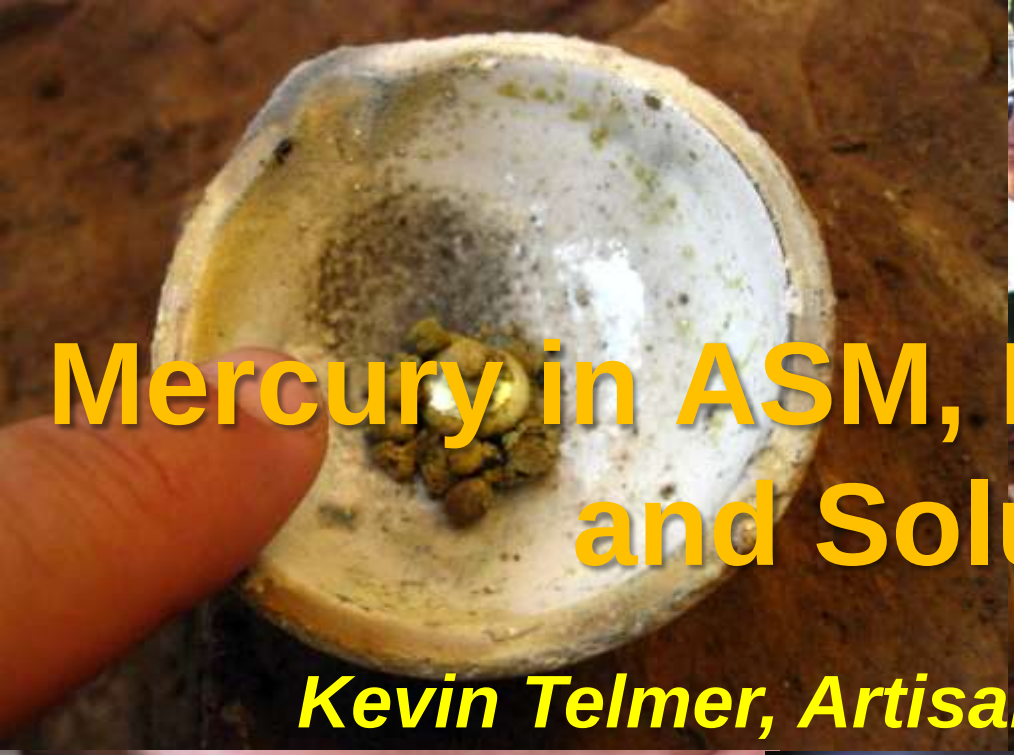


Mercury in ASM, Extent, Causes, and Solutions

Kevin Telmer, Artisanal Gold Council, University of Victoria

Mocambique, 2009, K. Telmer

Titulo Alternativo

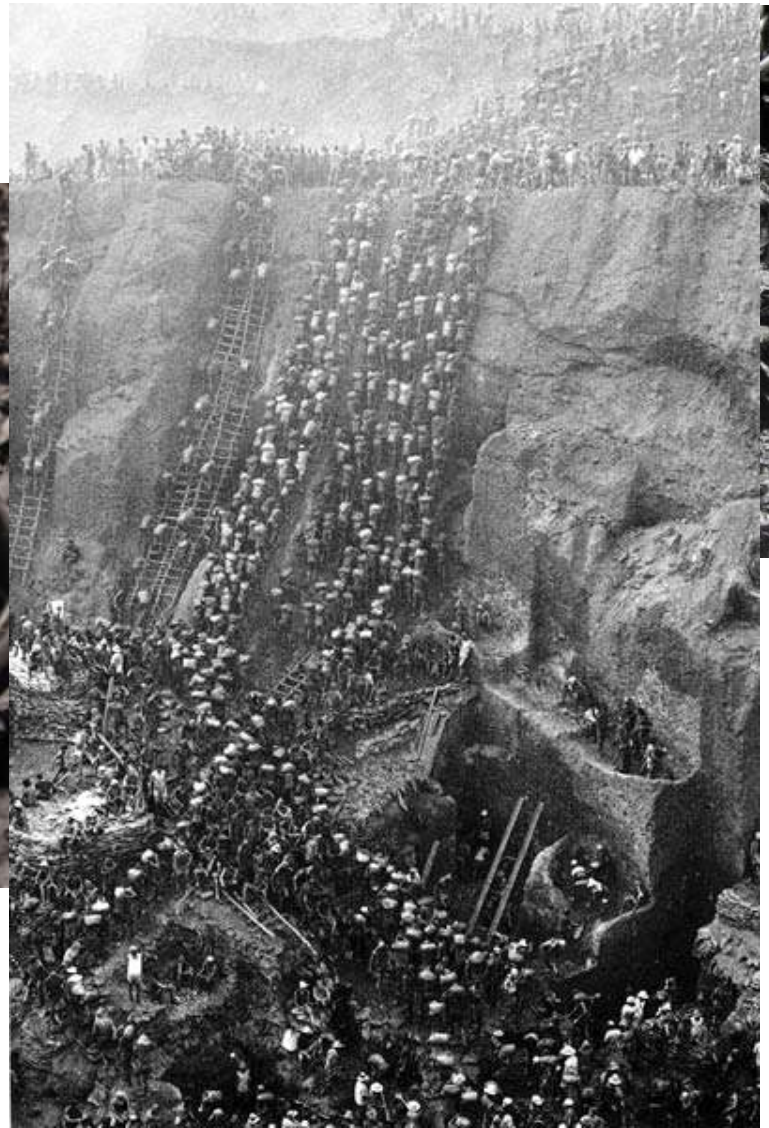
Gold in Poverty Relief

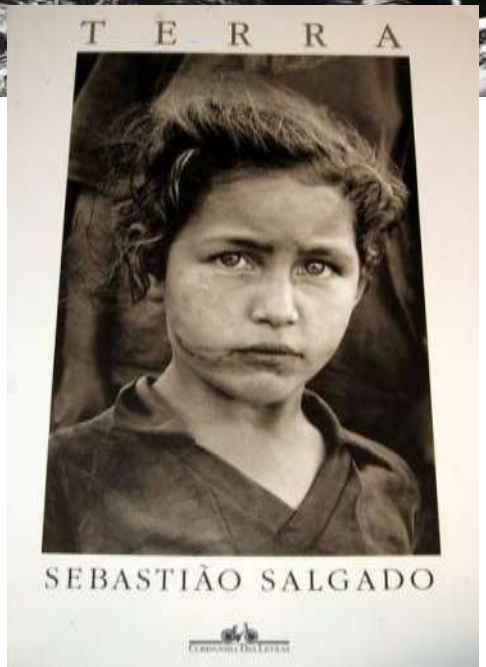
- Gold represents an excellent method of transferring wealth from rich to poor countries
- Small producers often get 70% or more of international price in remote areas
- This is not true for any other product
- Cell phones and the internet help
- Gold mining is a good development opportunity
- Needs to be brought into formal economy to maximize benefits
- Improved practices and reputation are essential to make this happen – Reducing Mercury is an important part of this effort.

Outline

- Extent and Background
- Causes
- Case Studies
- Solutions

Serra Pelada (The Naked Hill), Brazil
Ground Zero, 1979






Misperceptions!

Background

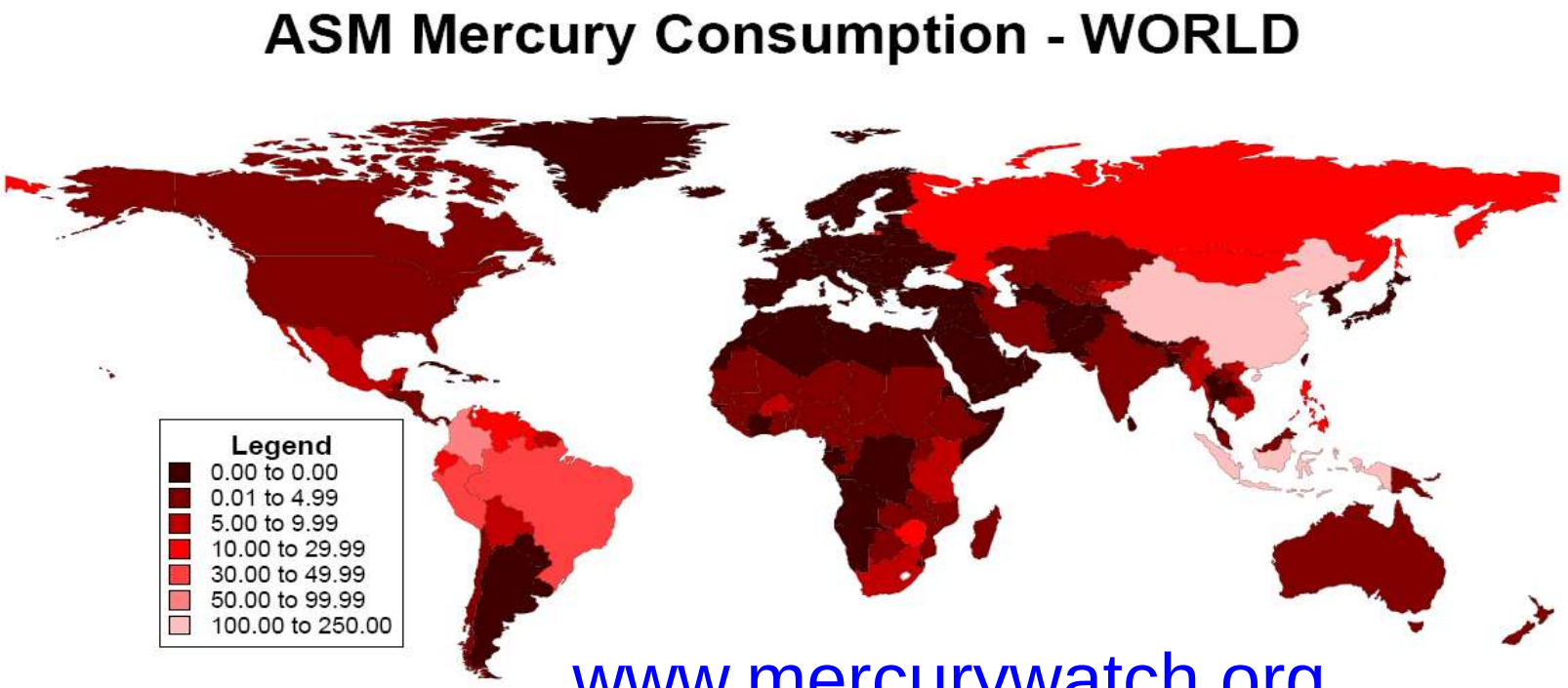
- ASGM = Artisanal and Small Scale Gold Mining
- LSGM = Large Scale Gold Mining
- The breadth of society that interacts with Artisanal and Small Scale Gold Mining (ASGM) is much broader than is generally recognized
- Existing gold (above ground gold – all historical production) is minimally 5% ASGM in origin (about 7000 tonnes)
- Current ASGM production is around 12% - larger than any single producer
- Risk (reputational and operational) for LSGM is increasing due to ASGM
- Gold is getting "dirtier"
  - AP Congolese Child Labour Gold Goes to Swiss Banks:
    - http://www.guardian.co.uk/worldlatest/story/0,,-7714811,00.html
  - Don't tarnish the Oscars with dirty gold
    - http://www.earthworksaction.org/PR_HarryWinston.cfm
  - But almost all gold remains in circulation...
- In February the world agreed to develop a global mercury treaty - UNEP

Perspective

- There is no single technological **“silver bullet”** to move to a mercury free system

Current Estimate and Distribution

- Vast decentralized source – 70 countries (76 probable).
- 400 tonnes/a volatilized to the atmosphere
- 600 tonnes discharged into soils, rivers and lakes
- 1/3 anthropogenic releases, 2nd only to coal burning
- Sources of Information: More than 100 documents + other sources



Telmer and Veiga, 2008

www.mercurywatch.org

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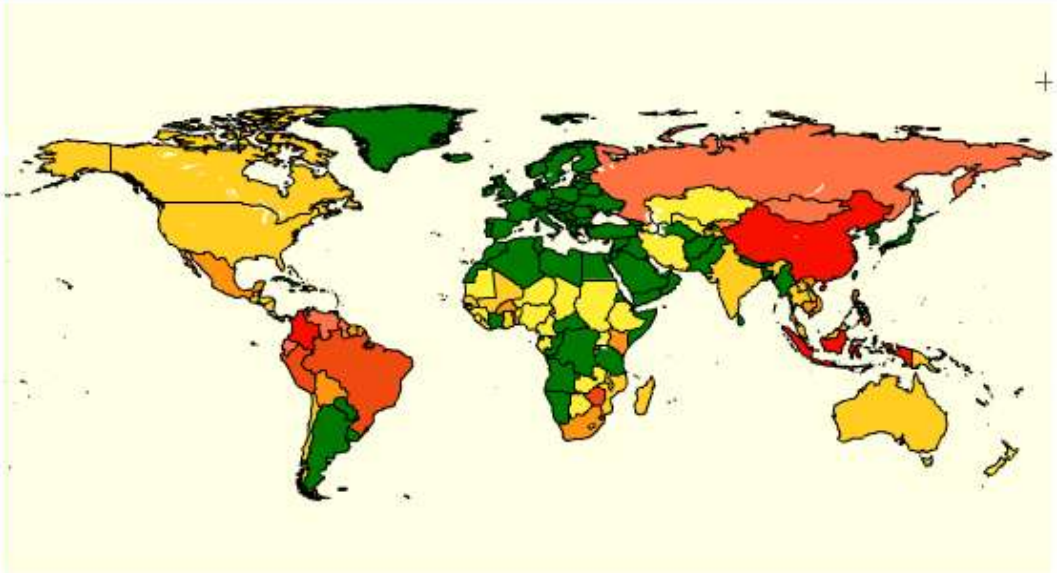
Global Database Research Paper

Mercury Hg Watch

Charting the improvement of artisanal small-scale gold mining



Mean AGSM Hg Per Year

Mercury Emission from ASGM (tons/a)

- no estimate made
- 0 to1
- 1 to 5
- 5 to 10
- 10 to 25
- 25 to 50
- 50 to 500

Welcome to MercuryWatch Beta Site - August 2009

Mercury Watch is is dedicated to collecting, analysing, and publically serving information about mercury released to the environment.

Artisanal and Small-Scale Gold Mining (ASGM) has become the world's largest 'direct use' emitter of mercury to the environment. In spite of this, a global database of the distribution of ASGM and mercury-use does not exist. This

MercuryWatch call for partners:

The breadth of society that interacts with Artisanal and Small Scale Gold Mining (ASGM) is much broader than is generally recognized. This, along with the global growth in ASGM underway makes it a significant issue for governments and society. This requires that they work harder towards making the sector safer, socio-economically sustainable and less detrimental to the environment. MercuryWatch is committed to these goals and is seeking

Scale and Economy of ASGM

- 330 tonnes of gold from 70 countries
- 10 billion USD at 900$/ozt
- 10 million miners (3 million women and children)
- $1000/miner - unevenly distributed
- Secondary economy, perhaps 50 million people at 50 billion USD/a
- Roughly 2 times the population of Canada at a GDP PPP 40 times lower
- Canada is a good reference because it is perhaps most involved in the gold industry on a per capita basis

Consumption/Emission Intensity ASGM vs LSGM

ASGM:

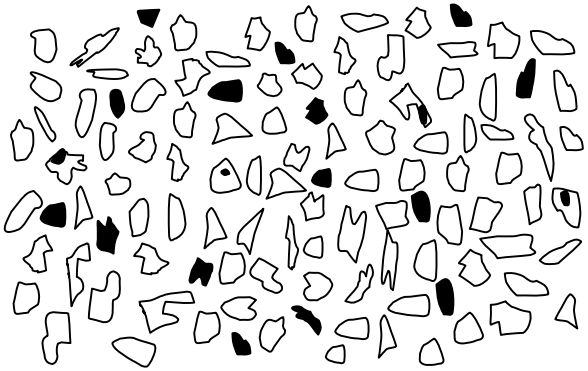
- More energy efficient (joules/unit gold)
- Releases less greenhouse gasses (CO2e/unit gold)
- Produces less waste rock and tailings per unit gold
- Releases 5 times more mercury in total
- Releases 40 times more mercury per unit of gold produced
- Those who use CN use about twice as much per unit of gold produced
- Do not practice waste management

Remaining ASGM Gold Resources

- LSGM resource is 50,000 tonnes of gold (USGS, 2007)
- No equivalent estimate of the ASGM resource
- At 12% of world production, the ASM resource is minimally around **6000 tonnes gold**.
- Would last for **18 years** and would use 18,000 tonnes of mercury.
- True ASGM resource may be significantly larger
  - Traditional estimation methods are inappropriate
- A better estimate is possible using geological evidence and grade and depth distribution models.

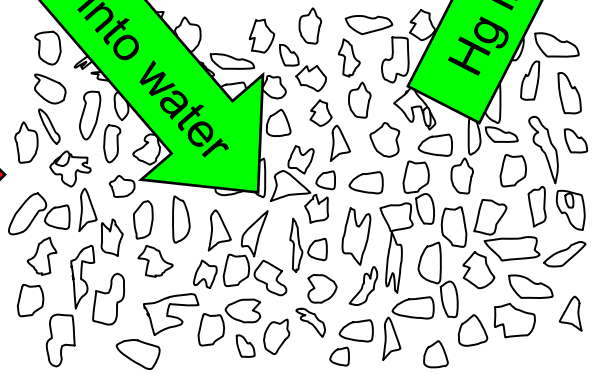
How is Mercury Used and Lost?

Gold + Sand

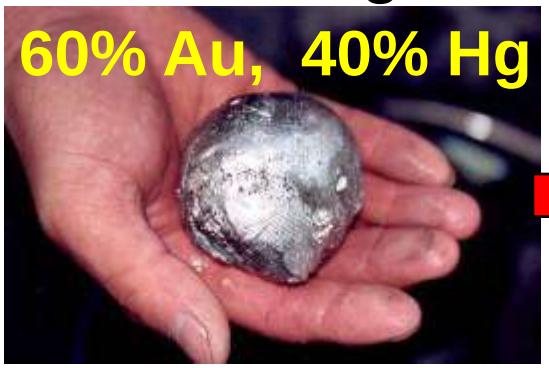


Add mercury to dissolve gold

Tailings



Form Amalgam

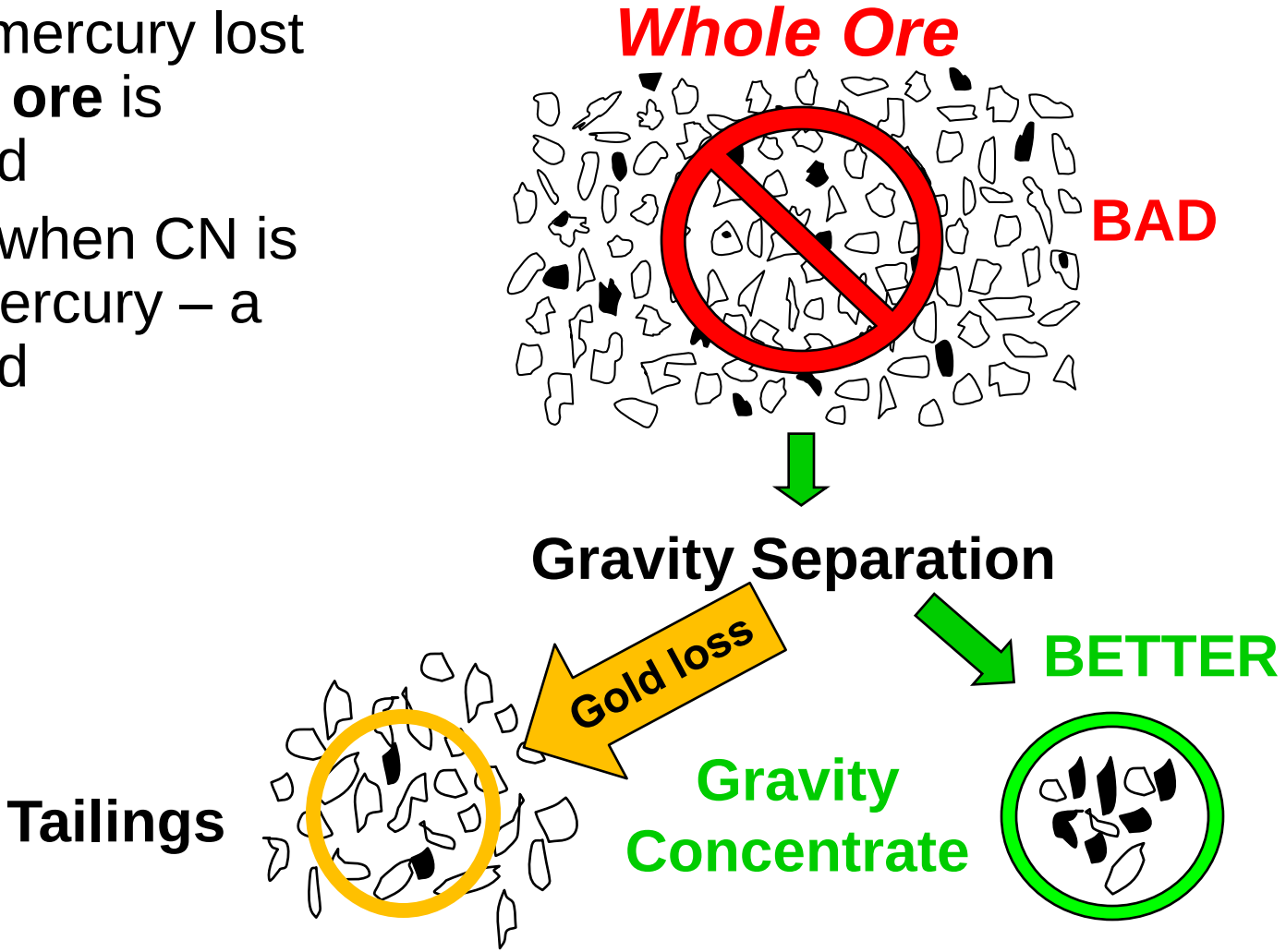


Apply Heat

Sponge Gold

Mercury Losses Vary With Style of Operation

- Much more mercury lost when **whole ore** is amalgamated
- Even worse when CN is used after mercury – a growing trend



Why is Mercury Used?

- Very easy
- Very independent – 1 person can do it
- Highly effective under field conditions
- Accessible
- Cheap:
  - Jan 22, 2008, mercury US$0.017/g; gold US$28/g
  - **1:1650**
  - (local prices are different)
  - Worst prices 1:125 – still cheap

- Facilitates precise transactions
- Produces quick capital (1 day)
- Divides profits
- Miners are not aware of the risks
- No choice


Mozambique, 2009

Case Studies, Different Mercury Scenarios

- Primary Mining and Whole Ore Amalgamation in Sulawesi, Indonesia (Hg:Au 20:1 or worse)
- Alluvial Mining and Gravity Concentrate Amalgamation in Kalimantan, Indonesia (Hg:Au = 1.3:1)
- Grasberg Tailings (Hg:Au = 0)
- **Primary Mining and Whole Ore Amalgamation Tsetsera, Mozambique (Hg:Au 3:1 ?)**
- **Primary Mining, Chrispen Penhalonga SSMine, Manica, Mozambique (Hg:Au = 0)**





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MINAS
CHRISPEN. E. CHIBAIA
PENHALONGA


CLEAN T MINING


Mercury Free Tailings waiting to
Be further processed perhaps
by leaching

Cyano-Mercury Complexes Released into Environment

- Enhanced Transport
- Enhanced Bio-Availability
- Enhance Volatilization

Mercury + Cyanide is a Widespread & Growing Problem

The misuse of mercury and cyanide has been observed in:

- Brazil, China, Ecuador, Indonesia, Peru, Phillipines, Zimbabwe
- Cyanide gets more gold but mercury produces quick cash and divides profits
- Sometimes both are used during transition from mercury to cyanide
- **Reputational risk for LSM is huge.**

Part II
Solutions

- Local to Regional Actions
- Global Actions

Requirements for Solutions

- Research & Education & Development
  - World Trends – Where and amounts of Mercury
  - Statistics on ASGM
  - Education on Mercury use and gold extraction
  - Knowledge Gaps
  - Reduction Scenarios
  - **Strategies for Engagement**
  - **Technology Innovation**
  - **Governance Innovation**

Approach

- Profit is the most important incentive for creating sustainable change in any ASGM operation.
- Stability and Dignity and Health count but to lesser degree
- Asking miners to change their behaviour in a way that induces a pay cut has been universally unsuccessful
- Interventions where better practices have come along with increased profits have thrived


Mercury Man


Chimney

Intervention, GMP, 2006-07

- Where are the largest Hg losses?
- In this case, in the gold shops
- Target gold shops
- Install fume hoods

35 US$ Captures 80% mercury

Reduce mercury consumption by recycling

- **Reselling Mercury**
- **Profitable after capturing only 1 kg Hg**
- **Prevents Further Imports by 80-90%**
- **Establishes Relationship with Community**
- **35 out of 35 shops installed hood within 6 months**
- **Still in place in 2009**

Sumali Agrawal & Budi Susilorini, GMP, 2007

Fume hood installed by USEPA

Rodolfo Neiva de Souza, GTFM, GMP, Vienna, 2007

Argonne National Lab Program with USEPA

- Argonne National Laboratory draft report (2008) "Technology Demonstration for Reducing Mercury Emissions From Small-Scale Gold Refining Facilities" prepared for U.S. Environmental Protection Agency

Reduction Scenarios

- If miners adopted emission control measures (fume hoods and retorts) mercury consumption globally could be reduced by a maximum of 27%
  - This is profitable
- Learning how to re-activate or clean used mercury could reduce mercury consumption by a maximum of 25%
  - This is profitable
- Elimination of whole ore amalgamation could reduce mercury consumption by 45% or more
  - Profitable but much ore complicated
  - More capital, more organisation, more processing sophistication

Sponsor Technology and Business Competitions *(Industry + IGO + NGO)*

- Sponsored competitions that offer ***cash prizes***
- ASGM X-prize: **"*revolution through competition*"**
  - http://www.xprize.org/
- Stimulates idea exchange between ASGM communities
  - "south-south" exchange
- Central categories:
  - (1) Waste management;
  - (2) Processing;
  - (3) Product Development / Diversification;
  - (4) Mining

Example: Waste Management and Material Stewardship Competitions

- Fume hoods for gold shops – these are far from perfect
- Retorts for field use – great occupational exposure still occurs to operators
- Mercury Re-activation/Re-Use – greatly decreases mercury consumption
- Tailings management – to reduce mercury loss and river siltation
- The **Artisanal Gold Council** will announce its first ASGM X-Prize in Chimoio – A cash prize for the winning design of a ***cheap solar powered micro retort*** - **Stay tuned!**

Example: Processing Design Competitions

- Elimination of mercury in small scale cyanide processing
- Elimination of whole ore amalgamation
- Tailings management for small scale cyanide
- Processing optimization for small scale cyanide
- Socio-economically viable zero-mercury processing options

Example: Product Development / Small Business Competitions

- Gold smelting and product development – value added of gold products locally: 24k, 22k, 18k,
  - sold directly to local jewellers
- Credit systems – credit increases processing sophistication, efficiency and “greenness”
- Transaction assurance system – assurance without mercury
- Transition to medium scale mining operation – rewarded with IPO on VSX

Gold Shop Processing - Upstreaming


Silver Recovery on Copper

24K

Internationally Tradable

ASM-LSM: Papua - Grasberg

- The milling processes at PTFI's Papuan operation do not capture all of the gold contained in the feed ore. Some goes into the the tailings. This gold is being extracted by Artisanal Small-Scale Miners using rudimentary manual sluicing techniques.

ASM-LSM

Currently Mercury free
But Mercury reduces time and gets more gold
Risk that it will arrive is real and represents a liability
Prevention based on awareness and economic development for the ASM sector

Initial Action: Public Service Mercury Monitoring

- Partnership with government, gold shops, company, community...

Monitor Atmospheric Mercury

(Partner + NGO)

- Install mercury vapour analysers as community education and awareness points (not enforcement mechanisms) – currently in progress in Indonesia in collaboration with LSM
- Offers protection for communities and companies – a deterrent to the *abuse* of mercury
- Reduces risk and liability and increases reputation
- Acts as an early warning system
- Creates a line of communication with the informal gold sector
- Establishes baseline conditions for the region and reduces conjecture about emissions

Knowledge Base and Monitoring System for ASGM *(Local Partner + IGO)*

- an open document for discussions with the ASGM community;
- encourage input from stakeholders;
- act as an education and awareness vehicle for governments to miners.
- See a pilot at www.mercurywatch.org

Lobby for Program Based Education and Awareness *(partner + IGO + program)*

- The One Laptop per Child program (OLPC, http://laptop.org/),
  - sponsored by AMD and Google and many others,
- Offers deep penetration into the rural poor and particularly to children and mothers.
- Raises awareness in both the developing and developed world
- Leveraging Resouces
- Preventative

Global Approaches

- Mercury Market
- Gold Market

Mercury Market

(*IGO + partner +Industry****)***

- Scarcity will cause mercury conservation in ASGM
- Fume hoods and *retorts* and re-activation alone can reduce mercury by 50%
- Have been embraced by ASGM communities because they are profitable
- This will be amplified if mercury prices increase
- Easily improved cheaply through technology competitions
- Contributing to causing scarcity provides a publicity opportunity to educate stakeholders about mercury and ASGM and how it can be sustainably reduced
- Underway through Global UNEP Mercury Treaty – needs teeth.

Gold Market

(partner + bank + IGO + Industry)

- Luxury goods market (gold jewellery), and the financial market (bank gold reserves) are becoming more politicized
  - consumer advocacy, investment ethics, sustainability indexing
- Separate ASM gold from LSM gold on world markets
- Of the gold in circulation, it can easily be argued that at least 5% or 7000 tonnes of it are ***artisanal gold (AG).***
- 7000 tonnes of AG gold already exists to be traded
- Begin by allocating and trading some gold as AG at a premium – can be a small amount to begin with
- Letting it trade would avoid over planning and would quickly bring together stakeholders
- Trasparency and re-investment of a premium provided through a non-profit approach
- Provides significant funding for improving ASM sector

Gold Market

(partner + bank + IGO)

- Provides a mechanism for communication with the world's ASGM miners and their governments and can be used to coordinate the improvement of practices and governance
  - a market based system to unite the ASGM community, formalize it, and clean up ASGM gold production
- Mission: to support poverty relief and green ASGM and to occur incrementally over time to drive standards towards those of LSM
- Instantly brings global publicity

Artisanal Gold Council

www.artisanalgold.org

Thank you!

Acknowledgements:

- The many miners and colleagues that I have worked with over the last 15 years on this issue
- University of Victoria
- Artisanal Gold Council
- Earthtone Environmental R&D Inc.
- NRDC
- UNEP Mercury Programme
- CASM