Evaluating and Mitigating the Damaging Effects of Mercury-based Artisanal and Small-Scale Gold Mining in South America

Duke UNIVERSITY | BASS CONNECTIONS *Team Gold*

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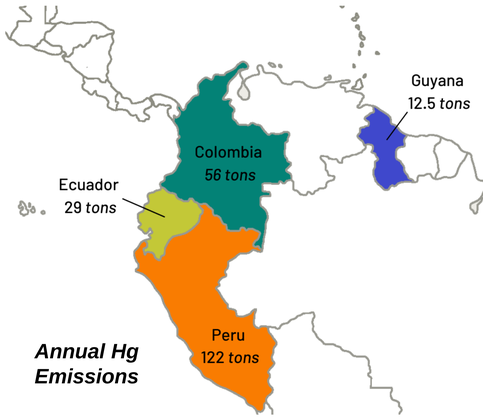
Artisanal and small-scale gold mining is the largest source of anthropogenic mercury



Millions of artisanal and small-scale gold miners (ASGM) use mercury (Hg) to extract gold from ore, generating Hg emissions and waste that threaten environments and public health. Our research team aims to evaluate and mitigate the damaging effects of mercury-based ASGM in Peru, Colombia, Ecuador, and Guyana.

Environmental Monitoring and Technologies

MONITORING:

- In regions of the Peruvian Amazon, up to 30% of mined land is permanently ponded due to mining.
- Low-oxygen environments such as ponds produce methylmercury-- the neurotoxic form of Hg that bioaccumulates in the food chain.


Photo: Jason Houston (CINCIA)

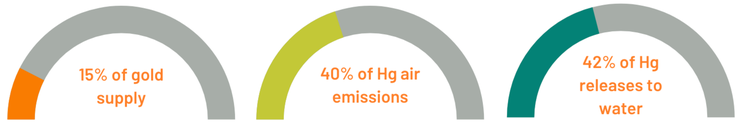
Shannon Plunkett collecting samples in a mining pond in Madre De Dios, Peru, March 2022 Photo: Yerko Rios Mardini

We partner with the Peruvian government to:

- Characterize water quality and mercury pollution in mining ponds.
- Test a new environmental sampling technology (Diffusive gradient in thin-film samplers) to determine mercury bioaccumulation potential in local fauna.

TECHNOLOGY

Gold amalgamation produces about 40% of anthropogenic mercury emissions.



Potential mercury-free technologies for gold-mining:

- Borax, cyanidation, chlorination, flotation, green leaching and amino acids leaching.

Implementing mercury-free technologies requires understanding of the chemical composition of local minerals, socioeconomics, and cultural barriers.


Photo: Rodrigo Abd (AP)

Measuring the Impact of Mercury on Health

MERCURY TOXICITY & MIXED EXPOSURES:

When exposed, Hg can have detrimental impacts on human health that include: developmental delays, cognitive impairment, and kidney effects among other symptoms.

Lead (Pb) exposure causes similar negative health outcomes, including developmental delay and hypertension in adults.

In South America, Hg exposure is linked with close proximity to artisanal gold mining and high fish consumption. Pb exposure is linked to wild game consumption. Our investigations found that co-exposure to lead and mercury is detrimental to neurodevelopment.

EXPOSURE ASSESSMENT:

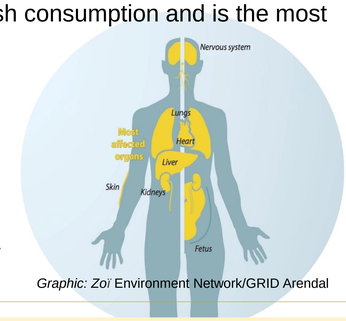
We evaluated the effect of joint Hg and lead (Pb) exposure on child cognitive development and adult cardiovascular disease risk.

Helena Frischtak, MD, conducting cognitive assessment tests (Woodcock-Munoz) on children in the Peruvian Amazon

The cognitive study revisited a publication by the team (Rueben et.al. 2020) that demonstrated a significant associated between elevated hair Hg and reduced cognitive **f**unction in children.

BIOMARKERS: Urine is the recommended biomarker in ASGM environments by the MINAMATA Global Mercury Treaty. However, hair is the gold standard for measuring organic Hg (methylmercury or meHg) exposure, which arises from fish consumption and is the most common exposure in Latin America.

We simulated the efficacy of urine vs. hair biomarkers to identify high Hg exposure due to: (1) Inhalation exposure; and (2) Dietary (fish) consumption (meHg). We estimated the % of iHg and meHg that hair and urine correctly identify as elevated Hg exposure.



Graphic: Zoi Environment Network/GRID Arendal

Economics & Policy Analysis

Intervention Analysis:

- Ex-post analysis to determine the efficacy of a United Nations Development Programme Intervention
- UNDP connected miners to mercury-free processing centers
- Expectations: miners will increase their income and reduce their mercury-use

Miner Well-Being Assessment:

- We are helping the Alliance for Responsible Mining construct a survey that assesses artisanal and small-scale gold miners' economic well-being in Colombia

Market Analysis:

- We are surveying gold consumers in the United States to gauge their knowledge and perceptions of responsible gold.
- The results will inform *Fairmined*'s efforts to increase responsible gold consumption.

Fairmined Eco Gold

Policy Development:

- Developing policies to remediate mine waste in Colombia
- Evaluating legal and regulatory frameworks
- Hosting collaborative workshops

Acknowledgments