

6th International Forum on Sustainable Future in Asia
6th NIES International Forum

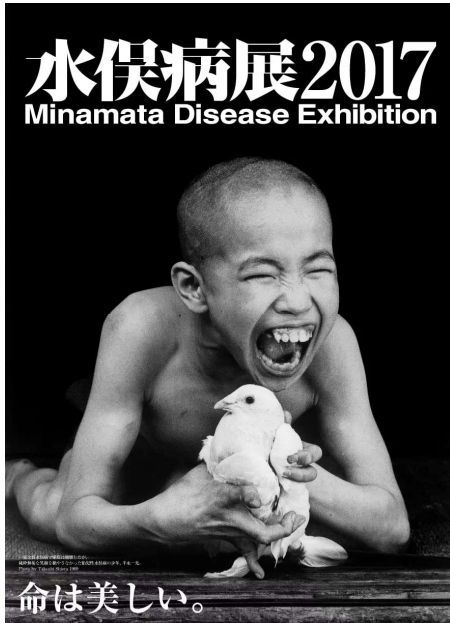
Artisanal and Small-scale Gold Mining (ASGM) and Mercury Trade Flow

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Why should we care about mercury?

Public nuisance disease: Minamata disease



1956

Minamata disease (Chisso-Minamata disease), Minamata city, Kumamoto prefecture

1965

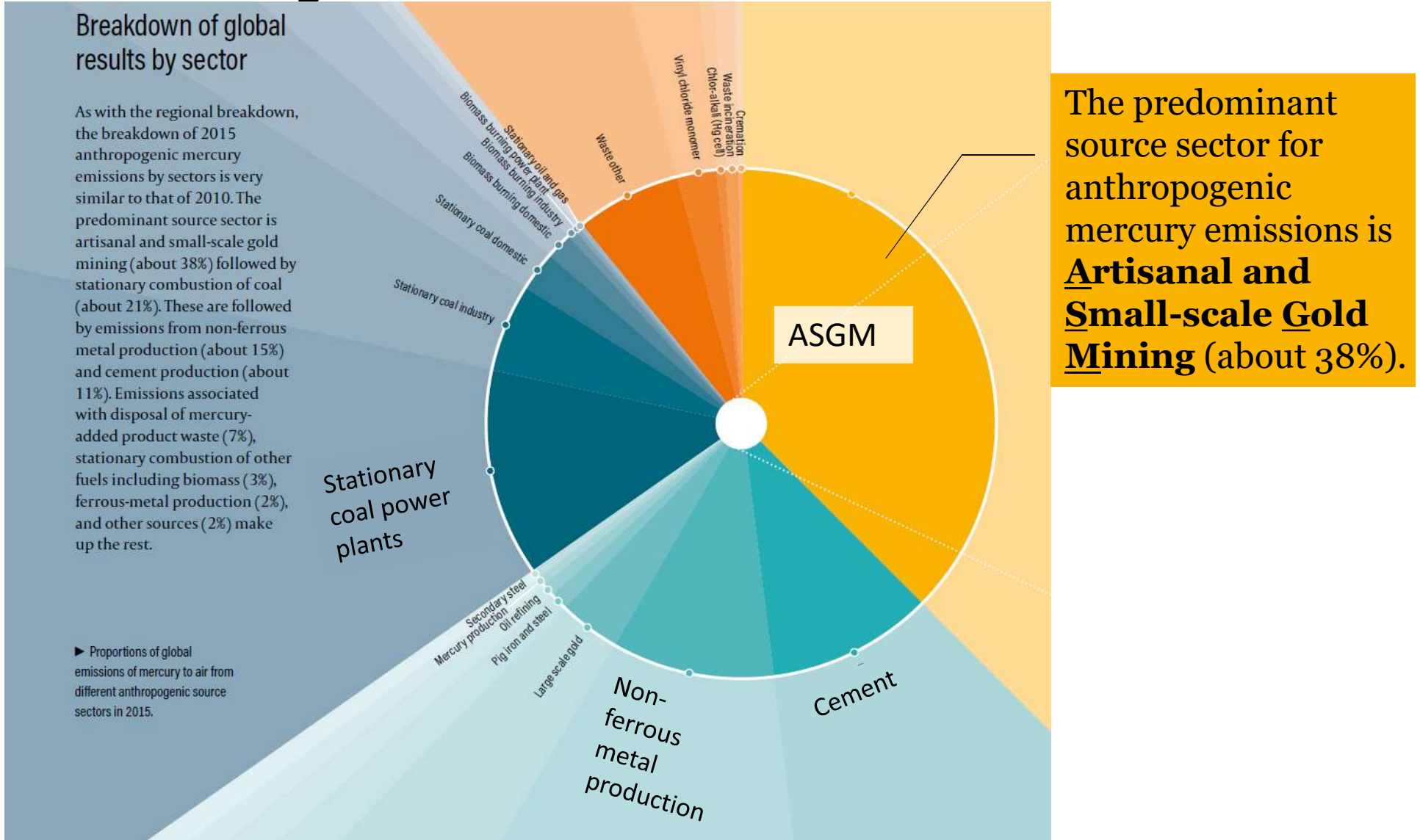
Niigata Minamata disease, Niigata Prefecture

1970

Ontario Minamata disease, Ontario Province, Canada

Anthropogenic mercury emission should be controlled.

What are the main sources for mercury emissions?



The predominant source sector for anthropogenic mercury emissions is **Artisanal and Small-scale Gold Mining** (about 38%).

[1] Global mercury assessment 2018.

Why does the ASGM process emit Hg? ⁴

How ASGM process works



[2] <https://www.slideshare.net/no2mininginpalawan/reducing-mercury-pollution-in-smallscale-gold-mining-philippines-20112014>.

What measures do we take for mercury control?

Men



Women & children



Approximately **15 million** people, including approximately **4-5 million women and children**, participate in the ASGM industry in **70 countries**[3].

- In 2017, the **Minamata Convention** [4] entered into force, which regulates the import and export of **mercury and mercury-added products**.



- However, **improper mercury trade** may occur, which is hard to detect.

[3] <https://www.planetgold.org/asgm-101>.

[4] Minamata Convention on Mercury, UN environment programme. <http://www.mercuryconvention.org/>.

Why does mercury trade matter?

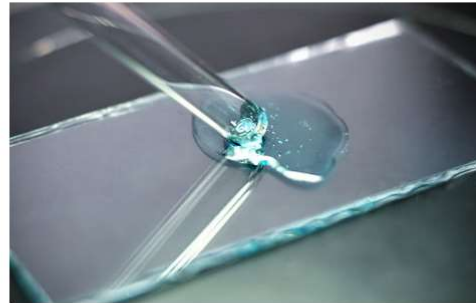
Illegal mercury trade on the rise, Unep report finds

22 April 2020

Restrictions required by UN convention has 'pushed [trade] out of sight'

[Multinational bodies](#)
[Global](#)
[Mining & minerals](#)
[Metals](#)
[Enforcement](#)
[Process safety](#)
[Chemical restrictions](#)

Illegal trade of mercury has increased as a result of countries' attempts to restrict the metal's supply and uses, following the agreement of the UN's Minamata Convention, according to a UN environment programme (Unep) report.



The Minamata Convention on mercury was [agreed in 2013](#) and entered into force in 2017.

It bans new mines of the toxic heavy metal and requires the phase-out of existing ones, as well as requiring the phase-out and phase-down of mercury use in a number of products and manufacturing processes.

- Philippine mercury supply relies primarily on import; mercury enters the country **legally (e.g. for dental use)** and **illegally** through the black market [5].
- A German company illegally exported large quantities of mercury- fraudulently characterized as waste material- to Switzerland [6].

Improper Hg trade flows can be hidden in the formal global trade, and a method that can detect such improper trade flows is desirable.

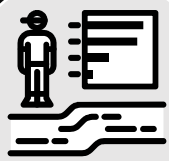
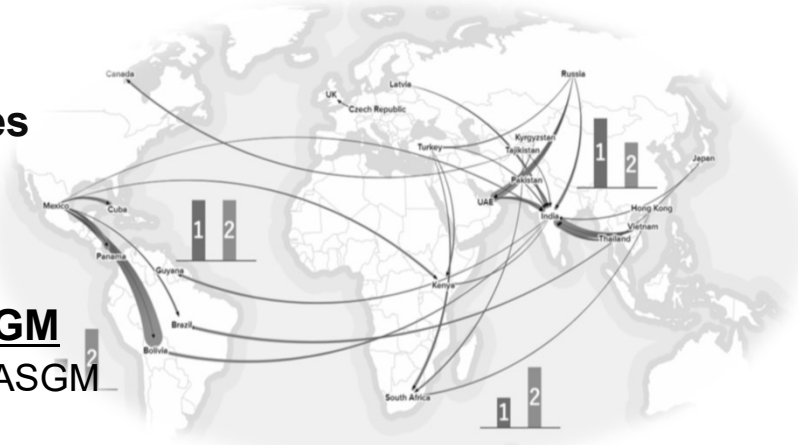
[5] <https://www.slideshare.net/no2mininginpalawan/reducing-mercury-pollution-in-smallscale-gold-mining-philippines-20112014>.

[6] UNEP and GRID-Arendal (2020). The Illegal Trade in Chemicals.

What do we do in our research?



1. Global mercury flow
Hg trade & Hg consumption in different countries (regions) in different categories



ASGM

2. ASGM list
ASGM production and ASGM Hg use in countries that have ASGM activities



3. Improper mercury trade detection & evaluation



① Hg consumption vs. ASGM Hg use
Detection: country/region & category related to ASGM



② Trade data analysis
Data Discrepancy and fluctuation-based detection

③ Panel data analysis
Time series and cross-section data analysis-based evaluation

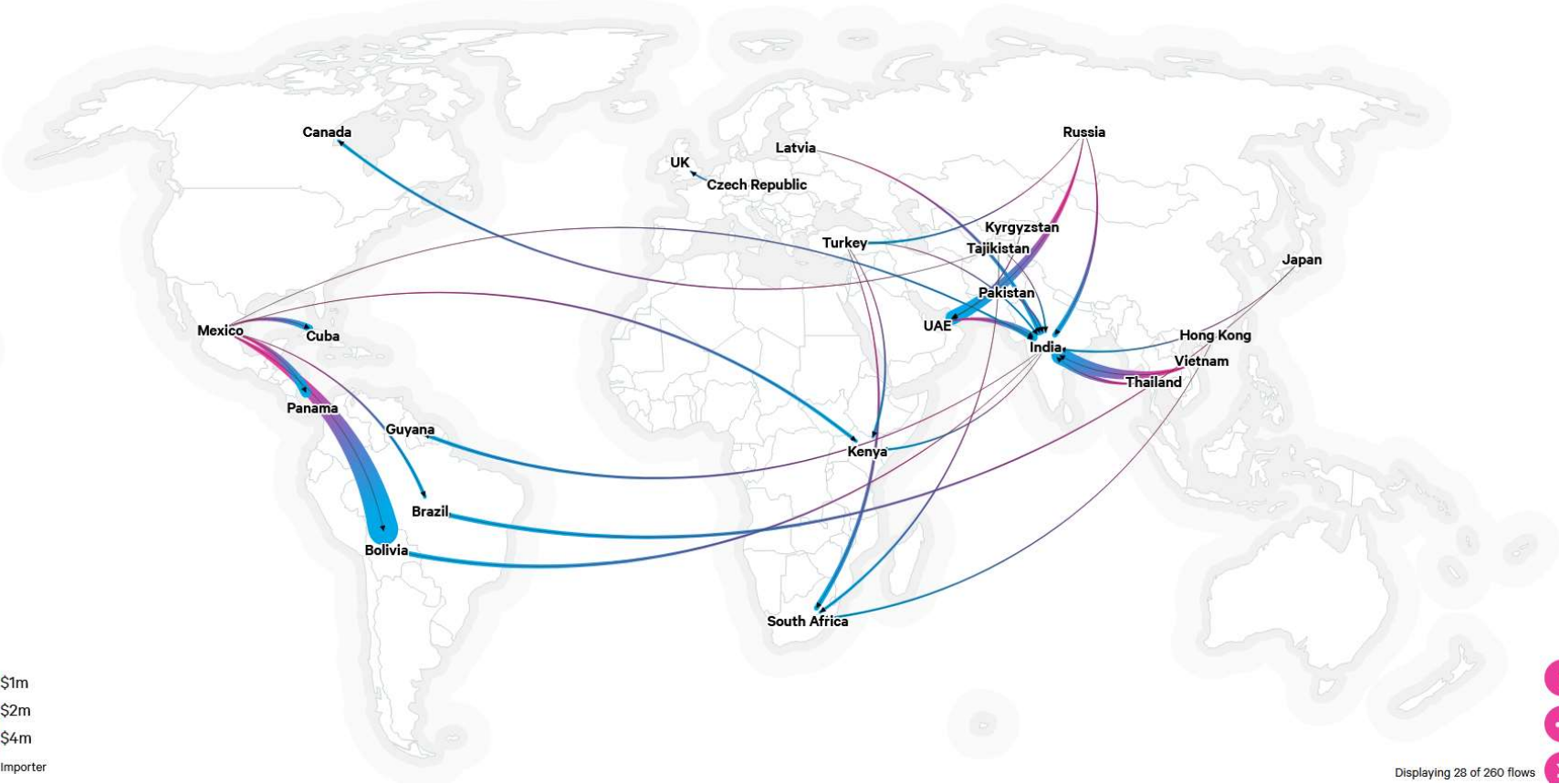
Supporting the proper management and regulation of Hg

1. Global Mercury flow

Exporter: All countries | Importer: All countries | Commodity: Mercury | Year: 2018

Measure
 ● Value
 ○ Weight
 <0.1%
 Share of global specialty metals trade

Scale
 \$1m
 \$2m
 \$4m
 Exporter | Importer

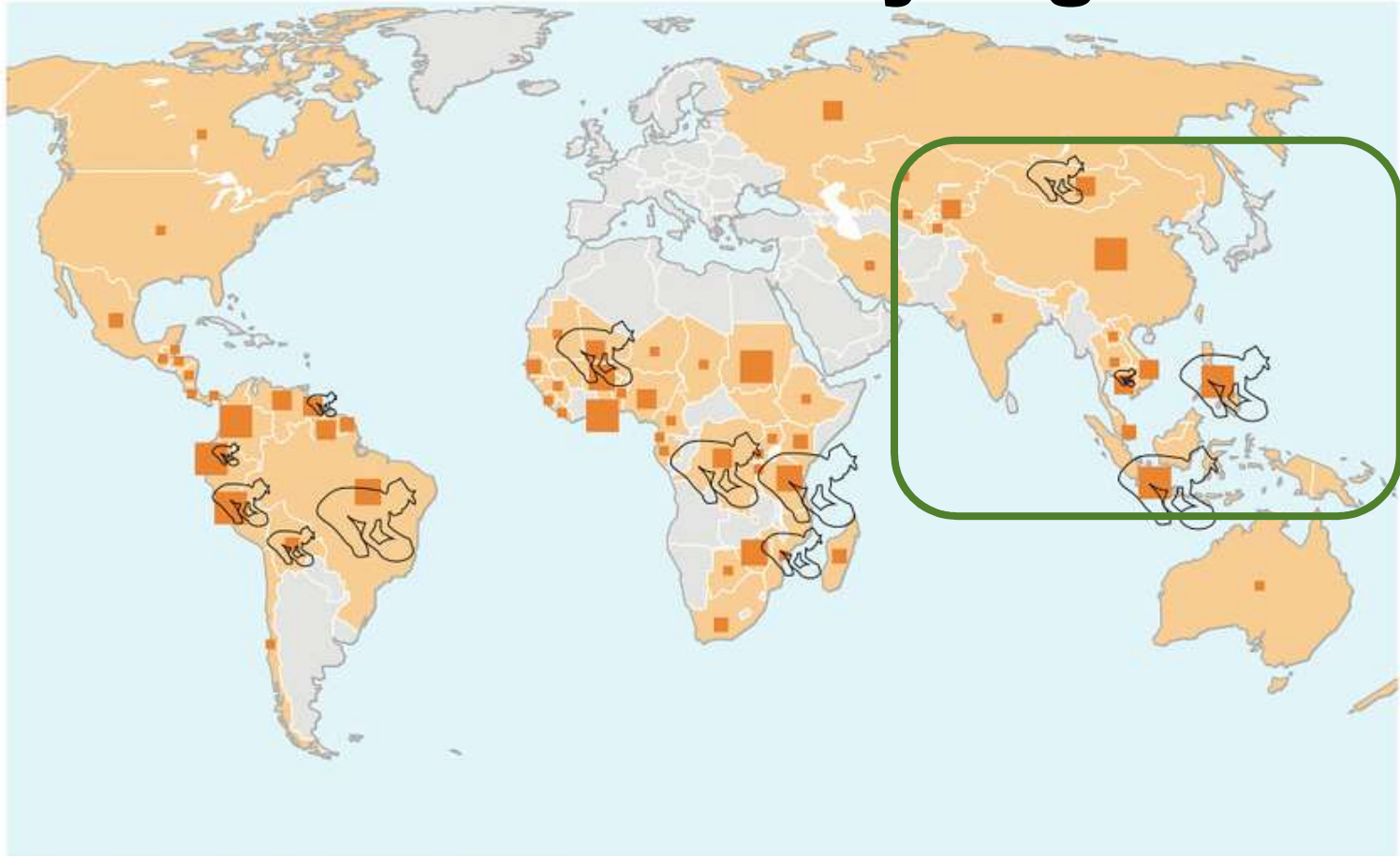


Displaying 28 of 260 flows



[7] <https://resourcetrade.earth/>

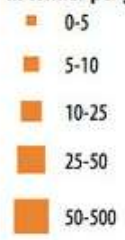
2. ASGM list: country/region



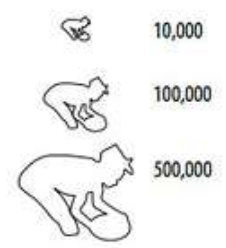
ASGM activities are being undertaken in Asian countries as well.

Artisanal and small-scale gold mining (ASGM)

Estimated mercury releases from ASGM in tonnes per year



Estimated numbers of miners



Over 70 Countries where ASGM is occurring

[8] <https://www.grida.no/resources/7774>

2. ASGM list: number of miners

Country	Directly working in ASM	Estimated number of dependents	Main minerals mined by ASM
ANGOLA	150,000	900,000	Diamonds
BURKINA FASO	200,000	1,000,000	Gold
CENTRAL AFRICAN REPUBLIC	400,000	2,400,000	Gold, diamonds
CHAD	100,000	600,000	Gold
CÔTE D'IVOIRE	100,000	600,000	Gold, diamonds
DRC	200,000	1,200,000	Diamonds, gold, coltan
ERITREA	400,000	2,400,000	Gold
ETHIOPIA	500,000	3,000,000	Gold
GHANA	1,100,000	4,400,000	Gold, diamonds, sand
GUINEA	300,000	1,500,000	Gold, diamonds
LIBERIA	100,000	600,000	Gold, diamonds
MADAGASCAR	500,000	2,500,000	Coloured gemstones, gold
MALAWI	40,000	-	Coloured gemstones, gold
MALI	400,000	2,400,000	Gold
MOZAMBIQUE	100,000	1,200,000	Coloured gemstones, gold
NIGER	450,000	2,700,000	Gold
NIGERIA	500,000	2,500,000	Gold
SOUTH AFRICA	20,000	-	Gold
SIERRA LEONE	300,000	1,800,000	Gold, diamonds
SOUTH SUDAN	200,000	1,200,000	Gold
TANZANIA	1,500,000	9,000,000	Gold
UGANDA	150,000	900,000	Gold
ZIMBABWE	500,000	3,000,000	Gold, diamonds, colored gemstones

15 million Miners
working in the ASGM
sector globally

[9] Fritz, M. M., McQuilken, J., Collins, N., & Weldegiorgis, F. (2018). Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues. HAL Working Papers, (hal-02547257).

2. ASGM list: ASGM production

Continent	Country	Expected ASM population	Estimated ASGM production	Large scale gold mining (LSM)	Ratio
		[× 1000]	[t]	[t]	ASGM : LSM
Asia	China	2746	48.2	371	13%
	Philippines	366	28	37.1	75%
	Indonesia	250	20	165.1	12%
	Pakistan	515	8.9	–	–
	Vietnam	63	7.1	3.7	192%
	Mongolia	–	5	12.4	40%
	India	915	1.2	–	–
Africa	–	9606–9701	85.4–90.3	572.9	15–16%
Central America	–	146–156	3.3	–	–
South America	Brazil	861	21–64.9	67.3	31–96%
	Colombia	268–418	41.4–50.8	37.5	110–135%
	Peru	70	40	189.6	21%
	Bolivia	130	24.8	6.5	382%
	Ecuador	128	24.5	17.6	139%
	Suriname	28	15	24.6	61%
	Venezuela	25–70	7–15.1	25.5	27–59%
	Guyana	28	7.6	14.4	53%
	Chile	17	5.5	44.5	12%
	French Guyana	7	3.6	3	120%

[10] Seccatore, J., Veiga, M., Origliasso, C., Marin, T., & De Tomi, G. (2014). An estimation of the artisanal small-scale production of gold in the world. *Science of the Total Environment*, 496, 662-667.

[11] GFMS gold survey 2019.

2. ASGM list: ASGM Hg use

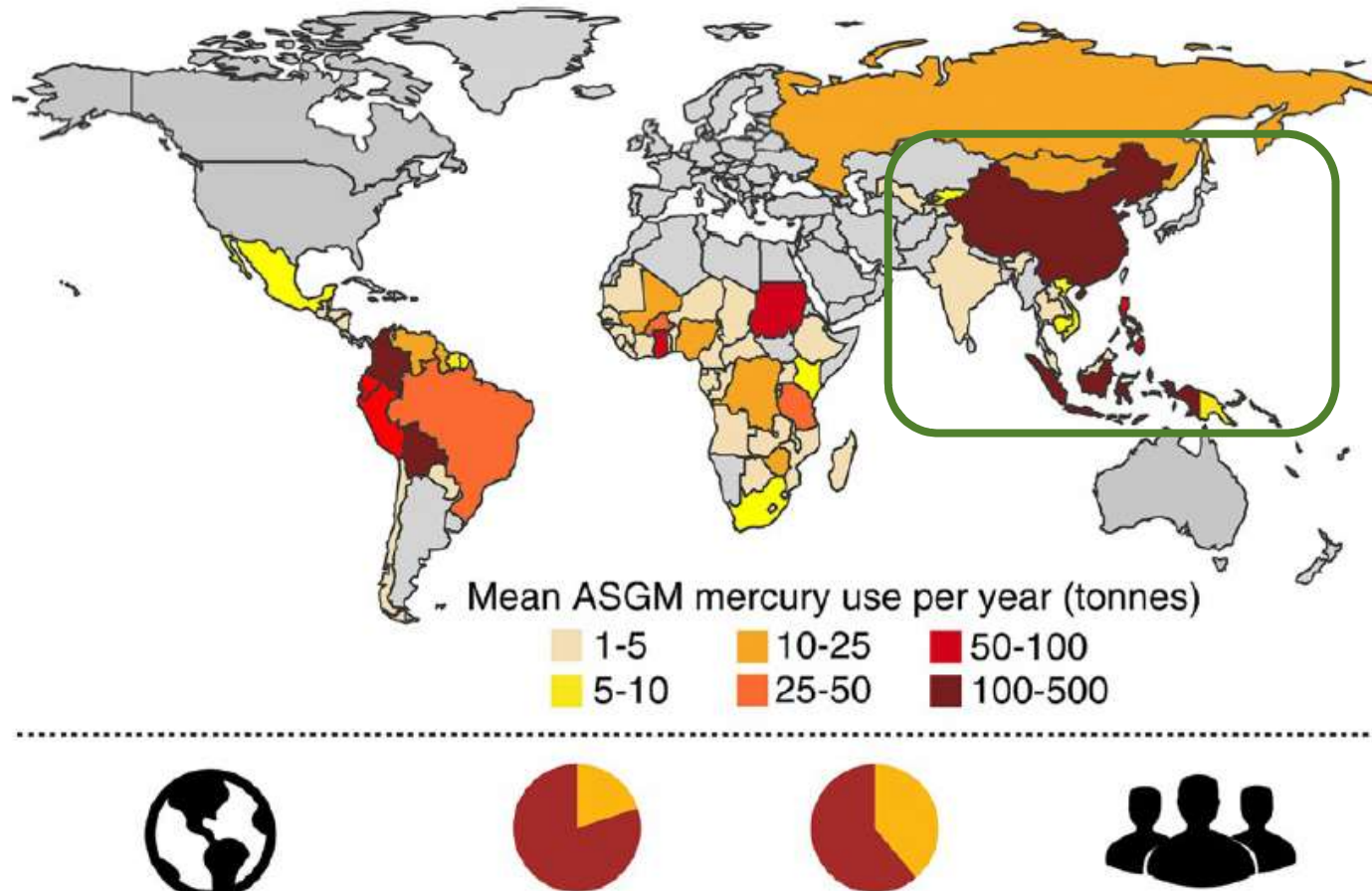
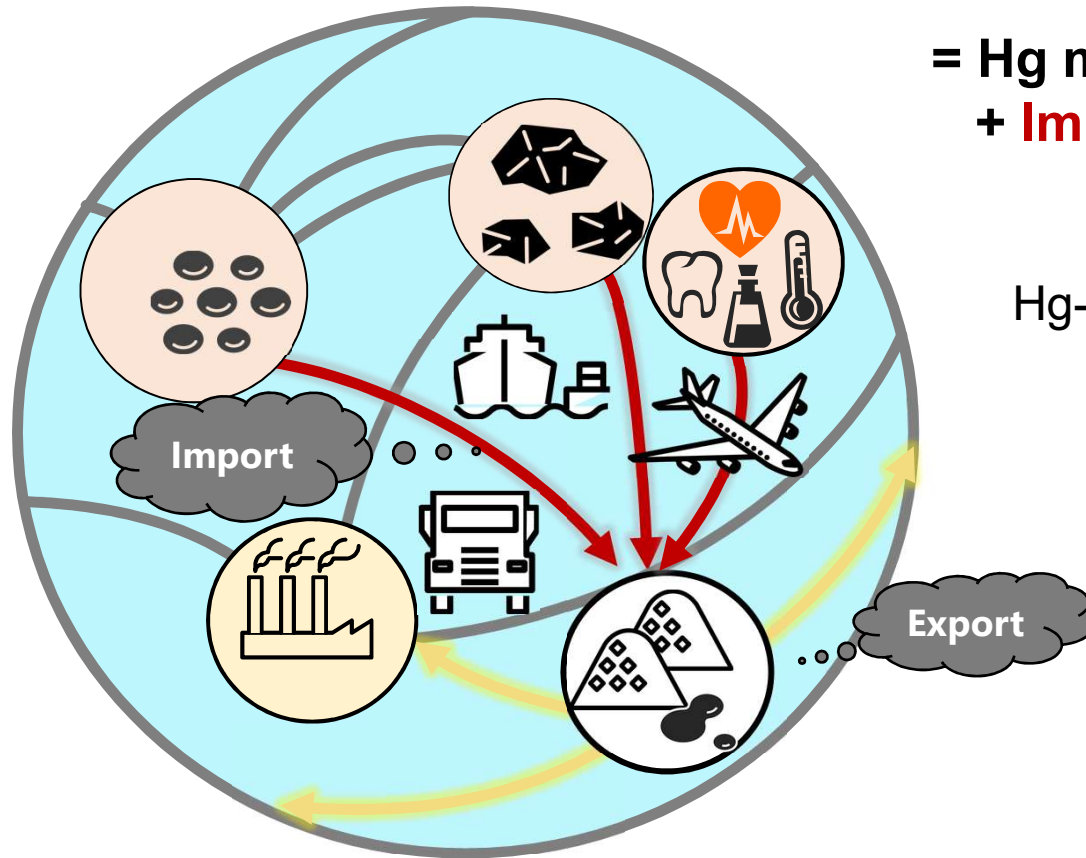


Figure 1. Estimated annual mercury use in artisanal and small-scale gold mining (ASGM) [12].

[12] Esdaile, L. J., & Chalker, J. M. (2018). The mercury problem in artisanal and small-scale gold mining. *Chemistry–A European Journal*, 24(27), 6905-6916.

3. Apparent Hg consumption



Apparent Hg consumption

$$= \text{Hg mining production} + \text{Import [Hg]} - \text{Export[Hg]}$$

Hg-added product* Hg content

Apparent Hg consumption means the total amount of Hg that is available for domestic use in each country.

Based on trade data on 5,000 categories, we screened out 112 categories that contain Hg, and calculated the global Hg trade flow.

[13] Nakajima, K., Daigo, I., Nansai, K., Matsubae, K., Takayanagi, W., Tomita, M., & Matsuno, Y. (2018). Global distribution of material consumption: nickel, copper, and iron. Resources, Conservation and Recycling, 133, 369-374.

3. Improper Hg trade

① Apparent Hg consumption vs. ASGM Hg use

Detection: country/region & category related to ASGM

Top 11 countries with large ASGM Hg use

Country	Hg production (tonnes)	Apparent Hg consumption (tonnes)	ASGM Hg use (UNEP) [14](tonnes)
Indonesia	621	360	210–630
Colombia	51	184	90–270
Peru	203	134	72.5–217.5
Bolivia	51	184	84–136
China	3,419	3,570	25–175
Ecuador	2	3	42.5–127.5
Sudan	24	24	63–103
Philippines	11	11	35–105
Ghana	28	38	35–105
Suriname	9	9	44.1–81.9
Brazil	60	55	22.5–67.5

[14] UNEP 2017 Global mercury supply, trade and demand.

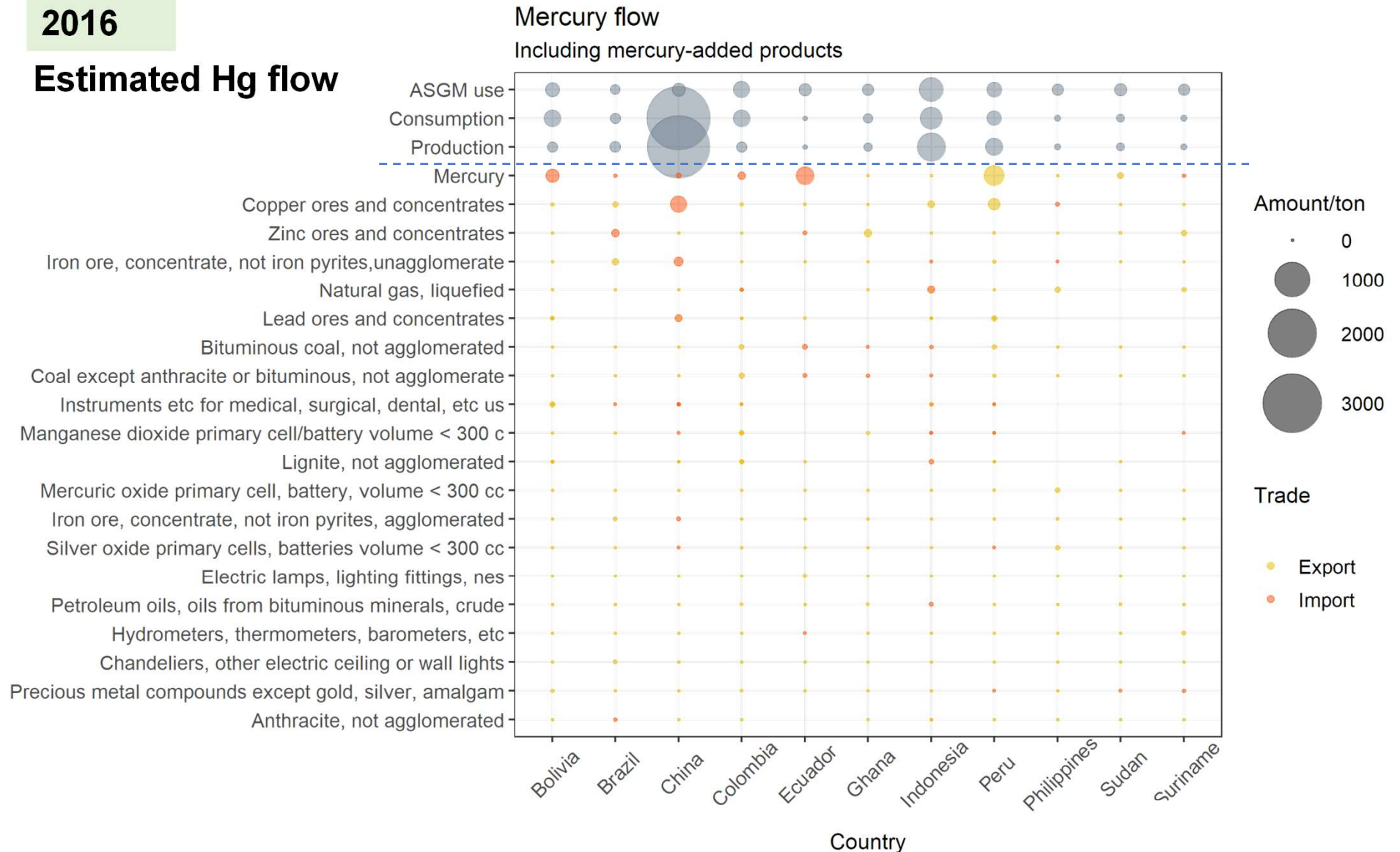
3. Improper Hg trade

Detection $\text{Apparent Hg consumption} = \text{Production} + \text{Import} - \text{Export}$

$\text{Hg-containing product} * \text{Hg content}$






2016

Estimated Hg flow



3. Countries with possible improper Hg trade¹⁶

ASGM Hg use > Apparent Hg consumption

	Ecuador	Mercury	Bituminous coal	Coal
	Ghana	Coal	Bituminous coal	
	Indonesia	Natural gas	Lignite	Petroleum oils
	Philippines	Copper ores	Iron ore	
	Sudan			
	Suriname	Mercury	Precious metal	Manganese oxide primary cell

However, whether these Hg flows are used in the ASGM still needs further investigation.

Summary

Black market, mislabeled trade, and transportation of Hg to the ASGM sector remain a global concern in Hg management.

A method for **improper Hg trade flow detection** can support the proper management and regulation of Hg.

Further investigation is necessary on the detection and evaluation of improper Hg trade flows to the ASGM activities.

Hg problem is a global concern and we need more data from **field research** in ASGM and **global cooperation** especially from countries and areas that have significant ASGM activities.

References

- [1] Global mercury assessment 2018.
- [2] <https://www.slideshare.net/no2mininginpalawan/reducing-mercury-pollution-in-smallscale-gold-mining-philippines-20112014>
- [3] <https://www.planetgold.org/asgm-101>
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- [6] UNEP and GRID-Arendal (2020). The Illegal Trade in Chemicals.
- [7] <https://resourcetrade.earth/>
- [8] <https://www.grida.no/resources/7774>
- [9] Fritz, M. M., McQuilken, J., Collins, N., & Weldegiorgis, F. (2018). Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues. HAL Working Papers, (hal-02547257).
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- [11] GFMS gold survey 2019.
- [12] Esdaile, L. J., & Chalker, J. M. (2018). The mercury problem in artisanal and small-scale gold mining. *Chemistry–A European Journal*, 24(27), 6905-6916.
- [13] Nakajima, K., Daigo, I., Nansai, K., Matsubae, K., Takayanagi, W., Tomita, M., & Matsuno, Y. (2018). Global distribution of material consumption: nickel, copper, and iron. *Resources, Conservation and Recycling*, 133, 369-374.
- [14] UNEP 2017 Global mercury supply, trade and demand.

Thank you for your attention!

ご清聴ありがとうございました！

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