



University of British Columbia
Norman B. Kevil Institute of Mining Engineering
Vancouver Canada

Processing Centers in Artisanal and Small-scale Gold Mining: Evolution or More Pollution?



Marcello M. Veiga

Associate Professor

Visiting Professor,

Dept Mining Engineering

University of São Paulo, Brazil

Artisanal Mining

The term artisanal mining encompasses all small, medium, informal, legal and illegal miners who use rudimentary processes to extract gold and other minerals from secondary and primary ores



Brazil



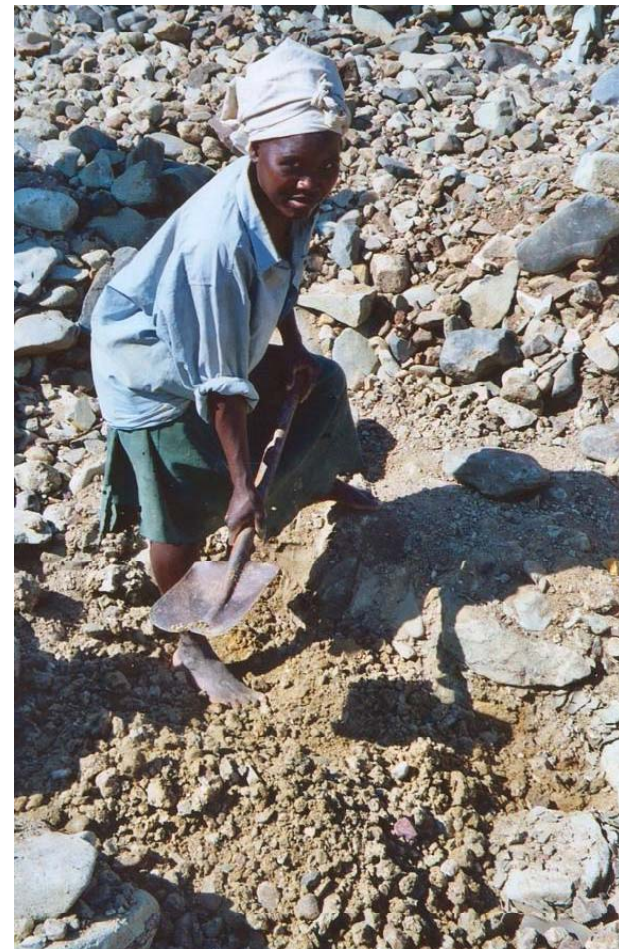
Ghana

Artisanal Mining

About 30 million artisanal miners extracting more than 30 minerals in virtually all developing countries

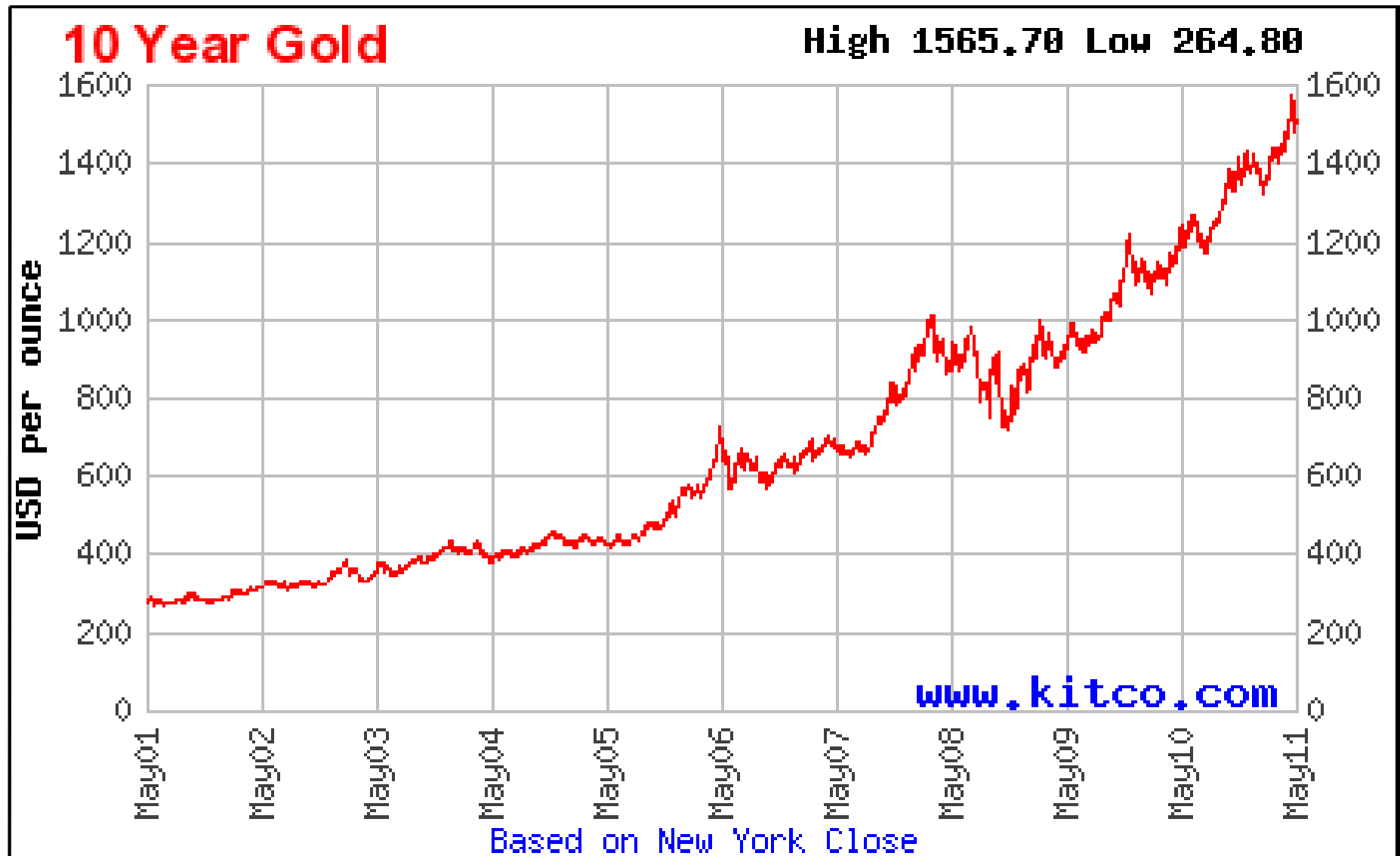


Venezuela



Zimbabwe

Gold price increasing = More people involved



This is the biggest gold rush the world has ever seen

- **10 to 15 million artisanal miners producing around 350 tonnes Au/a in more than 70 countries**
- **About 50-100 million people directly and indirectly involved in artisanal gold mining**



Guinea

**In the world as many as 9 million women
(50% involved in gold mining)**

Tanzania

A photograph showing a woman and a young child in a deep, earthen pit. The woman, wearing a white t-shirt and a patterned wrap, is holding the child. The child is wearing a patterned wrap and looking towards the camera. The pit is filled with reddish-brown soil and some dry vegetation. A wooden pole is visible on the left side of the pit.

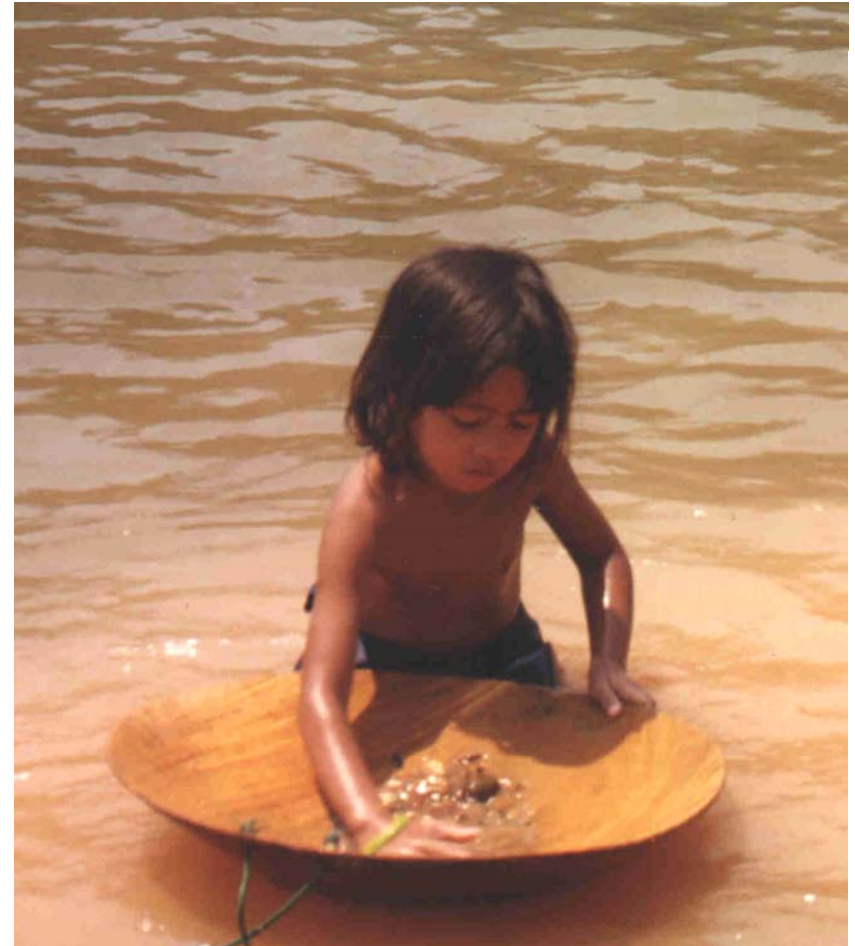


Children in Artisanal Mining

**ILO (2004) estimated 2 million children working
in artisanal mining**



Mozambique



Laos

Children in Artisanal Mining



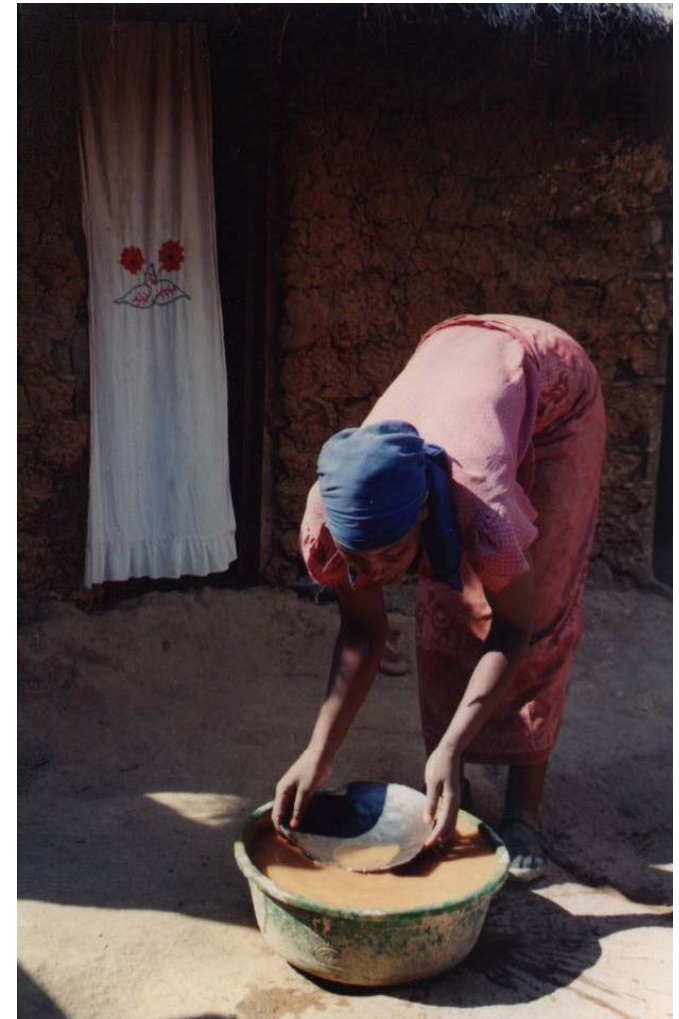
Suriname



Guinea
Photo: Rukimini

Causes of Poor Artisanal Mining Practice

- **Disorganization & Transience**
- **No technical assistance**
- **Lack of education of miners**
- **Inadequate regulations**
- **Financial barriers**
- **Lack of support from mainstreams of Society**
- **POVERTY**



Tanzania

Environmental, Health & Social Problems Caused by Artisanal Gold Mining

- **Water siltation**
- **Landscape degradation**
- **Prostitution, Drugs & Crimes**
- **Money laundering**
- **Deforestation**
- **TB, malaria, tropical diseases, HIV/AIDS**
- **Mercury & Cyanide pollution**



Indonesia

Galangan, Kalimantan, Indonesia

- 10,000 illegal artisanal miners invaded area
- 200 km² of forest (Orangutans habitat) destroyed
- 2 tonnes/a Hg lost



Before



After

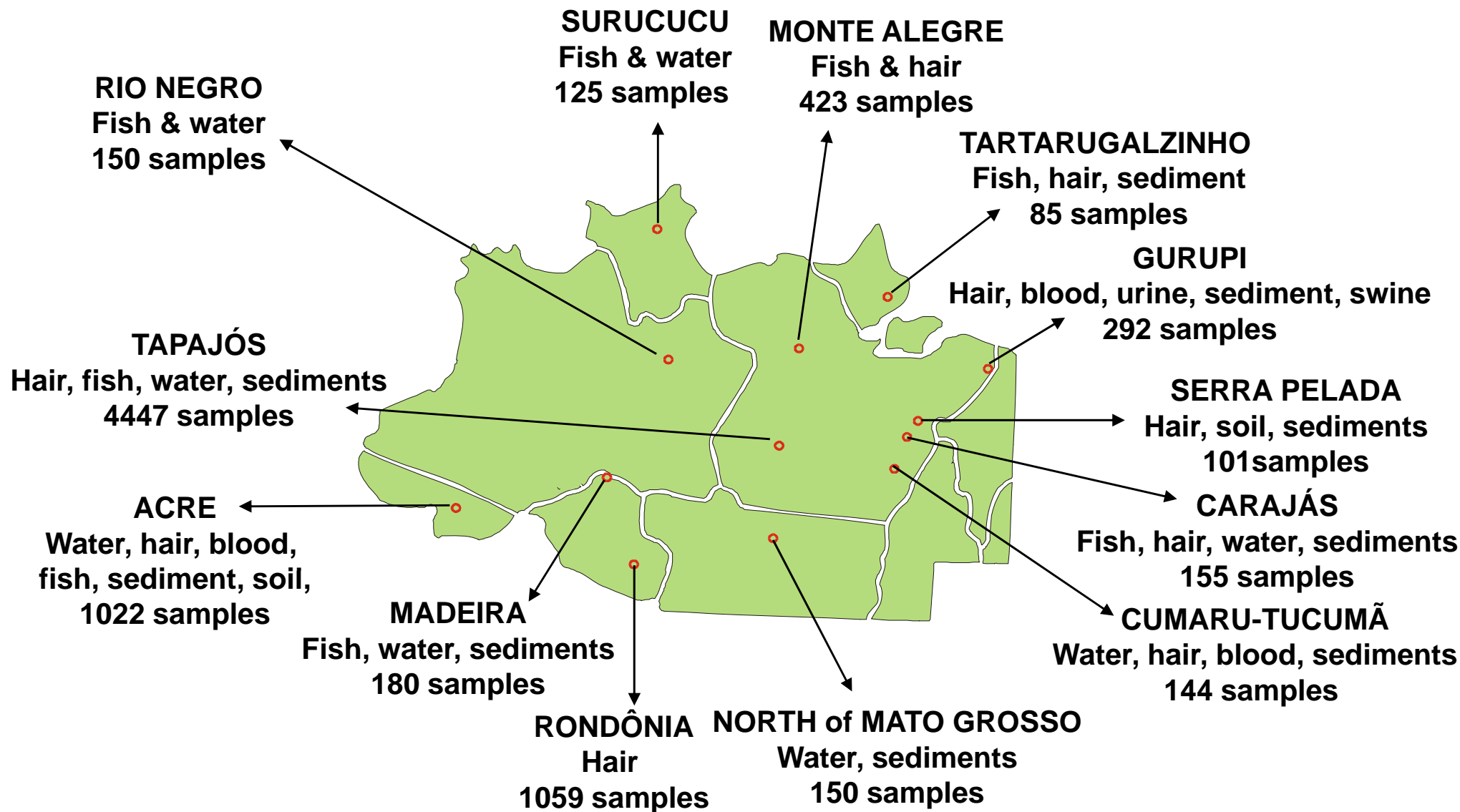
Burning Amalgam



Indonesia
Photo K. Telmer

What Are the Solutions?

- **Monitoring, monitoring and more monitoring (preferred by the MAJORITY of researchers)**
- **Legalization (preferred by MOST Governments)... but NO enforcement**
- **Processing Centers (being adopted in MANY artisanal mining regions)**
- **Education and technical assistance (ignored by ALL Governments)**

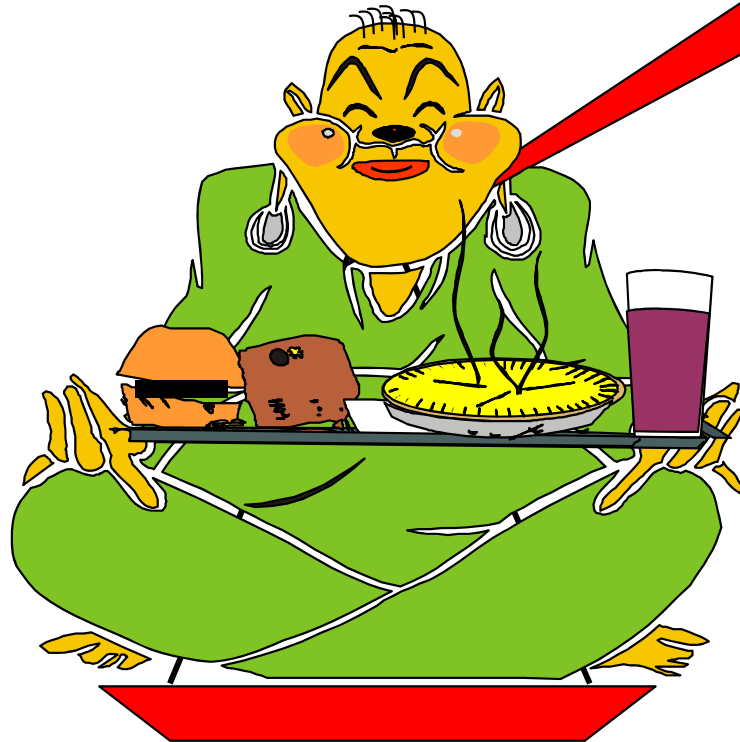


**Number of samples analyzed for Hg in the
Amazon: 8333 samples**

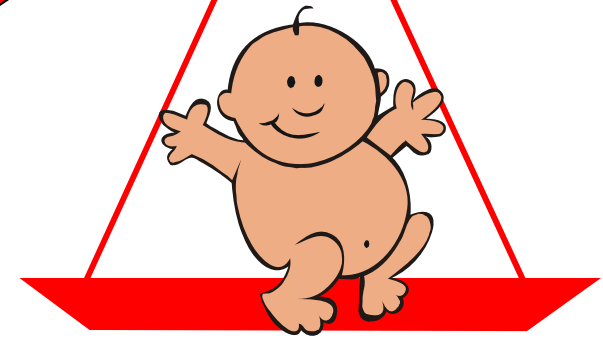
Source: Alberto Rogerio B. Silva

Monitoring in Artisanal Mining

No fair balance!!!



**Monitoring
and Studies**



**Solutions
for the Problem**

Examples of Ineffective Laws: Brazilian Approach

- **Law 97.507/89 – Hg and CN prohibition**

“No artisanal mining site is allowed to use Hg or CN without previous permit issued by the environmental authority. Environmental crimes are punishable with fines and jail”

- **Reality:**

Survey showed 99.3% of artisanal miners in Tapajós, Brazil using Hg and CN without any license



Brazil

PROCESSING CENTERS: Miners Take Their Ores to Be Processed by Trained Operators



Venezuela

Processing Centers in Indonesia



- They use the most rudimentary process
- 25 to 40% of Au recovered (LOW)
- Adding Hg into the Grinding Circuit
- About 40-50% of Hg added is lost
- P.C. owners keep the tailings with Hg & Au as a payment

Processing Centers in Indonesia



Hg-contaminated Tailings Are Submitted to Cyanidation

Processing Centers in Indonesia



**Tailings with
Hg & cyanide
reach the
streams**

Processing Centers in Colombia



Owners of the Processing Centers Use NaCN to Extract Residual Gold from Hg-Tailings

Processing Centers in Zimbabwe

- **Cu-Hg Plates amalgamate the whole ore**
- **Hg-contaminated tailings are submitted to cyanidation in Processing Centers**



Processing Centers in Ecuador

- Poor extraction of gold from the ore brought by miners to one of the 110 Centers in Portovelo
- P.C. owners retain the tailings



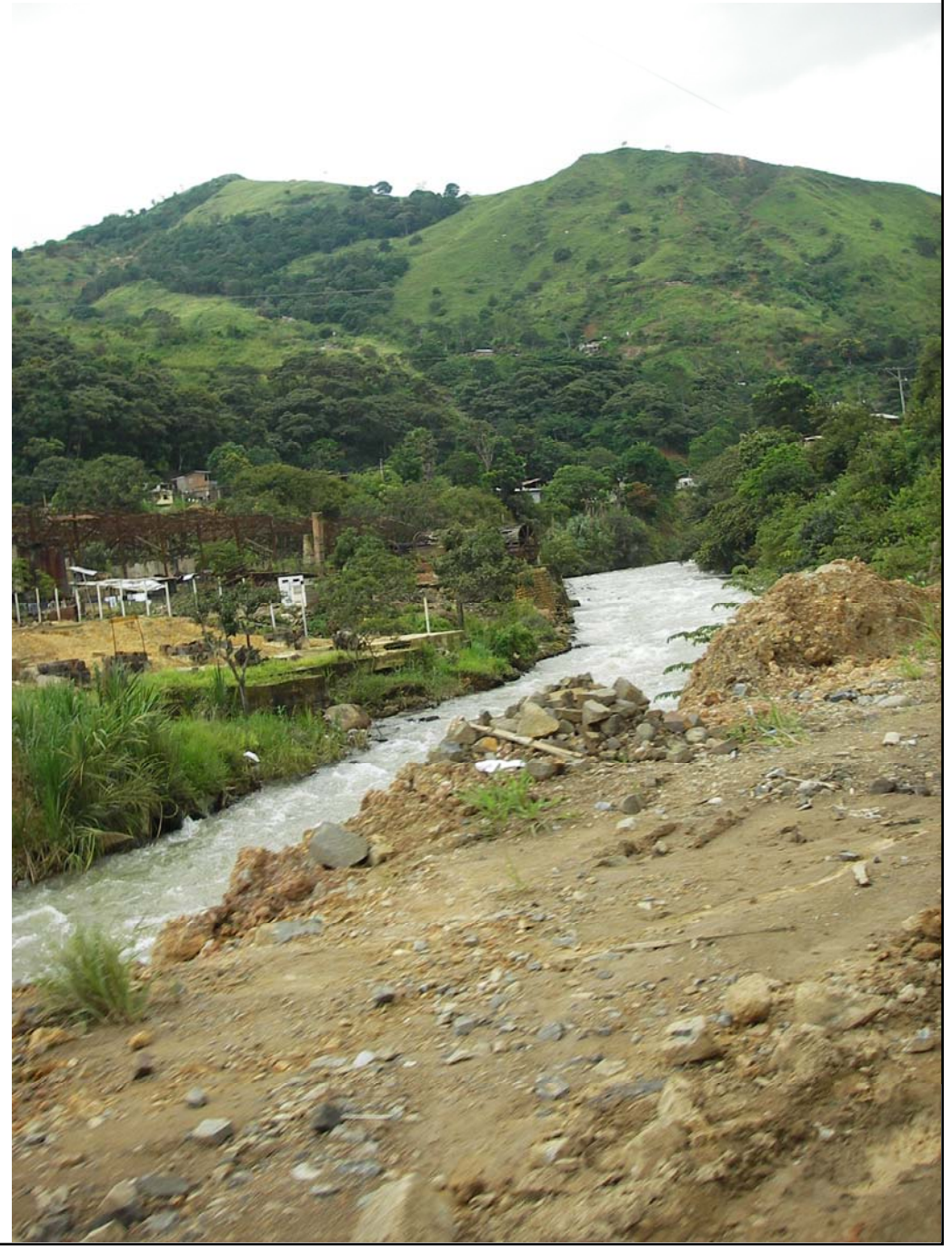
Processing Centers in Ecuador



**92 cyanidation
tanks in the town
of Portovelo
leaching Hg-
contaminated
tailings**

Processing Centers in Ecuador

**Tailings with
Hg and cyanide
are dumped
into the
Amarillo River**



Processing Centers in Brazil



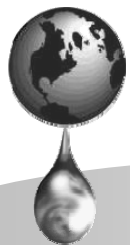
Miners use Cu-amalgamating plates to recover the “easy” more accessible gold

Processing Centers in Brazil

- Hg-tailings are leached with NaCN
- Hg-cyanide in tailings reach the rivers
- 60% of fish >0.5 ppm Hg
- WHO max guideline for edible fish = 0.5 ppm Hg
- One fish sample = 22 ppm Hg



*Brazil, São Chico,
Amazon*



Global Mercury Project



Sites		Mean Hg in fish (ppm or mg/kg)	Number of samples
Brazil	<i>São Chico</i>	2.53	73
	<i>Creporizinho</i>	0.36	161
Indonesia	<i>Galangan</i>	0.21	264
	<i>Talawaan</i>	0.58	156
Laos	<i>Luang Prabang</i>	0.066	65
Sudan	<i>Blue Nile</i>	0.05	108
Tanzania	<i>Rwamagasa</i>	0.13	285
Zimbabwe	<i>Kadoma</i>	0.41	52

Mercury Forms Soluble Complexes with Cyanide

- **$[\text{Hg}(\text{CN})_4]^{2-}$ which is stable at pHs above 8.5 and $\text{Hg}(\text{CN})_2$ (aq), stable at pH below 7.8**
- **These complexes can be either methylated in the sediments or directly bioaccumulated**

Education: Demonstration of Cleaner Techniques



Indonesia

- The pieces of equipment were discussed and designed with miners
- The majority of the equipment is locally manufactured

Demonstrating Cleaner Techniques



Laos



Sudan

Demonstrating Cleaner Techniques



Tanzania

Demonstrating Cleaner Techniques



Brazil



Zimbabwe

Demonstrating Availability of Gold Concentrators and How to Improve Efficiency



Zig-zag Sluice



Indonesia

**Zig-zag sluices
increase
chances of gold
being capture by
carpet**



Laos

Demonstration of Simple Solutions to Reduce Hg Vapor Exposure



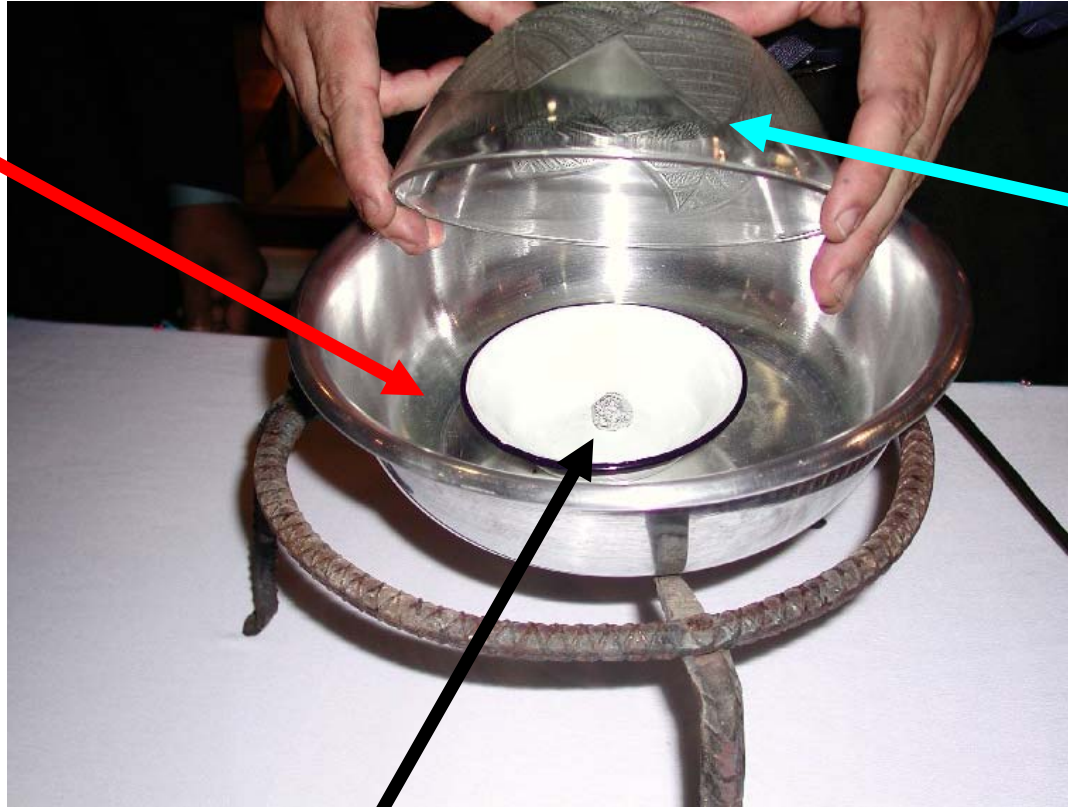
**Miner burning amalgam in an open pan
Hg vapor exposure of the whole family**

Cambodia

Photo: Tom Murphy

Home-made Retort Using Kitchen Bowls

wet sand
is added
to seal



mercury is
condensed on
the glass bowl
and recovered

amalgam in a
small cup

Retort Made of Kitchen Bowls



← **Using a enameled
steel bowl**

**Adding a small
stainless steel
salad cup**



Retort Made of Kitchen Bowls



Zimbabwe



Laos

Retort Made of Kitchen Bowls



Sudan

Kitchen-Bowl Retort

Sealed
with
wet
sand



Ecuador

Kitchen-Bowl Retort



Colombia

Kitchen-Bowl Retort



Chile

Brazil



Replacing Hg with Cyanide

Intensive Cyanidation of Concentrates

(Field Tests in Ecuador)

- **95%** of gold extracted from gravity concentrate in 8 h of intensive cyanidation in a small ball-mill
- Use of activated carbon
- Cyanide was destroyed with bleach



Ecuador

Training the Trainers



Indonesia



Brazil



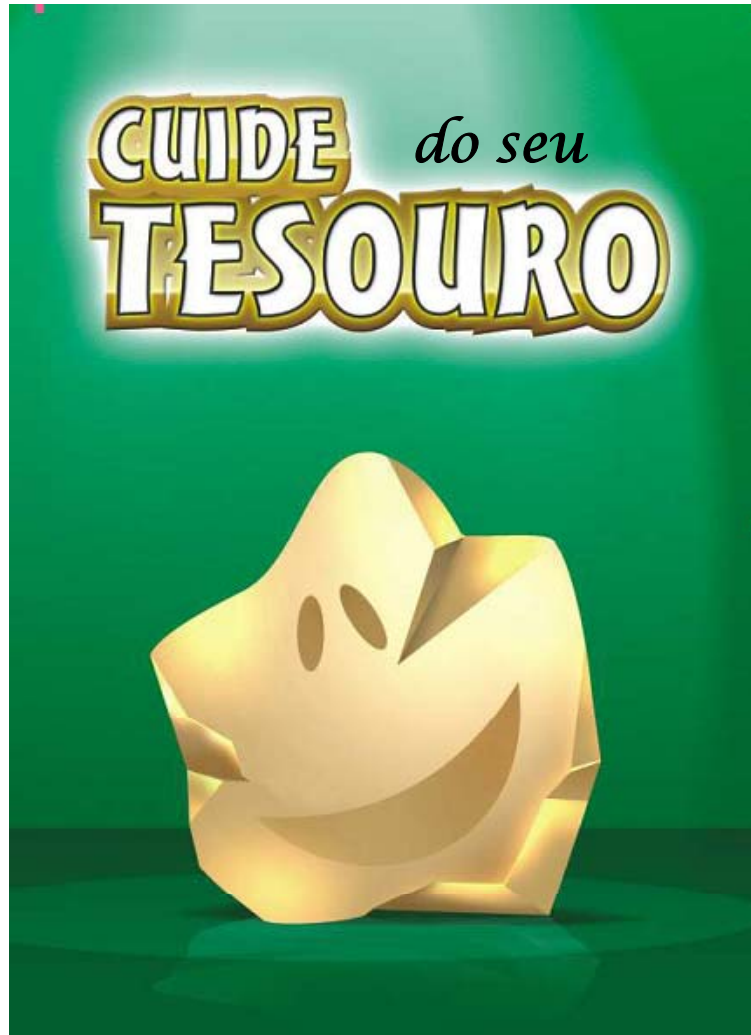
Sudan



Laos



Training Material



"Take care of your Treasure"

Brazil

Despesa na piscina

FAÇA A PISCINA QUANDO FIZER A DESPESCA NA PISCINA. LEMBRA VOCÊ RECUPERA O MERCÚRIO, O PEIXE AGRADECE E VOCÊ NÃO ADOECE.



COMO VOCÊ VÊ NO DESENHO ACIMA FAZER UMA PISCINA NÃO DARÁ MUITO TRABALHO, E O MATERIAL TAMBÉM NÃO É MUITO CARO E FÁCIL DE ACHAR.

Training Material



GEF
UNDP
UNIDO

ໂຄງການກ່ຽວກັບ
ການນຳໃຊ້ສານບາ
ຫຼອດໃນທົ່ວໂລກ

ການນຳໃຊ້ສານບາ
ຫຼອດ ແລະ ສຸຂະ
ພາບຂອງຄົນ ໃນ
ຄອບຄົວ

GEF-UNDP-UNIDO
Lao PDR

Global Mercury Project

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Laos



GEF
UNDP
UNIDO

ປົກປ້ອງຄອບຄົວຂອງທ່ານ

- ສານບາຫຼອດແມ່ນມີ
ຄວາມອັນຕະລາຍ
ຫຼາຍ ໂດຍສະເພາະ
ແມ່ນຕໍ່ລູກໃນຫ້ອງ
ແລະ ເດັກນ້ອຍ
- ໃຫ້ຜູ້ຍິງແລະເດັກນ້ອຍຢູ່
ໄກຈາກເຂດທີ່ມີການຈູດ
ບາຫຼອດ
- ຫ້າມຈູດຢູ່ບ່ອນພັກອາໄສ

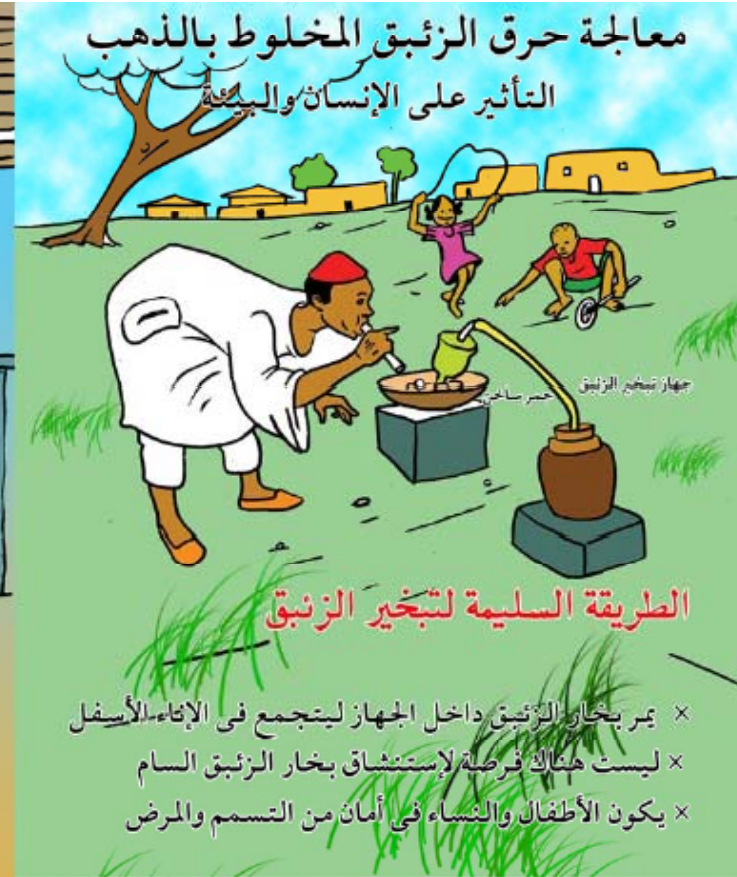
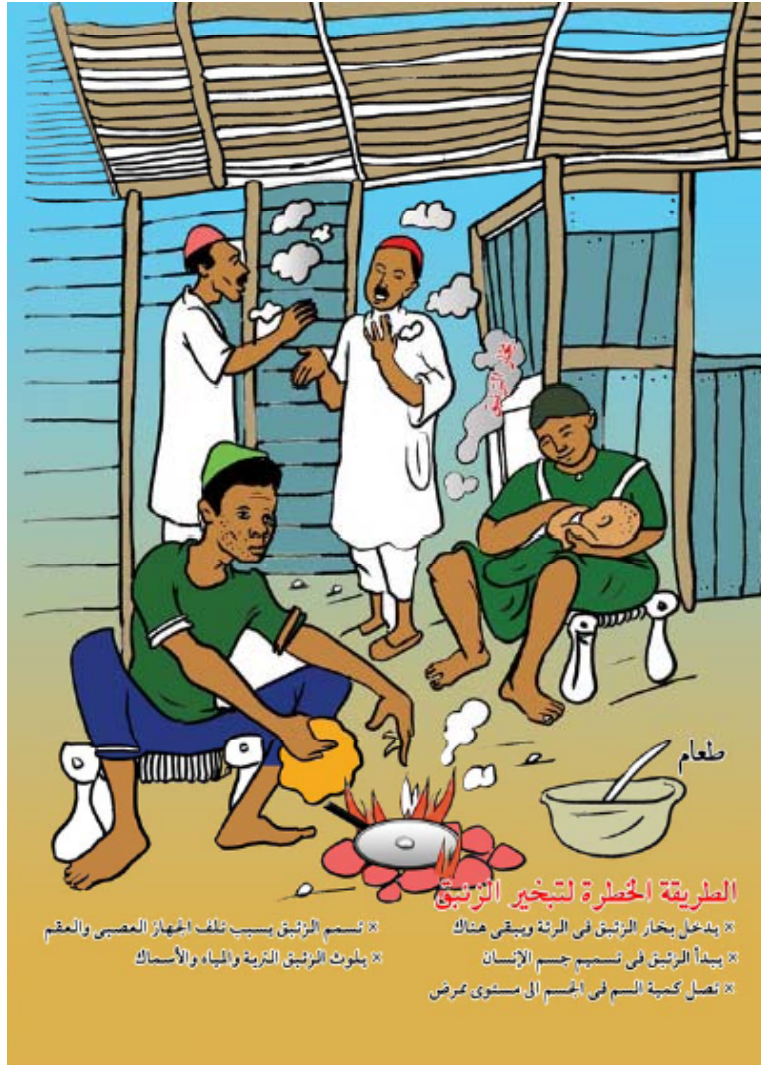
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Training Material



Indonesia

Training Material



Global Mercury Project



Sudan

There is Light at the End of the Tunnel

- **Artisanal miners are becoming small-scale miners**
- **More responsible and cleaner gold production**
- **No mercury being used**
- **Cyanide is destroyed after use**



Ecuador

Conclusion

- **Legal approach to introduce cleaner production in artisanal gold mining areas is ineffective**
- **Monitoring is important but not enough**
- **Processing Centers are concentrating wealth in the hands of owners and creating Hg & CN pollution**
- **Hg-cyanide environmental effects are still unknown**
- **Solution is education and permanent technical assistance to miners**
- **Solution is evolution of artisanal miners to become responsible small miner**

**We need to change this
perception:**

***“It’s easier for a man to
become an artisanal
miner than for a miner
to become a man”***

A Brazilian artisanal gold miner

Thank you

