Credit: Larry Price

Global Mercury Program Strategy

PURE EARTH

July 2023

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Reducing Mercury Pollution and Poisoning

I. Scope and Scale of Issue and Impacts

Mercury (Hg), a silvery, liquid, toxic metal [1], is one of the "top ten chemicals of public health concern," according to the World Health Organization (WHO) [2]. Mercury is dangerous to anyone exposed, but is particularly harmful to developing fetuses [3, 4] and people who are regularly exposed to high levels of mercury [5]. Impacts reach beyond health. A recent study of mercury levels in people in 15 LMICs published in the *Journal of Environmental Management* estimated economic losses attributable to lost productivity of USD 77.4 million [6]. Another study of an artisanal and small-scale gold mining (ASGM) area in Brazil estimated that, due to mercury-related DALYs, economic losses of USD 100,000-400,000 per kilogram of gold extracted [7].

A. Global Mercury Pollution

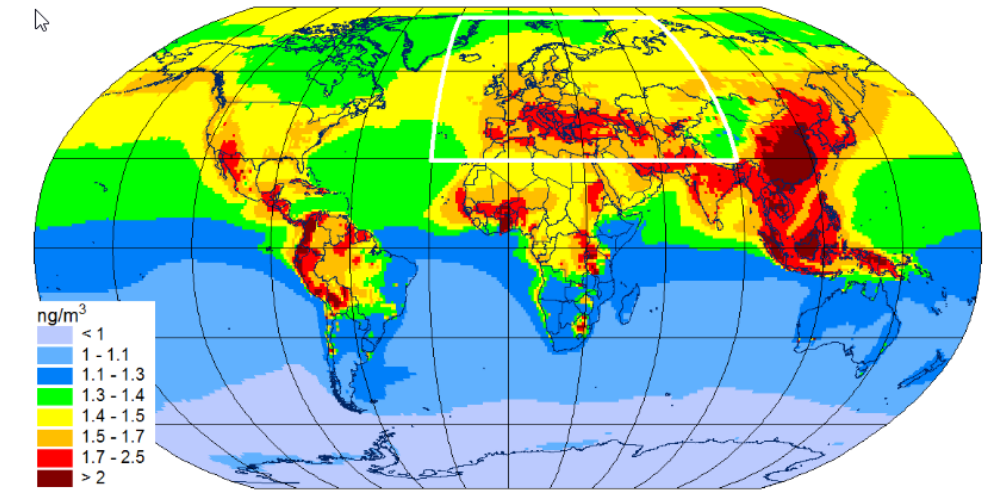
1. Global Emissions

Globally, anthropogenic sources of mercury emissions to air are, in descending order: ASGM, coal combustion, metal production, cement production, mercury-containing waste, and the oil and gas sector [8], (see ***Table 1***). Air monitoring data for mercury shows high concentrations over LMICs and traditional industrial regions [9] (see ***Figure 1***).

Table 1: Global sources of mercury emissions

Source	% Emissions
Artisanal and small-scale gold mining ASGM)	**38**
Coal combustion (power generation)	21
Non-ferrous metal production	15
Cement production	11
Waste (e.g., from Hg-added products like lightbulbs, electronic devices)	**7**
Oil & gas sector	3
Others (e.g., chlor-alkali industry)	**5**

Figure 1: Mercury "Global distribution of annual mean air Hg concentrations, 2018." [9]



2. Mercury Emissions from the ASGM Sector

Within regions or countries, the sources and quantities of emissions and exposure may vary greatly. ASGM accounts for more than 80% South America's mercury emissions and 70% of Sub-Saharan Africa's, but just 25% of mercury emissions in East and Southeast Asia, and only 2% in South Asia (see ***Table 2***).

Table 2: Quantities mercury emissions/releases, by sector and region

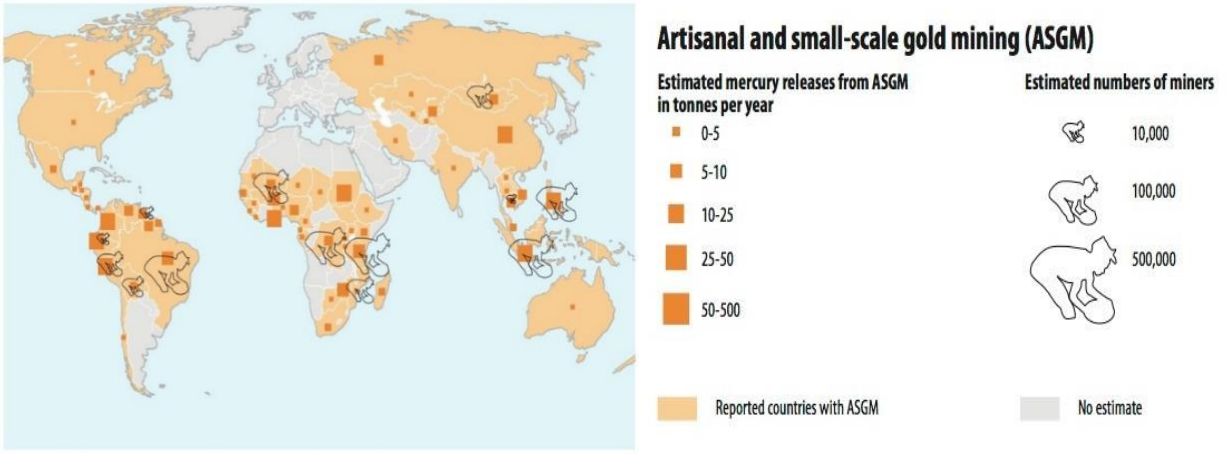
Sector group (emissions, metric tons)						
Region	**Fuel combustion**	**Industry sector**	**Intentional** (e.g., product waste)	**ASGM**	**Regional total**	**% of global total**
East & SE Asia	229	307	109	214 (25%)	859	38.6
South Asia	125	59.1	37.2	4.5 (2%)	225	10.1
South America	8.25	47.3	13.5	**340** *80% of regional total*	**409**	**18.4**
Sub-Saharan Africa	48.9	41.9	17.1	**252** *70% of regional total*	**360**	**16.2**

ASGM is the world's largest source mercury emissions, affecting not just individual miners, but also contaminating soil, waterways (regional, national and beyond), and global food chains [8]. Multiple investigations of ASGM miners and people in nearby communities, including infants and children,

have found elevated concentrations of mercury in urine, hair, and blood [10-21]. While miners are often the most severely poisoned,[1] their family, people living near or downstream from mining operations, and millions around the world who consume contaminated seafood are also affected. See ***Figure 2***, below, for major worldwide ASGM areas along with their estimated mercury releases and estimated numbers of miners.

Phasing out mercury in ASGM is a persistent global challenge, and progress has been slow. Interventions singularly focused on awareness raising of health and environmental issues, formalization and regulatory actions, or clean mining techniques have often proven insufficient to change behavior and sustainably reduce mercury emissions [32]. Miners may be less concerned about mercury than other hazards like poverty, injuries, noise, dust, and crime [33]. Mercury use is a complex problem demanding strong, holistic responses that center miners' socio-economic and health needs [34]. It is important to recognize that many of those who profit from the mining sector are in high-income countries, but that the health and environmental burdens are experienced primarily in LMICs, and that rising global economic disparities fuel ASGM. [8]

Figure 2: Artisanal-scale gold mining (ASGM) map (28)



3. Mercury emissions from non-ASGM sources

Mercury emissions from other sources include:

- Coal combustion for power generation, which spreads mercury widely through air emissions depositing upon surface soils and water resources.
- Mercury emission from the chlor-alkali industry and abandoned chlor-alkali facilities which result in contaminated sites that are long-term hazards for residents.
- Former mercury mining and processing areas.

[1] There's no international accepted definition of mercury (Hg) poisoning. Hg poisoning is considered if typical symptoms like neurological deficits (ataxia, tremor, coordination problems and increased Hg levels) are identified. Hg levels can be assessed by biomonitoring threshold values, blood Hg level < 5 µg/l (HBM-I), between 5 - 15 µg/l or > 15 µg/l (HBM-II).

B. Mercury as a Global Health Problem

As asserted by the WHO and described in the following section, mercury exposure is a major global health problem. From a public health perspective, contaminated seafood consumption, living or working in ASGM or other contaminated areas, and the use of mercury-containing cosmetics are of high concern.

1. Characteristics Relevant to Human Exposure

Mercury has three main chemical forms [1, 5, 36, 37]:

- Elemental: Liquid at room temperature. In thermometers, dental amalgams, fluorescent light bulbs, electrical switches. Emitted during ASGM, industrial processes (e.g., cement industry), released into air when fossil fuels burned. Can evaporate, emitting mercury vapor [38, 39].
- Inorganic: Formed when mercury combines with other elements. Used in industrial processes and making other chemicals. Inorganic mercury salts are used in cosmetic skin-lightening products.
- Organic: Methylmercury, the most common and harmful form [40]. Converted by bacteria from inorganic and elemental forms. Bioaccumulates up aquatic food chains, eaten by humans. [41, 42]. No known threshold for methylmercury below which neurodevelopmental impacts do not occur.

Transboundary and Persistent: Once released into the environment, mercury migrates quickly and can travel great distances through air and waterways, eventually being deposited in soils, water, or plants, contaminating crops, food chains, and ecosystems [43]. Methylmercury bioaccumulates – becomes increasingly concentrated – as it moves up the food chain, from small fish to larger predatory fish and marine mammals, and then to humans, endangering the health of millions [44]. Mercury persists in the environment and can't be destroyed. Its removal results in contaminated waste, also a source of releases. Mercury must be managed responsibly via stabilization or adequate final storage, not an option in many LMICs.

2. Health Impacts

Chronic exposure to mercury can, depending on the dose, damage the central nervous, digestive, cardiovascular, and immune systems [36]. Mercury has acute effects on the lungs, kidneys, skin, and eyes [2, 3, 5, 12]. It can cause behavioral disorders and neurodevelopmental problems [45]. Exposure has been shown to be related to reduced performance in verbal and neuropsychological skills and executive functioning [46, 47]. Mercury is dangerous to anyone exposed, but is particularly harmful to people regularly exposed to high levels [5] and developing fetuses, as the tragic poisoning disaster of Minamata showed: high methyl-mercury contamination of fish due to industrial mercury releases resulted in increased severe birth defects, malformations, and impaired cognitive development [3, 4].

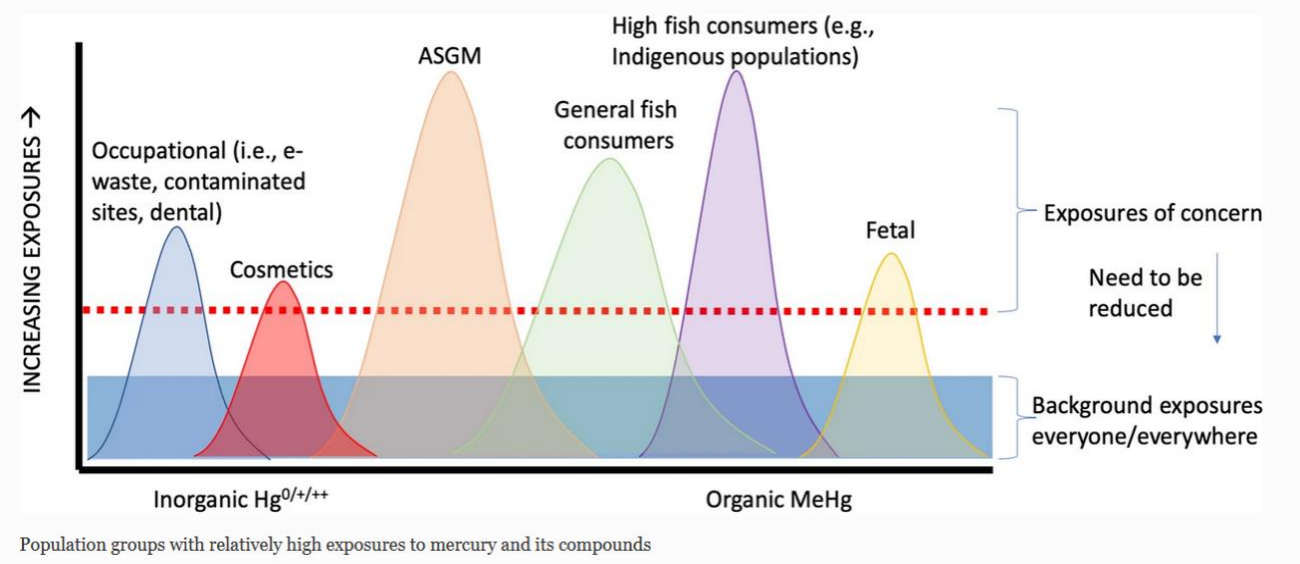
3. Exposure Pathways

People can be exposed through a number, or combination, of pathways:

- **Occupational.** The inhalation of mercury in occupational settings (e.g., smelting and vaporizing mercury-gold amalgams in ASGM [48], mercury vapors from dental amalgams), or direct skin contact with liquid mercury or products containing inorganic mercury salts. Main risk group are workers, especially in ASGM areas (mainly Africa, Latin America, Asia), and vinyl chloride monomer production (mainly China) [49]. Over 60% of global mercury use relates to these two industries [49].
- **Ingestion of contaminated food.** A 2012 study by the Korea FDA showed an exposure contribution rate to food of 98.85 - 99.48% [50]. For many communities (artic-, small island-, tropical riverine-, coastal-), seafood, and/or marine mammal consumption is their primary source of exposure [12, 51-53]. Mercury can also contaminate rice. Seafood mercury levels are driven by the contamination, much of it from ASGM, of waterways. It is a concern that mercury pollution reduces the safe availability of a key protein source [54] for many indigenous or vulnerable populations.
- **Exposure from industrial and household wastes** that contain mercury (e.g., lightbulbs, e-waste, thermometers). [1]
- **Skin-lightening products (SLPs).** Mercury is an often-illegal ingredient of certain soaps and creams. Many young people, especially women, unaware of the potential risks, use them on a regular basis. The mercury can be absorbed via skin, and accumulate in the body. During a pregnancy, this mercury is released and transferred through the placenta to the fetus. [55-58]
- **Traditional medicine**, esp. Ayurvedic medicines, can contain high levels of mercury. [59]

Figure 3, below, illustrates the relative seriousness for humans of different exposure levels and pathways. Populations that consume large amounts of fish and those that work in the ASGM sector are of highest concern, though exposure through general fish consumption, other occupational modes, the use of SLPs, and fetal exposure are also high concern and must be reduced.

Figure 3: Population groups with relatively high exposures to mercury (Basu, Bastiansz et al. 2023)



Population groups with relatively high exposures to mercury and its compounds

4. Data and Data Gaps

Mercury can be measured in hair, urine, feces, or blood, but there is a dearth of national biomonitoring initiatives and capacity to collect this data. While many high-income countries manage databases of biomarker data and there have been a number of one-off, localized scientific studies in LMICs, data - especially recent data - from many LMICs are limited or completely lacking [3]. Existing localized studies (examples below), which can help identify when, where, and on what to conduct biomonitoring, indicate **the need for more, high-quality, and nationally representative data** to gauge changes in human exposure over time and geography, and to enable coordinate of biomonitoring activities across regions.

- A review of 316 mercury studies that collected 424,858 mercury biomarker measurements from 335,991 individuals in 75 countries concluded that "there's great variability within and across regions, **and there remain many regions and subpopulations with limited data, hindering evidence-based decision making."** [12]
- Most Asian countries are minimally involved in biomonitoring, with the exception of Japan, India, Pakistan, and Korea [60, 61]. There are some studies on Latin American ASGM countries, but **very limited studies in Africa,** e.g. a few Zimbabwe and Ghana studies [20, 24, 62-65]. ***Figure 4***, below, illustrates the scarcity of biomonitoring data from Africa.
- The highest incidence rate of intellectual disability, a key indicator of mercury exposure, was 17.37 per 1,000 infants in a subsistence fishing population in the Amazon," equivalent to 202.8 DALYs per 1,000 infants. This indicates that high consumption of contaminated fish poses increased neurodevelopmental risk, though a **global burden of disease calculation was not feasible due to a lack of biomonitoring data [66].** Africa, the Western Pacific, and parts of America have the highest incidence rates for DALYs [67].

- A 2017 study of women in 25 countries showed 42% had mercury-hair levels > 1 ppm. Highest levels were the Pacific Islands, where populations have fish-rich diets. High results in ASGM areas of Indonesia, Kenya and Myanmar likely from ASGM and contaminated fish [68].
- Some **countries with highest fish consumption are poorly covered by biomonitoring,** including much of Latin America, Western & Central Africa, many parts of Asia including the Indo-Pacific.
- A comparison of **foodborne DALYs attributed to methylmercury, arsenic, cadmium and lead indicated that lead contributes most, but mercury is second** [69]. (see ***Figure 5***)

Figure 4: Whole blood mercury concentrations (Sharma, Sanka et al. 2019)

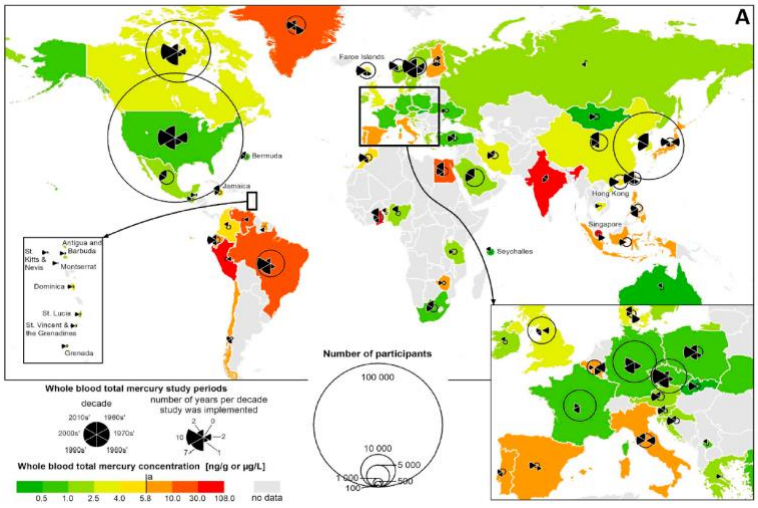
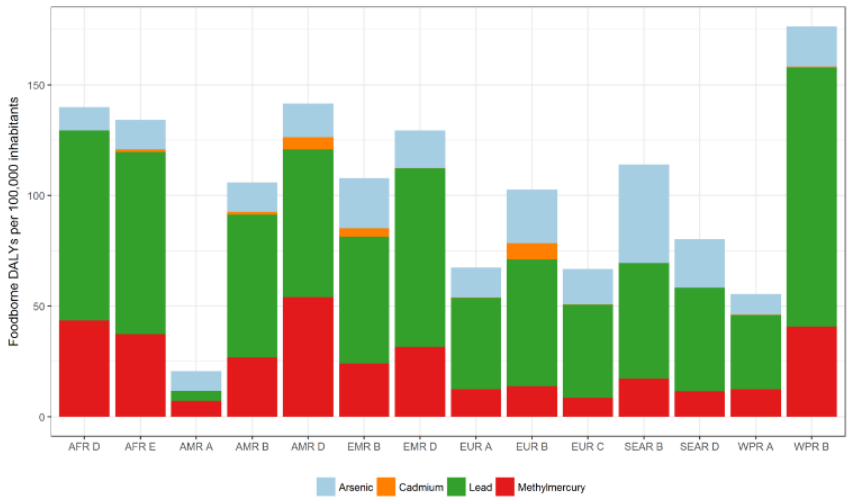


Figure 5: Relative contribution to the DALY incidence from 4 metals for each WHO subregion [69]



5. International Governance around Mercury

The Minamata Convention on Mercury, a legally binding international treaty, was adopted in 2013 and entered into force in 2017. The Convention's objective is "to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds [70]."

Treaty stipulations include: a ban on new mercury mines, the phase-out of existing mines, the phase-out and phase-down of mercury use in a number of products and processes, restrictions on the export of mercury, and control measures on mercury emissions to air and on releases to land and water. The Convention also addresses interim storage of mercury and its disposal, sites contaminated by mercury, and health issues, and calls for international and national action, including ASGM-focused action [8, 71, 72]. Of the treaty's 141 Parties (as of May 2023), twenty-six, including Ghana, Indonesia, and Kyrgyzstan, have created National Action Plans. Specific to ASGM, while it does not outright ban mercury use, the treaty obligates Parties to "take steps to reduce, and where possible eliminate," the use of mercury and to reduce the emissions and releases of mercury to the environment.

The strengths of the Minamata Convention include its clear agenda, with health as priority (§ 1 and § 16), its legally binding nature, and its related funding mechanisms, particularly the Global Environment Facility Trust Fund (GEF). However, like other UN treaties, the Minamata Convention functions by consensus, causing delays and deterioration of its agenda. Also actions are implemented as time-limited projects rather than sustainable, comprehensive, long-term investments [32].

II. Strategy

A. Diagnostic Summary and Programmatic Focus

- After its release into the environment, mercury becomes problematic. Whereas it can be removed from soil or "fixed" there through different techniques that prevent its spread, this requires careful management of its waste. **Once the mercury reaches water or air, removing it from the environment becomes almost impossible.**
- While mercury is a near-omnipresent pollutant, **the main source of its release is ASGM.** Due to the characteristics of this economic activity, mercury releases often occur in or near waterways, facilitating the global spread of mercury in its various chemical forms, especially through water and air, reaching areas far from the source. Other major sources such as coal combustion, some types of industry, and waste, act in the same way, spreading through air and water.
- **Mercury contaminates and bioaccumulates in plants, seafood, and marine mammals, entering food webs and affecting huge numbers of people** who consume these products. Mercury absorption through skin or inhalation is also important in regards to some exposure sources.
- Mercury poisoning's impacts of human health normally correlate with proximity to and level of contact with the source. By far, **the most acute and severe cases of exposure are occupational and mainly affect artisanal miners, their families, and surrounding communities.** For the vast majority of the world's population, however, mercury exposure occurs through **food consumption or the use of products containing or adulterated with mercury (skin-**

lightening creams, light bulbs, etc.). In the case of food and products, the effects are more gradual and less detectable, but increase health risk factors related to central nervous, digestive, cardiovascular and immune systems diseases.

- **The actual (or estimated) global burden of disease of mercury exposure is unknown.** There is no systematic detection, diagnostic or biomonitoring of mercury exposure, even in the most at-risk areas. So far nobody has scientifically estimated prevalence, magnitude or severity of mercury exposure at global level and we are far from knowing the number of people potentially affected by this problem and the full impacts and costs at global level.
- Geo-politically, the **Minamata Convention has established goals for actions to prevent and reduce mercury emissions, releases, and exposures.** However, there are many challenges and ongoing efforts are still needed by Parties to achieve these goals.

Pure Earth's mission is to protect human health and environments from toxins. As such, our Mercury Program Strategy focuses on decreasing mercury emissions to the environment from the main source of pollution, ASGM, and reducing human exposures with an emphasis on the most severely affected populations, namely miners and surrounding communities. Pure Earth endeavors to contribute to the generation of needed health data and health systems capacity; to engage with communities, industries, governments, and global networks to share knowledge and advocate for strong, well-functioning regulatory frameworks; and to increased resources and capacity focused on addressing mercury.

B. Mercury Program Goal and Expected Outcomes

Pure Earth's Mercury Goal / High-Level Outcome

Reduction of the prevalence of mercury exposure of target populations

- *Indicator:* % target population with elevated levels
- *Indicator:* Average level of mercury (in blood, urine, hair, feces)

Intermediate Outcomes

1. Reduction or elimination of mercury emissions, releases, and concentration in products

Illustrative indicators

- % of environmental media samples (soil, water) exceeding mercury standard or reference value
- # hectares remediated to level below standard or reference value
- # hectares in which mercury's bioavailability is reduced (reforestation, biochar)
- Average mercury concentration (ppm) in a specific source (soil, rice, skin-lightening products)
- % of product samples that exceed standard or reference value (skin-lightening products)
- % of markets or shops selling products that exceed standard or reference value
- # miners or mining operations who adopt mercury-free methods
- Amount of mercury recovered from mining tailings
- # tons of mining tailings from which mercury is recovered

2. Reduction of human exposure to mercury

Illustrative indicators

- # of people exposed to contaminated sites
- % of people or households using mercury-adulterated (over reference) products
- # of miners or mining operations who adopt mercury-free methods

Sub-Intermediate Outcomes

1. Increased research, data, knowledge, awareness

Illustrative indicators

- # of signals of support from key actors towards generating data, learning from existing data, or sharing data (e.g., form working groups, make progress towards Minamata commitments)
- % target audience that demonstrate knowledge about risks of mercury
- # new technologies field tested

2. Strengthened regulatory systems

Illustrative Indicators

- # of laws, policies, or standards that restrict or eliminate mercury use developed or adopted
- # of actions taken by key actors in response to recommendations

3. Increased resources and capacity to address mercury

Illustrative Indicators

- # of signals of support from key actors towards taking forward inventions begun through a Pure Earth activity (e.g., reforestation)
- Value (USD) of new funding allocated or leveraged by partners for mercury programs
- # of people trained that apply new skills or knowledge
- # key groups or organizations that adopt improved tools, technologies, practices
- # of new or improved programs, projects, systems implemented by key actors (e.g., biomonitoring / surveillance)

C. Types of Mercury Program Activities

Pure Earth has gained significant expertise in contaminated site assessment and remediation associated with individual "point sources" such as abandoned mining concessions. While it's important to continue this work as it addresses existing sites of mercury pollution, a more proactive approach is also necessary to prevent mercury emissions and releases from occurring in the first place. Pure Earth works with technical experts and trusted partners within two main activity categories:

1. **Support miner transition towards mercury-free techniques** through sub-activities such as:
    - Governmental advocacy (e.g., policy and regulatory recommendations)
    - **Raising awareness** and **community education** among miners and their families.
    - **Training on mercury-free mining techniques** (technical capacity to transition)
    - Testing and piloting new **technologies**
    - **Market-based activities** that: 1) increase demand for mercury-free gold; 2) provide other incentives for producing or purchasing mercury-free gold; 3) ensure a low-

friction marketplace for transacting mercury-free gold, and other activities aimed at ensuring the responsible miners have an economically attractive future (including through existing relationships with actors in the jewelry industry, the leading user of gold)

2. **Management of toxic mercury sites** through sub-activities such as:
    - **Toxic Sites Identification Program (TSIP)***
        - Includes site identification, environmental assessment, health risk assessment, and contaminated sites database/knowledge management
    - **Tailings management (clean-up and final disposal)**
    - **Reforestation**, fixing with biochar, and phytoremediation methods*
    - Responsible mercury **waste management** strategies including final disposal*
    - **Raising awareness** and **public education** while engaging in risk communication activities.

3. **Other.** We will also engage in other, strategically advantageous and technically feasible opportunities that arise and which address the following *underlying causes* of mercury emissions and exposure:
    - **Lack of data**, e.g., on the burden of disease of different sources (e.g., e-waste, fish consumption, rice); a lack of biomonitoring systems to generate data on exposure prevalence, severity, and reach. To the extent possible, we will include **biomonitoring** activities in mercury projects to enable data collection, identify further research needed, and gauge success of interventions.
    - **Lack of regulatory frameworks** (e.g., end imports and sales of SLPs)
    - **Low national capacity** (laboratories, technical skills) to address mercury exposure. Pure Earth will push for health systems strengthening to enable LMICs to collect data, carry out long-term monitoring of toxic exposure, and conduct case management.

Pure Earth is one of very few organizations doing this work, a competitive advantage.

D. Priority Countries for Mercury

Historically, Pure Earth has implemented mercury activities, focused on ASGM and contaminated sites management, in nine countries, some of which are no longer priority countries. We will continue existing mercury activities in the Pure Earth priority countries of Indonesia, the Philippines, Colombia, and Peru, and will begin to work on ASGM-related mercury in Ghana, another priority country. We may also work in additional countries if well-aligned opportunities materialize. For example, our Takeda Pharmaceutical Company Limited-funded project addresses lead and mercury by strengthening health systems in Colombia, Peru, India, Indonesia, and *Kyrgyzstan.*

See ***Table 3***, below, for a set of condensed facts about key sources of mercury emissions / releases alongside data from Pure Earth's current priority countries.

Table 3: Abbreviated statistics, by mercury source and Pure Earth strategic countries

Abbreviated Statistics	Pure Earth Strategic Countries
ASGM	
ASGM is the leading source of mercury emissions, globally • ASGM is a necessity livelihood for many [33] • Predominantly in rural areas in 80 LMICs [80] • Largest gold sector employer, ~90% of global goldmining workforce • Estimated 19M miners incl. 4.5M women and 600k children [49] • Produces ~20% of world's gold (400-600T/year) • To release gold from gold ore, many ASGM miners use mercury **ASGM has serious negative health impacts** • During processing, mercury is released, evaporates, and is inhaled by miners and nearby communities, exposing them to negative health effects and chronic mercury intoxication [5] • Between 3.3-6.6M miners suffer from chronic mercury vapor intoxication (between 1.2-2.9M DALYs) [81] • ASGM is related to numerous health hazards: accidents, injuries, dust & noise, cyanide exposure, infectious diseases, STIs, drug & alcohol abuse [82]	**Top mercury users & Pure Earth priority countries [83]:** • **Indonesia** – 427 tons through 2012 • **Peru** – 327 tons • **Colombia** – 175 tons; almost 90% of gold mining is ASGM, ~60% is untitled & considered illegal [84, 85] • **Philippines** - 70 tons • **Ghana** – 55 tons **Bolivia, Brazil** & **China** also use >100 tons; not Pure Earth priority countries **DALYs/country [81], Years lived w/ Disability (YLD)** – 2014 data • **Philippines** – 31,915 – 46,139 • **Colombia** - 23,370 – 52,694 • **Indonesia** – 21,800 – 31,516 • **Ghana –** 17,440 - 126,062 • **Peru** – 6,104 – 8,824 "Success" is not limited to whether miners use mercury or not; it also must take into account miners' priorities.
Soil / Hotspots	
Hotspots and Industrial Waste • Many facilities use mercury despite available alternatives; released with byproducts like wastewater, sludge, gaseous emissions • Chlor-alkali industry use has decreased in last 20 years, but still produces ~2.4 % of mercury emissions to air; chlor-alkali workers show neurological symptoms [36]	**TSIP -** 627 potential mercury-contaminated sites in publicly-accessible database • **Colombia –** 76 sites • **Indonesia –** 48 sites • **Philippines –** 39 sites • **Ghana –** 23 sites • **Peru –** 16 sites
Food / Seafood	
Contaminated water causes increase of methylmercury in fish	**Pure Earth priority countries & level of concern of exposure via seafood** [87]: • **Colombia** - High

• ASGM emissions pollute atmosphere through rain & waterway contamination • Industrial activities with mercury emissions contaminate waterways **Bioaccumulation of mercury endangers global food webs** • 84% of fish sampled from around the world contained mercury concentrations > EPA's fish consumption guidelines [87] Seafood is main source of protein for 3+ billion people. People who consume high amounts of seafood can be exposed to high levels of methylmercury despite health benefits [12]	• **Peru** – High • **India** – Medium / High • **Ghana** – Medium • **Philippines** – Medium • **Bangladesh** – Medium – Low • **Indonesia** – Low **Highly impacts vulnerable groups** like some indigenous populations
Products	
Skin-lightening products pose serious health risks to vulnerable groups • Mercury is added because it suppresses melanin production • Though manufacture & sales of SLPs with mercury is often illegal, they're widely available [56-58]. A 2020-22 study of products accessed from 17 countries via >40 online platforms showed 129/271 SLPs had mercury > 1 ppm, Minamata limit [55] • SLP global market projected to reach USD 11.8 billion by 2026. In some populations, > 50% of individuals use SLPs regularly [55] **Traditional medicines**, e.g., Ayurvedic medicine [59] **Mercury-added products & their waste (batteries, lightbulbs, electronics)** Regional average consumption, tons: • East and South East Asia – 538 • South Asia – 227 • Sub-Saharan Africa – 81 • South America – 80 • **Hazardous**, medical and regular **waste incinerators** release mercury into the air to the tune of ~125 tons annually (6.5 %).	**Pure Earth priority countries & SLPs with mercury [55]** • **Bangladesh** – 75% samples had concentrations of 245 - 15,000 ppm • **Indonesia** – 61% samples, 131 - 65,000 ppm • **India** – 56% samples, 2,080 - 15,128 ppm • **Philippines** – 42% samples, 1,800 - 20,000 ppm • **Mexico** – 38% samples, 3,315 - 23,197 ppm Per US FDA regulations, concentration of mercury in cosmetic products must be **less than 1 ppm.** **SLPs mainly targeted to and used by women of childbearing age** and can be **transferred to the fetus in utero** where it causes serious health effects. [57, 88, 89]

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Annex 1. Mercury Program Goal and Outcomes, with Illustrious Activities and Indicators

	Examples of Activities	Illustrative Indicators
Mercury Program Goal		
Reduction of the prevalence of mercury exposure of target populations		• % target population with elevated levels • Average level of mercury (in blood, urine, hair, feces)
Intermediate Outcomes		
Intermediate Outcome 1: Reduction or elimination of mercury emissions, releases, concentration in products	• Directly contribute to elimination of mercury use in ASGM and other selected sources (mercury-free-free technologies & methods, gold value chains/incentives) • Reduce impact of mercury already released in the environment and preventing its spread (site remediation/reforestation, tailings)	• % of environmental media samples (soil, water) exceeding mercury standard or reference value • # hectares remediated to level below standard or reference value • # hectares in which mercury's bioavailability is reduced (reforestation, biochar) • Average mercury concentration (ppm) in a specific source (soil, rice, skin-lightening products) • % of product samples that exceed standard or reference value (skin-lightening products) • % of markets or shops selling products that exceed standard or reference value • # miners or mining operations who adopt mercury-free methods • Amount of mercury recovered from mining tailings • # tons of mining tailings from which mercury is recovered
Intermediate Outcome 2: Reduction of human exposure to mercury	• Reduce occupational risks for groups most severely affected (mercury-free technologies) • Reduce risks from consumption of contaminated foods • Reduce use of contaminated products (skin-lightening products)	• # of people exposed to contaminated sites • % of people or households using mercury-adulterated (over permitted level) products • # of miners or mining operations who adopt mercury-free methods
Sub-Intermediate Outcomes		

Sub-Intermediate Outcome 1: **Increased research, data, knowledge, and awareness**	• Increase health system capacity to monitor and manage mercury exposure • Baseline biodata collection • Research (supply chain analyses, KAP surveys) • Awareness and public education • Publish research papers • Pilot new technologies and innovations	• # of signals of support from key actors towards generating data, learning from existing data, or sharing data (e.g., form working groups, make international commitments, make progress towards Minamata commitments) • % target audience that demonstrate knowledge about risks of mercury • # new technologies field tested
Sub-Intermediate Outcome 2*:* **Strengthened regulatory systems**	• Legal and regulatory assessments and recommendations • Advocacy	• # of laws, policies, or standards that restrict or eliminate mercury use developed or adopted • # of actions taken by key actors in response to recommendations
Sub-Intermediate Outcome 3: **Increased resources and capacity to address mercury**	• Training, skills, and knowledge transfer (surveillance, environmental data collection, lab equipment) • Technical assistance and intervention design • Collaborative fundraising	• # of signals of support from key actors towards taking forward inventions begun through a Pure Earth activity (e.g., reforestation) • Value (USD) of new funding allocated or leveraged by partners for mercury programs • # of people trained that apply new skills or knowledge • # key groups or organizations that adopt improved tools, technologies, practices • # of new or improved programs, projects, systems implemented by key actors (e.g., biomonitoring / surveillance)