

Mercury contamination index to estimate the risk in public health from ASGM

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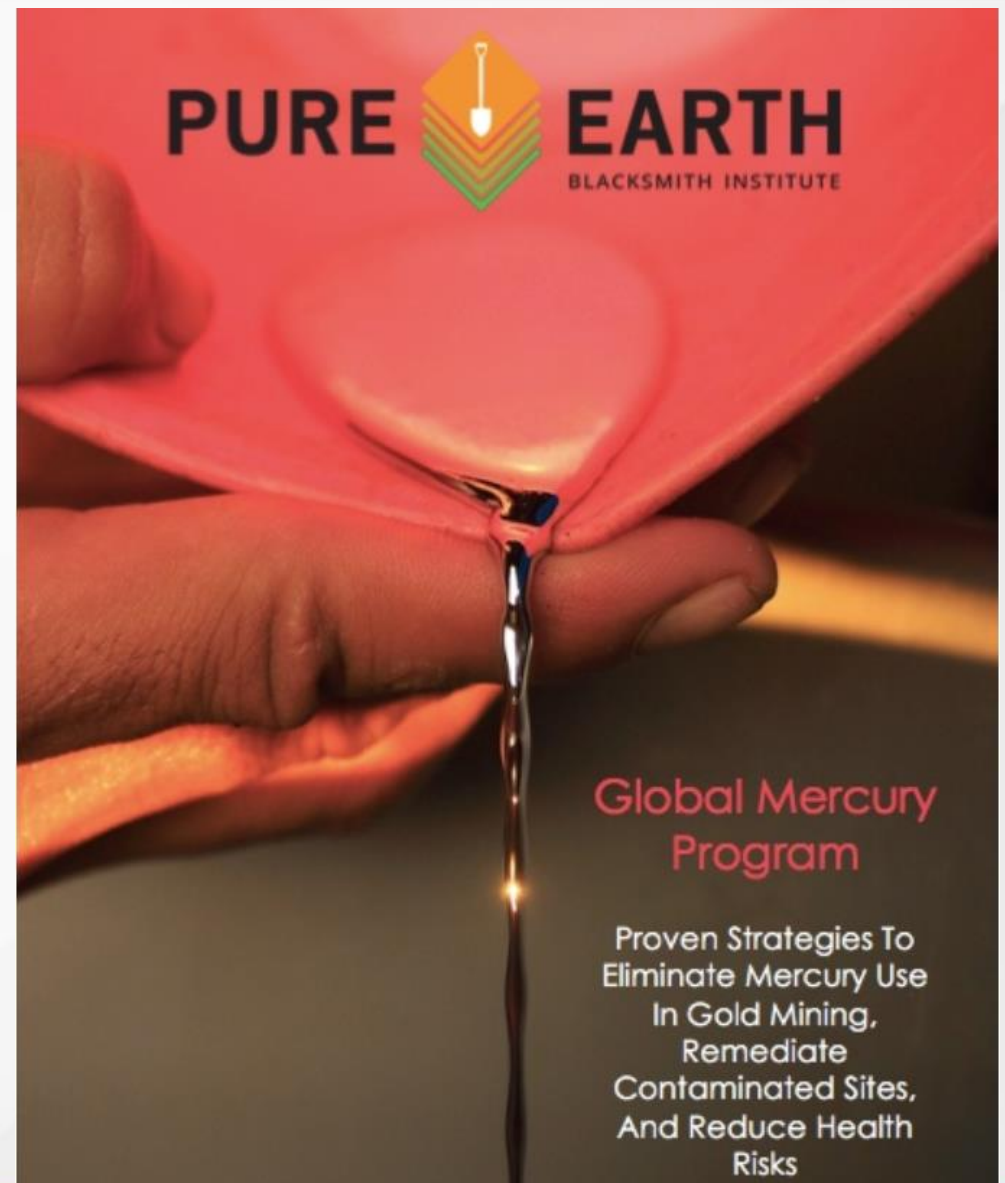
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Agenda

- ◆ Colombia Context
- ◆ Mercury Contamination Index criteria
- ◆ Mercury Contamination Index formula
- ◆ Results and Interpretation



Colombia Context



Other projects

- 37 Sites identified (2016 – 2019)

UNDP (Planet Gold)

- 35 Sites identified (2020 – 2021)

UNPD (Ministry Mining)

- 140 Potential Sites (2021 – 2022)
In progress

Main causes of contamination



Environmental liabilities

Mining Activities before June 2018

Illegal Mining Activities :

Use of mercury after June 2018

Lack of proper tailings management

- New underground market
 - Reprocessing by cyanidation
 - Transportation
 - No final disposal methods
-



Piles



Sacks



Tailing Pool

Importance of applying the Blacksmith Hg Contamination Index (BIHg Index)



◆ Confirm the presence or absence of mercury contamination in soil, water and air.



◆ Estimate the number of people at risk of health impacts due to mercury contamination



◆ A summary “score” for the site reflecting the public health risks for use in prioritizing further action / Decision-making process

Blacksmith Index

First tool developed by Pure Earth in 2014 with the same purpose for various contaminants

<https://www.sciencedirect.com/science/article/pii/S2214999614002938>

Caravanos, Gualtero, Dowling, Ericson, Keith, Hanrahan

Blacksmith Mercury Contamination Index

Fundamental Concepts

- ◆ **Index is focused on public health**
Additional evaluation of legality and economic significance of an ASGM site can be added in overall risk evaluation summary as separate factors
- ◆ **Index only considers mercury contamination and its hazards**
Not other contamination sometimes related to ASGM mining such as silica dust
Not occupational health hazards such as falls, heat exhaustion, etc.
Not other health impacts on communities near ASGM sites
- ◆ **Index will consider mercury contamination of soil, water and outdoor air pollution and indoor air pollution**
Historically, the Blacksmith Index was focused primarily on soil contamination, with some consideration of water pollution
- ◆ **The overall BIHg Index score for a site is the total for all media (soil, air, water) where mercury contamination is found. This reflects that the hazard from each media contributes to the overall site hazard**

Mercury Contamination Index Fundamental Concepts

Five types of operations considered in the investigation of ASGM sites:

- 1) Mining
- 2) Concentration using mercury
- 3) Extraction of gold from mercury amalgamate (i.e. “burning”)
- 4) Tailing disposal from 1) , 2) and 3) above if they may contain mercury
- 5) Residential areas or sensitive population areas near the above

SITE DEFINITION – Separate area where one of the above operations is done and where mercury is used or may be present will be considered a separate site.

Operations may be located together or at separate locations

Each separate location considered a separate site

There may be multiple locations for a type of operation, such as multiple areas where mining or concentration is done.

Each area considered as a as a distinct site

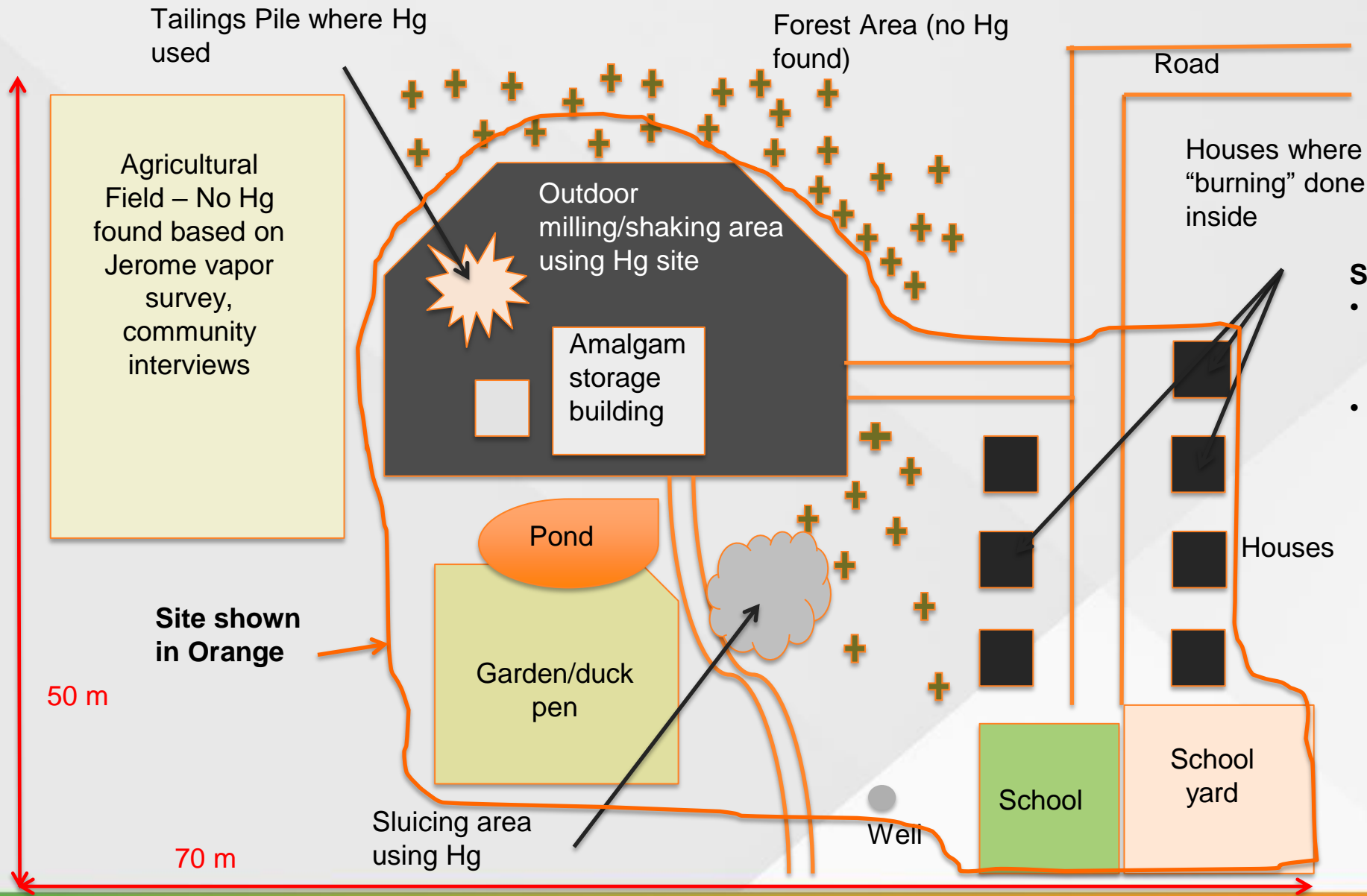
Investigations include a map showing each site in detail

Level of contamination compared to health impact based reference values:

For air = 1 ug/m³

For soil and tailings = 10 mg/kg

For water = 2 ug/l (USEPA drinking water standard)



- Site Definition:**
- Contiguous area where contamination found.
 - Usually fairly small, close to mercury use area

Mercury Contamination Index – Formula

$$BI_{Hg} = [\log_{10}(a_2)] + 3[\log_{10}(a_3)] + 2[\log_{10}(b_{ia})] + [\log_{10}(b_{oa})] + [\log_{10}(b_{sl})] + [\log_{10}(b_{ta})] + [\log_{10}(b_w)]$$

<i>a2</i>	Adult population in proximity to the site of interest
<i>a3</i>	Child population between 0 and 12-years-old and pregnant women in proximity to the site of interest
<i>bia</i>	(N-bia / D-bia)
<i>boa</i>	(N-boa / D-boa)
<i>bsi</i>	(N-bsi / D-bsi)
<i>bta</i>	(N-bta / D-bta)
<i>bw</i>	(N-bw / D-bw)



<i>N - bia</i> ($\mu\text{g}/\text{m}^3$)	Average measurement result of Hg vapours in indoor air
<i>N - boa</i> ($\mu\text{g}/\text{m}^3$)	Average measurement result of Hg vapours in air for open spaces
<i>N - bsi</i> (mg/kg)	Highest Hg concentration for all soil samples
<i>N - bta</i> (mg/kg)	Highest Hg concentration for all tailings samples
<i>N - bw</i> (mg/L)	Highest Hg concentration for all water samples
<i>D - bia</i> ($\mu\text{g}/\text{m}^3$)	Reference value – indoor air
<i>D - boa</i> ($\mu\text{g}/\text{m}^3$)	Reference value – outdoor air
<i>D - bsi</i> (mg/kg)	Reference value soil
<i>D - bta</i> (mg/kg)	Reference value tailings (if is different of soil)
<i>D - bw</i> ($\mu\text{g}/\text{L}$)	Reference value drinking water

Use 0 where measurements are below the screening threshold level

Mercury Contamination Index - Notes

- ◆ **Health risks for ASGM operations primarily relate to inhalation of mercury vapors (which cross lung/blood barrier)**
Secondary routes: ingestion of contaminated water, fish, poultry or eggs
- ◆ **Overall risk is a factor of both the concentration of mercury inhaled (or drunk or eaten) and population exposed**
 - Risks for different exposure routes additive
- ◆ **Logarithmic scale used because contamination concentrations tend to increase exponentially at contaminated sites, rather than just arithmetic increases**
- ◆ **Greater weight given to young child and pregnant women populations**
 - Smaller body weight and greater activity can lead to higher exposure levels for children for the same air concentration
 - Mercury exposure to pregnant women and young children can lead to impaired neurological development of foetus or children, since their brains are in active development

Mercury Contamination Index - Notes

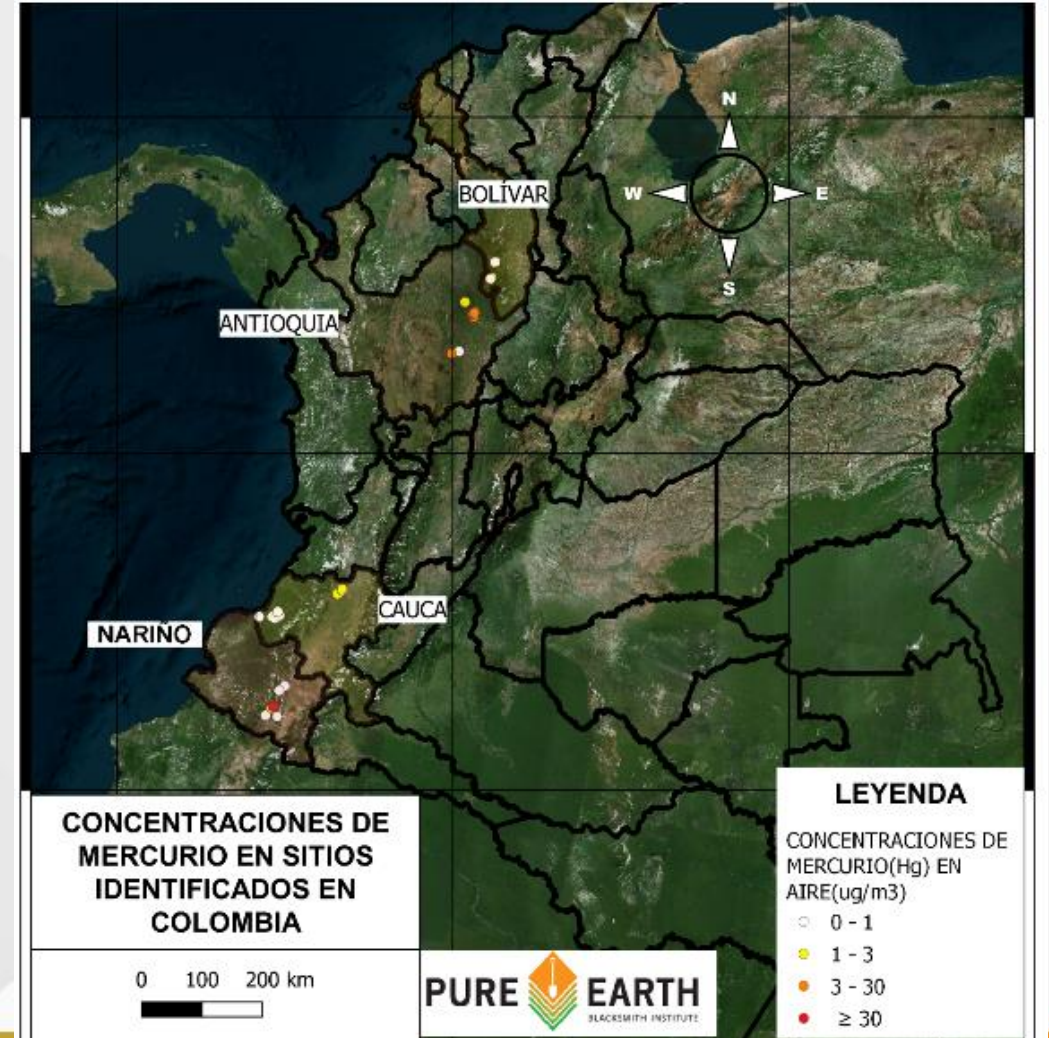
◆ Greater weight given to indoor air contamination because

- Mercury vapors are more likely to linger and not attenuate rapidly after cessation of generating operation
- Mercury is more likely to condense and settle in indoor spaces, meaning longer times for exposures as indoor spaces heat up in day time
- People are more likely to spend more time in indoor locations compared to outdoor processing area, particularly if operations or storage is done in homes or shops where people spend much time.
- Secondary routes: ingestion of contaminated water, fish, poultry or eggs

◆ Focus is on exposure of people near mercury operations or tailings since mercury vapor concentrations tend to attenuate very rapidly with distance

◆ Additional evaluation of legality and economic significance of an ASGM site can be added in overall risk evaluation summary as separate factors

Collecting field data



Results

BIHg Index evaluation is done on a programmed Excel sheet, with formulas built in and space allowed for each type of ASGM operation

Departamento	# Sitio	Municipio	Nombre	Indice Sitio	I. Comunidad (2)	I. Comunidad (3)
Cauca	1	Suarez	La Turbina	1,59	6,38	7,61
	2		El Desquite	1,28	4,04	4,64
	3		Tamboral	1,39	5,32	6,36
	4		Marabeles	1,28	7,11	8,82
	5		Pueblo Nuevo	0,85	3,02	3,02
	6	Buenos Aires	La Paila	1,22	6,89	8,37
	7		HIGUERILLO	1,16	6,51	7,87
	8		HIGUERILLO RIO TETA	1,36	5,04	5,64
Nariño	9	San Francisco	Mina Gualconda	0,97	1,87	1,87
	10	LA LLANADA	COODMILLA	0,69	1,39	1,39
	11	SANTA CRUZ	EL DIAMANTE	2,18	3,93	4,23
	12		PISILTES	1,12	1,42	1,42
	13		QUEBRADA HONDA	0,22	0,69	0,69
	14	MALLAMA	EL VERDE- MINA TESORITO CAUSALIDAD	1,04	2,00	2,00
	15	MALLAMA	EL VERDE-MANGO VERDE	0,00	0,00	0,00
Antioquia	16	San Roque	Don Alfonso	1,32	3,51	3,98
	17		El colegio	0,00	0,00	0,00
	18		Don Purino	2,34	5,82	6,73
	19	Remedios	parque remedios y alrededores	1,65	5,22	6,07
	20		Boca Toma	2,79	3,49	3,49
	21		La Cruzada	3,04	6,10	6,71
	22	Segovia	Parque Segovia	1,93	5,70	6,70
	23		Parte baja quebrada la Cianurada	1,58	2,06	2,06
24	Machuca		1,97	5,60	6,60	
Sur de Bolivar	25	MONTECRISTO	EL RAYO	0,90	3,97	5,12
	26		ARSENICO	1,63	2,48	2,48
	27		ESTUFA DE LEÑA	1,15	2,15	2,15
	28	SANTA ROSA	TINTO	0,86	2,06	2,37
	29	SANTA ROSA	CENTRO LA MARIZOSA	0,55	5,58	6,98
	30		DESPUÉS DEL RÍO	0,56	4,34	5,38
Cauca	31	Guapi	Centro Guapi	0,00	0,00	0,00
	32		Concepción	0,00	0,00	0,00
	33		Guajui Bajo	0,00	0,00	0,00
	34	Timbiqui	Timbiqui	0,00	0,00	0,00
	35		El Desquite	0,00	0,00	0,00

Summary and Conclusions

- ◆ **The mercury contamination index offers a quick estimate of the risk that a specific population can establish. However, it does not replace the detailed risk assessments that can be carried out in the same area.**
- ◆ **This tool helps decision-making by government agencies that need to prioritize urgent interventions or effective budget management.**
- ◆ **An update of the mercury contamination index can be achieved by incorporating specific data on food and fish contamination from the assessed area. However, data collection can be affected by the quick of the study and results.**
- ◆ **A history over time of the calculated indices is work to be done in the future. This would provide evidence of the reduction in risk in a specific site after an intervention performed.**

Thank You