L., Guo, X., Sandler, D.P., 2005. Blood mercury level and blood pressure among US women: results from the National Health and Nutrition Examination Survey 1999–2000. Environmental Research 97, 194-199.

Zhang, H., Lindberg, S.E., 1999. Processes influencing the emission of mercury from soils: a conceptual model. Journal of Geophysical Research 104, 21889-21896.