

Health and Environmental Impact of Mercury in Small-Scale Gold Mining in the Philippines

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Outline of the Presentation

- Background of Small-Scale Gold Mining in the Philippines
- Environmental Impact
- Health Impact
- Recommendations

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Small-scale gold mining

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Background of small-scale gold mining in the Philippines

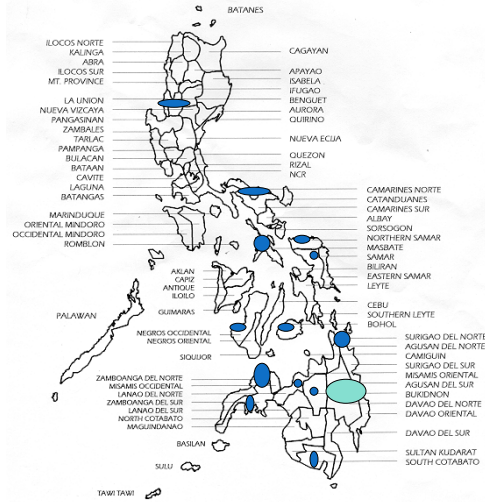
- In the mid-80's , gold miners engaged actively in processing the ore using the crudest method of gold extraction by amalgamation
- improper use of mercury during gold smelting and uncontrolled disposal of mercury wastes into the environment
- estimated that some 26 tons of mercury are dumped annually into bodies of water in Mindanao
- population swollen from 70,000 to as much as 100,000

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MAP OF THE PHILIPPINES



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Philippine Annual Gold Production



Philippine Annual Gold Production, 1997 – 2008 (in kilograms)

Year	Total	Small-Scale	Large-Scale
1997	31,199	14,062	17,137
1998	34,038	19,859	14,179
1999	31,050	17,045	14,005
2000	36,540	21,193	15,347
2001	33,841	22,656	11,185
2002	35,848	27,993	7,855
2003	37,843	31,473	6,370
2004	35,464	29,473	5,991
2005	37,488	32,117	5,371
2006	36,141	29,361	6,780
2007	38,792	31,193	7,599
2008	35,568	28,198	7,370

Sources: U.S. Geological Survey Minerals Yearbook
Mineral and Geological Survey

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Small-Scale Gold Mining

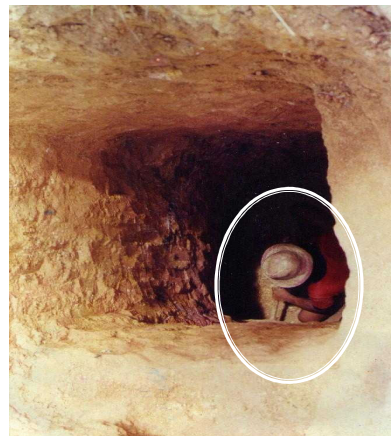


Small-scale mining operations have polluted tributaries and water systems resulting in fish kill aside from adversely affecting the cattle/livestock industry and agricultural production

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Small-scale mining practices



Crude methods and safety issues

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Small-scale mining practices



Testing the ores for gold before loading the ores in the sacks.



Small-scale mining practices



Adding mercury to the mixture of ores and water.



Small-scale mining practices



Residue after panning operation where most of the water are removed.

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Small-scale mining practices

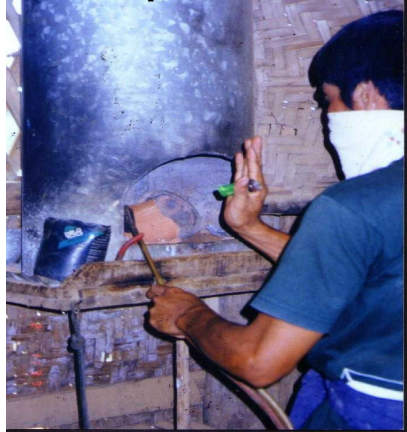


Placing of residue in filter cloth to remove the mercury from the residue.

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Small-scale mining practices



Blow-torching is still rampant despite the introduction of the retort method

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SMALL-SCALE GOLD MINING OPERATIONS



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Forest trees that were cut-down contribute to the loss of the topsoil while water for mineral processing deprive the people of water for domestic use.

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The transformation in the natural environment of inorganic Hg to Me-Hg could eventually lead to bioaccumulation in fish and other organisms through the aquatic food chains.

Two main pathways of mercury contamination that can affect human populations in gold mining areas: exposure to inorganic Hg due to direct inhalation of Hg and skin contact during gold recovery processes and second, exposure to Me-Hg contaminated fish consumed by people who depend on riverine products for food sources.

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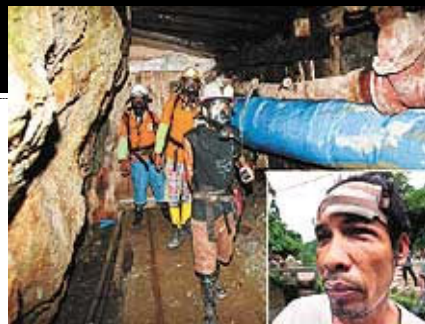
Landslides

- People working in mines during the rainy season regularly risk drowning from flash floods or the collapse of retaining walls.



Diwalwal, 2005

Total Number of fatalities -	32
miners	
recovered	- 27
trapped/missing	- 5
Injured	2
Rescued	9
	Total: 43
miners	



Health studies on Mercury

- Integrated Surveillance of the Health and Environmental Impacts of Mercury Exposure in Gold Processing (Maramba, N. et.al, 1988)
 - 26% (60/230) of the workers use some form of protective device such as facial cover or masks, boots and gloves
 - 47%(106/230) showed gray or focal deposits in the gingiva upon PE
 - 16% (36/230) had decreased breath sounds
 - 11%(24/230) had thyroid enlargement
 - The cross-sectional survey revealed that blood mercury levels were elevated in 13 of the workers examined
 - Showed statistically significant association of blood mercury levels with the duration of work, eosinophil count and serum glutamic amino transferase

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Health Studies on Mercury

- Health Impact of Mercury Among Small-scale Gold Miners in Camarines Norte (1991)
 - 7 out of 99 (7%) were found to have elevated mercury blood levels
 - 4 miners detoxified
- Health and Environmental Impact of Mercury Among Schoolchildren in Apokon, Davao del Norte (2000)
 - Blood and hair samples from 162 schoolchildren aged 5-17 years were collected and analyzed at the NIMD
 - Summary of physical examination results showed that predominant findings include underheight, gingival discoloration, adenopathy, underweight and dermatological abnormalities among children examined

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Health Studies on Mercury

- Mercury as a health hazard due to gold mining and Mineral processing activities in Mindanao/Philippines (UNIDO, 2001)
 - Clinical symptoms among those examined showed that a fair amount of workers from Diwalwal showed severe symptoms that could be very well related to the classical picture of mercury intoxication
- Symptoms include fatigue, tremor, memory problems, restlessness, loss of weight, metallic taste and sleeping disturbances
- Intentional tremor, mainly fine tremor of eye lids, lips and fingers, ataxia, hyperreflexia and sensory disturbances as well as bluish discoloration of the gums
- More than 70% (73 /102) of the occupationally-burdened population suffer from chronic mercury intoxication
- Higher percentage among amalgam smelters (85.4%)
- 1/3 of the non-occupationally burdened is intoxicated

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“Health and Environmental Impact of Mercury ” (IAEA Project)

- Collaboration of the DOH, UP-National Poisons Control and Information Service with the National Institute for Minamata Disease-Japan
- IAEA Research Coordinated Project on mercury (10 countries)
- provided technical assistance in the analytical determination for total and methyl mercury using a semi-automated cold vapor atomic absorption spectrometry developed at NIMD-Japan and GC methods (Akagi Method)



IAEA Mercury Project in collaboration with NIMD-Japan, UP-NPMCC (1999-2003)

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“Health and Environmental Impact of Mercury in the Philippines (IAEA Project)”

§ Environmental Assessment

§ establish sampling stations based on the selection of study site and assess the following:

- § drinking water supply
- § river quality assessment
- § effluent discharge
- § sediment/soil contamination
- § air quality (ambient/personal/workplace)
- § marine life

IAEA Mercury Project in collaboration with NIMD-Japan, UP-NPMCC (1999-2003)

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Monitoring of Mercury Levels in Soil/Sediment Samples*

Activity	T-Hg (mg/kg d.w.)
Small-scale gold mining	
Ballmilling/refining (Tagum, 2000)	0.55 - 66.47
Mining/processing (Sibutad, 2001)	0.050 - 0.035
Ballmilling/Refining (Tagum, 2004)	0.014 - 4.48
Mining/processing (Mt. Diwata, 2005)	0.024 - 47.76

US EPA Primary Remediation Goal (PRG) for Hg = 23 mg/kg

** IAEA Mercury Project (DOH, UP-NPMCC, NIMD-Japan)*



Monitoring of Mercury Levels in River Systems*

Activity	T-Hg (ng/ml)
Small-scale gold mining	
Ballmilling/refining (Tagum, 2000)	72.8 - 78.4
Mining/processing (Sibutad, 2001)	0.36 - 0.55

RP-DENR Standards: 2 ng/mL

** IAEA Mercury Project (DOH, UP-NPMCC, NIMD-Japan)*

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Monitoring of Air Mercury Levels*

Activity	T-Hg (ng/m ³)
Small-scale gold mining	
Mining/processing (Mt. Diwata, 1998)	
ambient air	0.168 -0.388
workplace	3.54 - 6.46
Mining/processing (Sibutad, 2001)	4.74 - 13.44

US-EPA: 0.4 ug/m³ (ambient) ; Occupational: <0.025 mg/m³

**NIOSH Method 6009*

IAEA Mercury Project (DOH, UP-NPMCC, NIMD-Japan)

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Monitoring of Mercury Levels in Fish*

Activity	T-Hg (mg/kg)	Me-Hg (mg/kg)
Small-scale gold mining		
Mining/processing (Mt. Diwata, 1998)	0.679 - 1.071	no data
Ballmilling/processing(Tagum, 2000)	0.0011- 0.439	0.0071 - 0.378
Mining/processing (Sibutad, 2001)	0.004 - 0.063	0.0038-0.036
Ballmilling/processing(Tagum, 2002)	0.001 - 0.104	
Ballmilling/processing(Tagum, 2005)	0.005 - 1.976	0.002 - 0.580

US-FDA:RPDA (T-Hg): 500 ng/g; Japan standards : T-Hg (400 ng/g); Me-Hg (300 ng/g)

* **IAEA Mercury Project (DOH, UP-NPMCC, NIMD-Japan)**

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Fish Advisory

- A fish advisory was prepared to provide information on fish species which are safe for the consumption of the general public.

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Monitoring of Hair Mercury Levels*			
Activity	Population	T-Hg (ng/mg)	Me-Hg (ng/mg)
Small-scale gold mining			
Ballmilling/processing(Tagum, 2000)	162 schoolchildren (5-17 yrs)	0.278 - 20.39	0.19 -18.47
Mining/processing (Sibutad, 2001)	38 workers & non-worker	1.05 - 68.68	0.86 - 5.81
	13 children	0.95 - 2.73	0.73- 2.29
Mining/processing (Mt. Diwata, 2005)	92 workers and residents	0.56 - 307.51	0.52 - 5.99
Gold Mining (UNIDO-Diwalwal, 2001)	150	0.8 - 42.2	no data
Abandoned mercury mines (Palawan, 2004)			
BGS, 1999	130 residents	2.2 - 4.41	no data
DOH/UP-NPCIS, 2004	35 children	0.18 - 13.29	0.16 - 8.01
	35 mothers	0.53 -10.56	0.53 -7.06
NV adopted: hair total mercury: adults and children ≤ 4ng/g ; hair methylmercury: < 2 ng/g <i>*IAEA Mercury Project (DOH, UP-NPMCC, NIMD-Japan)</i>			

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Determination of Blood Mercury Levels			
Activity	Population	T-Hg (ng/ml)	Me-Hg (ng/ml)
Gold processing areas (Apokon, 2000)	162 schoolchildren (5-17 yrs)	0.76 - 56.88	1.36 - 46
Gold mining (Sibutad, 2001)	38 workers & non-worker	3.38 - 29.48	1.63 - 23.11
	13 children	2.74 - 14.2	1.63 -11.48
Gold Mining (UNIDO-Diwalwal, 2001)	150 residents	<0.25 - 107.6	no data
Gold Mining (UNIDO-Diwalwal, 2001)	150 residents	<0.25 - 294	
<p>Biological Exposure Index for Mercury (Blood): adults = 15 ug/L; children =7.5 ug/L</p>			

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Updates

- Mercury levels in hair, blood, fish, water, soil/sediment and water samples were analyzed as part of the continuing collaboration with the National Institute for Minamata Disease-Japan.
- Samples were collected among 100 residents of the mining community in Mt. Diwalwal, Monkayo, Compostela Valley in collaboration with the Center for Health Development for Southern Mindanao and the local health unit.
- Samples were analyzed February-March, 2005
- Split sampling analysis with the EOH Collaborating Center



Summary of the results are as follows:

- Five out of 100 residents from Mt. Diwalwal are recommended to undergo further health examination, for possible detoxification.
- These residents have blood mercury levels > 75 ug/ml (permissible limit: 15 ug/ml).
- 39 more residents with blood mercury levels > 15 ug/ml will also have to be examined.
- 39/92 (42.39%) persons examined have total hair mercury levels > NV of 4 ug/g.



Summary of Blood and Hair Total and Methylmercury Levels, Mt. Diwalwal, 2005

	Total mercury	Methyl mercury	% Methyl mercury
Blood (N=100)			
Mean+/- SD	21.44 +/- 27	7.2 +/- 4.61	46.41+/-26.23
Range	3.61 – 239.99	1.04 – 24.60	8.54 – 100%
Hair (N=92)			
Mean+/- SD	13.34+/-39.92	1.84 +/- 1.12	52.06+/-31.02
Range	0.66 – 289.21	0.52- 5.99	1.46 – 100%

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Summary of the results are as follows:

- The results of the laboratory tests showed that inorganic/elemental mercury is the predominant mercury specie in the blood samples and this is indicative of the environmental and occupational exposure of residents to the small-scale gold mining operations in the area rather than their dietary intake from contaminated fish. (see Table 1).

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Mercury Vapor* levels in Barangay Palanas, Camarines Norte February 25, 2010

Area	(Hg levels), ng/m ³	Remarks
Ambient environment (near the barangay hall, 4:55 pm)	153 - 1262	Outside the barangay hall
Gold Processing Area – House 1	7044 – 28,890	Ballmilling and panning operations
Gold Processing Area – House 1	50,000	Blowtorching area; no activity was prevailing during the monitoring
Gold Processing Area – House 2	429 – 27,200	Ballmilling and panning operations
Threshold Limit Value (TLV)	50 ug/m ³ or 50,000 ng/m ³	Occupational standards were exceeded in the workplace in the blowtorching area
Ambient air monitoring guidelines in residences, USEPA	200 ng/m ³	Levels were exceeded in the households/residences where the monitoring was done.

* Air Monitoring using Lumex Mercury Vapor Analyzer

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Results of the Blood Mercury Monitoring, Paracale, Camarines Norte, 2010

Name of Patient	Blood Mercury levels* (ug/L)	Remarks
1. NS	82.7	Elevated, blood Hg level 17 yo, 2mos as small-scale miner
2. RD	51.3	Elevated Hg blood level 53 yo, housewife, residence with SSGM operations
3. VD	39.4	Elevated Hg blood level 51 yo, 20 years-oversee SSGM operation)
4. AA	36.4	Elevated Hg blood level 20 yo, 6 mos as small-scale miner
5. WT	35.9	Elevated Hg blood level 27 yo, 5 mos as small-scale miner
6. MV	23.1	Elevated Hg blood level 25 yo, 1 yr. as small-scale miner
7. AE	19.2	Elevated Hg blood level 16 yo, 2 yrs as small-scale miner
8. EG	18.6	Elevated Hg blood level 34 yo, 10 yrs as small-scale miner
9. PH	5.2	60 yo, 20 years as small-scale miner
10. MD	ND:DL=1	21 yo, compressor diver

Biological Exposure Index for Mercury (Blood): adults = 15 ug/L; children =7.5 ug/L

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Management of Mercury Poisoning Cases

- Detoxification with DMSA (dimercaptosuccinic acid)
- EMG-NCV testing
- repeat mercury and other laboratory tests
- repeat physical examination
- repeat neurological examination



Role of the Local Government Units

- Health findings showed exposure of schoolchildren to mercury from the ballmilling operations in Tagum, Davao del Norte
 - LGU established a zoning ordinance
 - Closure of ballmilling operations near institutions (i.e. schools, hospitals, etc)



Evaluation of a new, mercury-free method for small scale gold mining in the Philippines

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Recommendations

- Need to establish a reference laboratory to undertake a comprehensive inorganic and methyl mercury determination in the area to provide the necessary guidelines on fish intake to the community especially high risk groups such as pregnant women and children
- Education of high risk groups e.g as pregnant women/children
- For the community to conduct the ff:
 - continue health& environmental monitoring activities in the affected areas
 - Require establishments to install anti-pollution devices for air pollution and waste treatment recovery/treatment facilities
 - Relocation of ballmilling/refining process into an industrial zone
- For the local government units to conduct monitoring of fish especially those regularly consumed by the people



WHAT NEEDS TO BE DONE:

- Need to formulate/update existing regulations to further restrict mercury use in the country
 - Exposure to Hg should be minimized by phasing-out certain uses of mercury where environment friendly alternatives are available (e.g. medical, mining, etc)
 - **Department of Health has issued Administrative Order No. 21 on the Gradual Phase-out of Mercury in Philippine Health Care Institutions**
- Conduct of Health and environmental monitoring activities
 - undertaken to take into consideration low-dose chronic exposure among the general population and sensitive sub-populations such as pregnant and lactating women including infants and children

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■ WHAT NEEDS TO BE DONE

- Train miners on alternative environmental-friendly technology in the extraction of gold from the ore
- Integrate cost considerations for health, environment as well as temporary storage and disposal of wastes, clean up and remediation in the issuance of permits by regulatory agencies in allowing continuing mercury use in artisanal small-scale mining
- **Advocacy: People should be made aware of the toxic effects of mercury to human health even at low doses**
- **Need to strengthen collaborative linkages with international organizations /non-government organizations**

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- Local Governments/Health Units of Tagum and Puerto Princesa Cities, Calaca, Sibutad and Monkayo.

