Global Mercury Project

Indicators of Reduction of Mercury Pollution in an Artisanal Gold Mining Region in Brazil

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Amazon forest – Crepori River

14th Annual BC/MEND Metal Leaching / Acid Rock Drainage Workshop

Artisanal and Small-scale Mining (ASM)

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

About 30 million ASM

About 10 to 15 million ASM producing 600-800 tonnes Au/a in more than 60 countries

Lao PDR, 2000

This is the biggest gold rush the world has ever seen

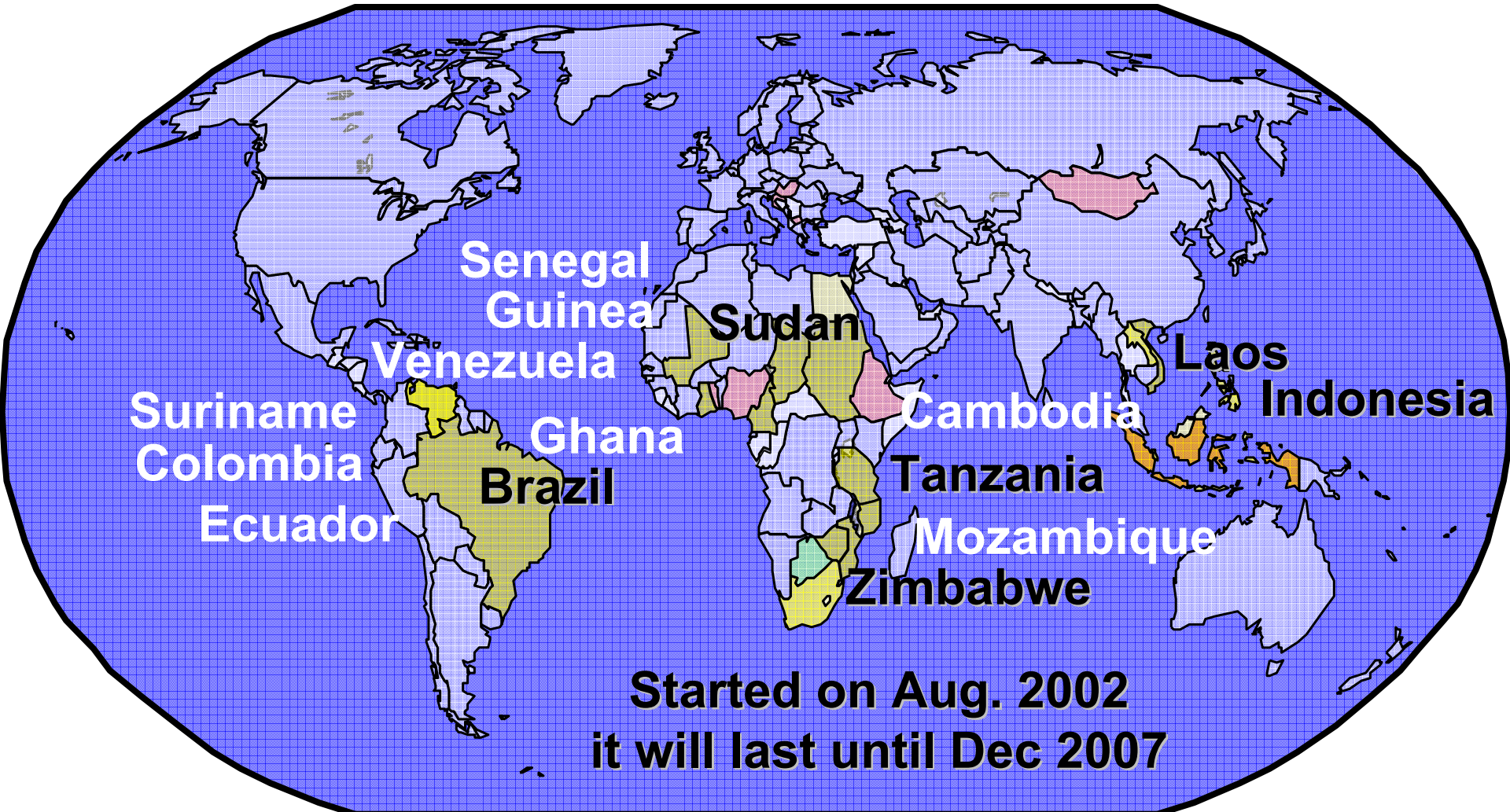
Gold price increasing = More people involved

- **About 50-100 million people directly and indirectly involved in artisanal gold mining**
- **About 1000 tonnes/a of mercury lost to the environment**

Guinea, 2006

Global Mercury Project

In collaboration with UBC Dept of Mining Engineering

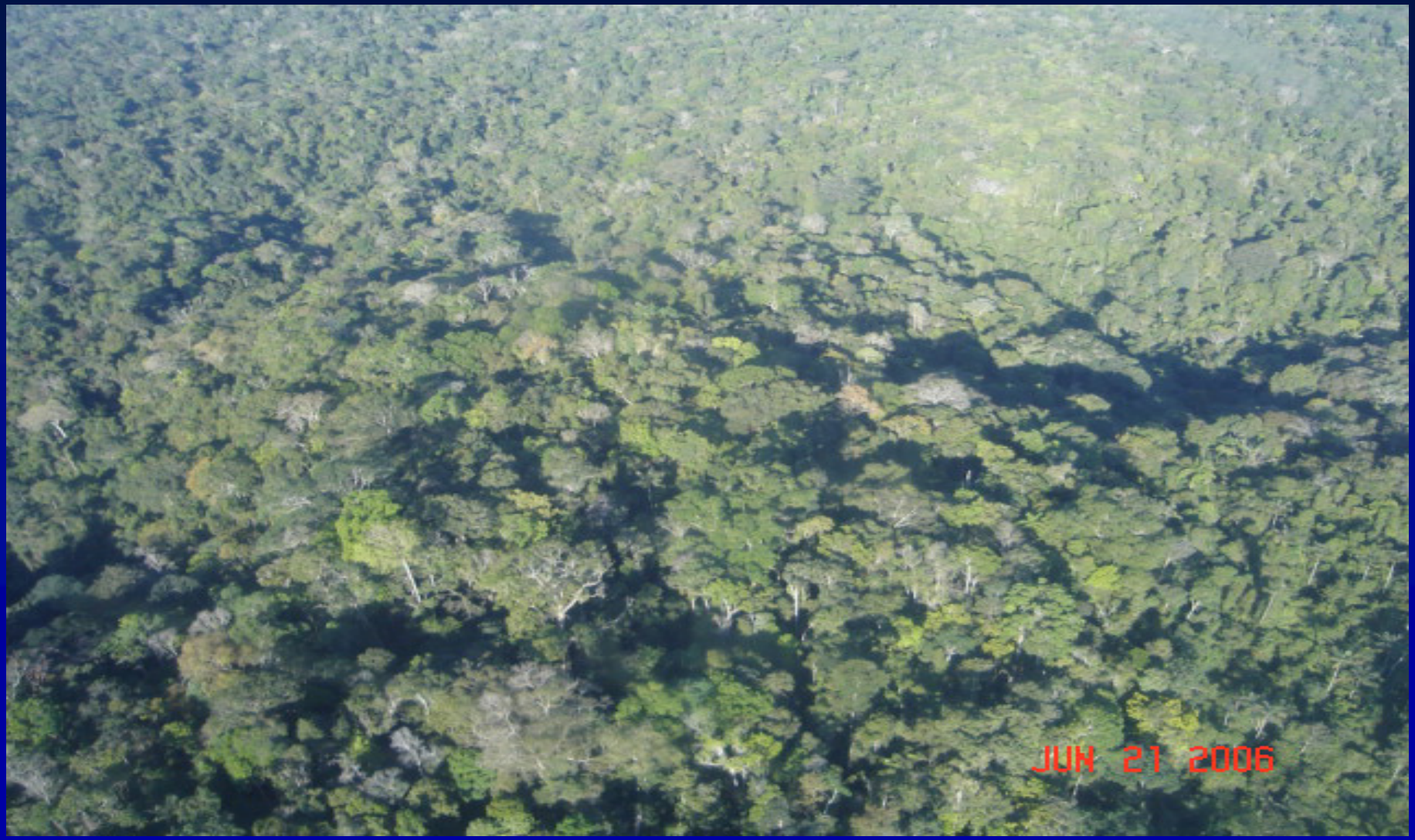


Goals of the GMP

- ✓ Reduce mercury pollution caused by artisanal miners, protecting human health and local water bodies
- ✓ Introduce cleaner technologies for gold extraction and develop mechanisms to allow this technology to be supplied locally
- ✓ Train local miners and develop community awareness about all environmental impacts derived from artisanal mining

Location of the main site in Brazil Itaituba, Creporizão, “Garimpos”

Location of the main sites in Brazil
The Amazon Forest



Dimension of artisanal gold mining in Brazil and in Tapajós region

- ✓ 100,000 artisanal miners (garimpeiros)
- ✓ 40,000 in the Tapajós region. Reached 200,000 miners - mining peak in 1990
- ✓ 2,000 mining sites (garimpos)
- ✓ 432 air strips
- ✓ 6 to 8 tonnes/year of gold in the Tapajós region = amount of Hg lost to environment

Creporizao – Mining Community

Cabaçal – Mining Community

Socio-economic aspects

1. Most miners are illegal. Little or no technology for primary gold processing
2. Most miners are male. Education varies from illiteracy to an elementary level. No child labour
3. Gold is the main source of revenue. Agriculture and cattle are very incipient. Deforestation occurs mainly due to fires.
4. Transportation by airplanes and boats, at very high cost.
5. Mercury locally costs US$200/kg. Gold is sold by US$20/g

Environmental and Health Aspects

1. High level of mercury in fish (4 to 5ppm, with maximum of 21.9ppm), exacerbated by the use of cyanide

2. High level of Hg in soil/sediment s

3. Very basic living conditions, with high level of malaria and parasitosis

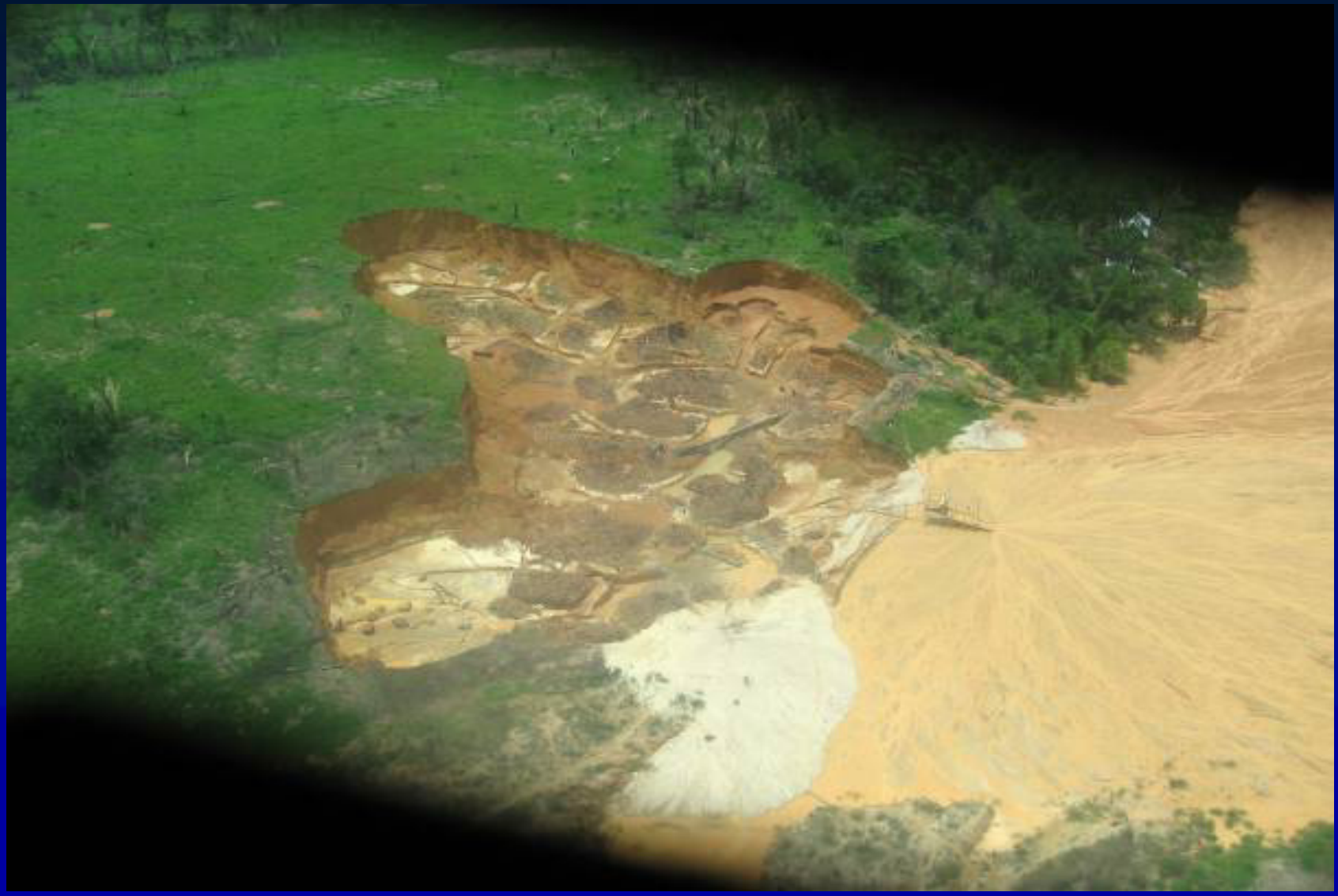
4. Water consumed directly from the river, no use of latrines, no care with garbage

Environmental and health impacts:
mercury and sediments in rivers, contamination of fish and people

Crepori River

Hydraulic monitors – huge open pits in the forest

Sediment / tailings released directly into the rivers



Sediments / tailings released directly into the rivers

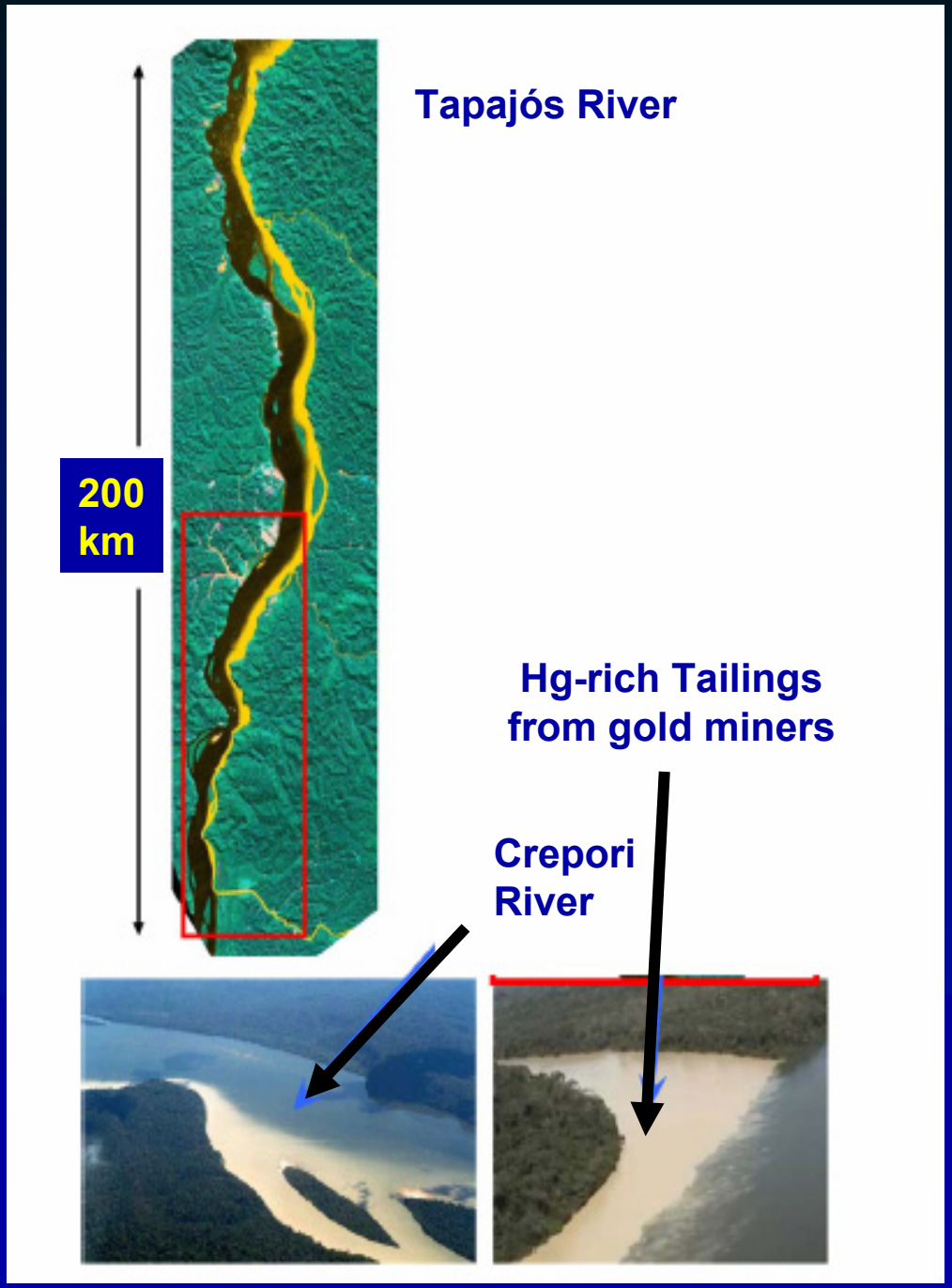
Sediment released by sluice boxes – Crepori River

Mobility of Hg-contaminated Tailings

Hg-tailings go >200km downstream in the Tapajós River

Tailings take >4 t/a of Hg to other areas

Hg is methylated and bioaccumalted downstream



Miner Burning Amalgam (exposed to Hg vapor)

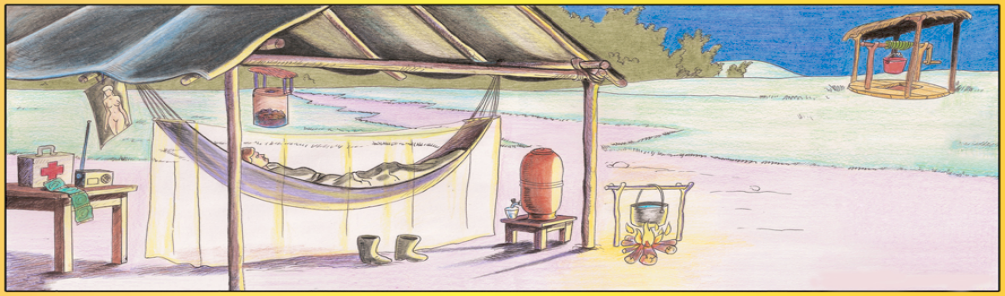
GMP Actions - 01

- ✓ Social-economic study, alternatives of microcredit, environmental and health assessment, environmental legislation study

- ✓ Implementation, promotion and dissemination of 20 “best practices” (technological, economical, environmental, health, legalization)

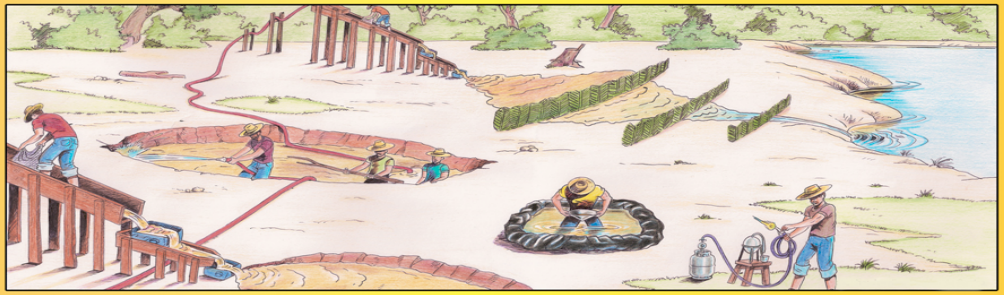
Project promotion: “Take care of your treasure”

CUIDE DO SEU TESOURO



Utilizar sempre o mosquiteiro para evitar picada de insetos transmissores de doenças (malária).
A água para beber e cozinhar deve ser fervida e filtrada.
O sanitário tem que estar distante da cacimba (poço da água), pelo menos 50 metros e ficar sempre tampada.
Na relação sexual, use sempre camisinha para prevenir doenças sexualmente transmissíveis: AIDS, gonorréia, sífilis e outras .

O óleo queimado dos motores deve ser depositado em tambores para serem reutilizados. Evite o vazamento dos motores.
Aproveitar os barrancos aterrados como área para reflorestamento.
O lixo deve ser enterrado longe do barraco para evitar doenças.



Evitar jogar o rejeito da caixa diretamente no rio ou igarapé.
Todo melexete deve ser depositado em barrancos trabalhados ou aparados por pelo menos três abatadores.
O bateamento da despesca deve ser feito em piscina de lona para evitar o contato do azougue (mercúrio) com o igarapé e o solo.
A queima do ouro azogado deve ser feita sempre na retorta para reaproveitar o azougue e evitar a contaminação do vapor do azougue (mercúrio) com o ar. Na venda do seu ouro, exija sempre Nota Fiscal

Amigo garimpeiro o seu trabalho vale ouro, cuide de você e do meio ambiente

Training of trainers (multipliers)

Training of miners / awareness campaign

Indoor Training

Outdoor Training - Practical field lectures

Multiplication of training / awareness campaign

Multiplication of training / awareness campaign

Introduction of biosand water filters

Demonstration of homemade retorts

Distribution of retorts to disseminate the culture of protection against mercury vapour during the amalgam burning

Demonstration of mercury reactivation and recycling

Implementation of pilot plant for training on gold processing, including hammer mill, ball mill and centrifuge

New Centrifuge (Falcon) for ASM and Itaituba mayor

Homemade prototypes (amalgamator)

TDU - Transportable Demonstration Unit

Cyanidation tests – A lab in the jungle

Fume hood in Gold Shops: GMP & USEPA

GMP Actions - 03

9. Workshops in all levels (Federal, State and Municipal) to promote the program and identify partnerships

10. Promotion of communication and joint effort between stakeholders

Workshops in all levels (Federal, State and Municipal) to promote the program and identify partnerships

Evaluation of Effectiveness

- ✓ Evaluation of “garimpos” done prior to the training and 90 days after training:

- ✓ 5 OBJECTIVES:
  - ➢ Legalization of mines
  - ➢ Improvement of Gold Production
  - ➢ Protection of Forest and Water
  - ➢ Reduction of Hg Use
  - ➢ Improve Health and Sanitation

- ✓ Prevention and corrective actions, monitoring

Practical changes in the field
Results of evaluations - 01

Objective		Evaluated Item (Performance Indicator)	% Mines attending requisites		
			Evaluation before training	Evaluation after training	Variation %
Legalization of mines	1	Environmental License available	0.7	2.1	1.4
	2	Mining Permit available	1.4	2.1	0.6
	3	Invoice issued for selling gold	13.4	33.3	19.9
Gold Production	4	Use scientific method for finding gold	44.2	50.0	5.8
	5	Right equipment and process available	46.0	50.0	4.0
	6	Equipment and process recover fine gold	46.7	50.0	3.3
	7	Equipment maintenance and stock of supplies	51.4	66.7	15.2

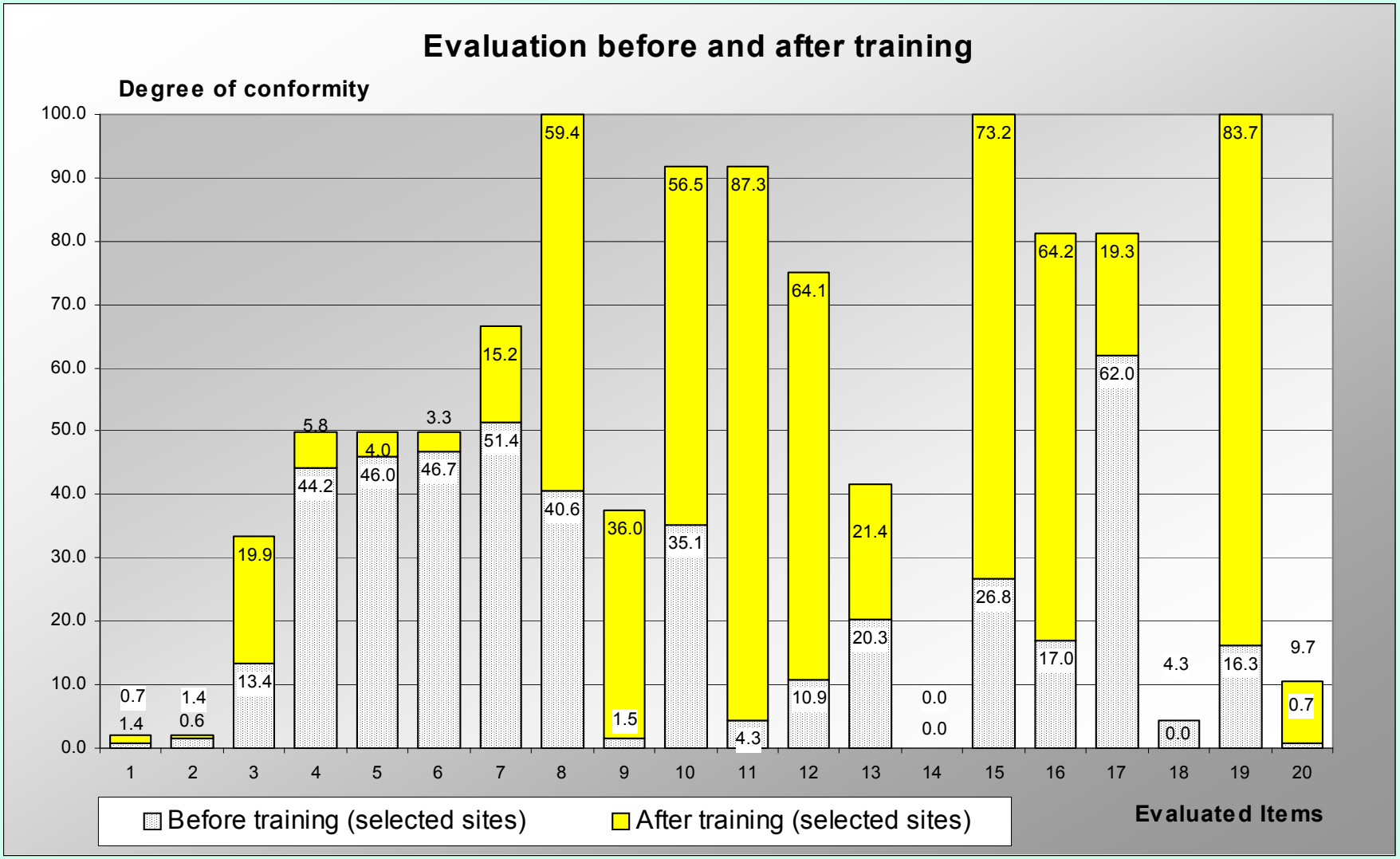
Number of evaluated sites: 141 = 7% of total number (2000)

Variation: absolute difference between 1st and 2nd evaluations

Results of evaluations - 02

Objective		Evaluated Item (Performance Indicator)	% Mines attending requisites		
			Evaluation before training	Evaluation after training	Variation %
Protection of water and forest	8	Refilling of old pits	40.6	100.0	59.4
	9	Reforestation of degraded areas	1.5	37.5	36.0
	10	Quality of water / containment sediments	35.1	91.7	56.5
Use of Mercury	11	Mercury reactivation and recycling	4.3	91.7	87.3
	12	Mercury confinement / pool amalgamation	10.9	75.0	64.1
	13	Use retorts during burning process	20.3	41.7	21.4
	14	First steps for technology free of mercury	0.0	0.0	0.0
Health and Sanitation	15	Use of latrines	26.8	100.0	73.2
	16	Use of filtered drinking water	17.0	81.3	64.2
	17	Use of methods for prevention of malaria	62.0	81.3	19.3
	18	Exposure to risks and safety	4.3	4.3	0.0
	19	Garbage disposal	16.3	100.0	83.7
	20	Practices of awareness of miners	0.7	10.4	9.7
		Mean	22.2	53.4	31.3

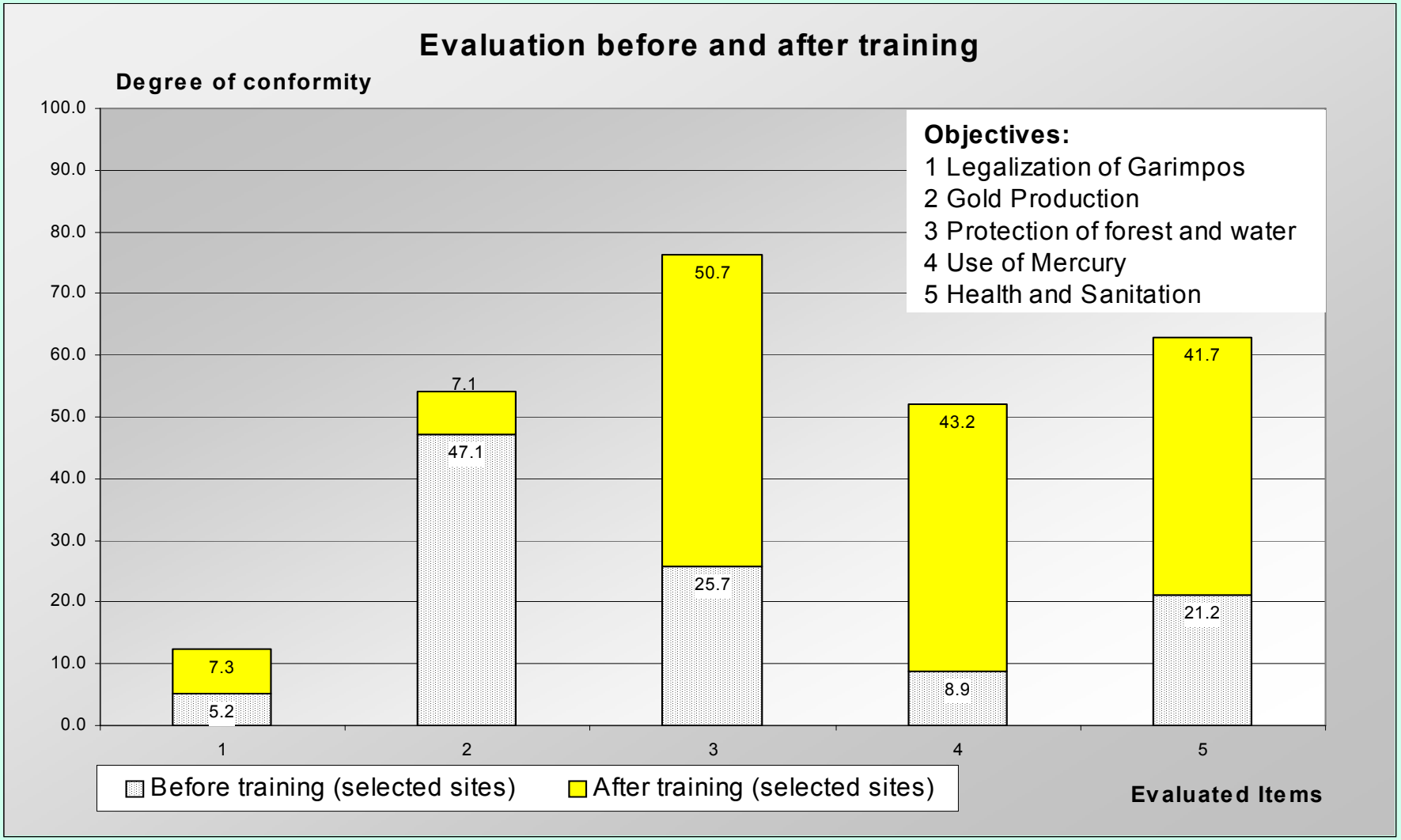
Results of evaluations - 03



Results of evaluations - 04

Objective	% Mines attending requisites		
	Evaluation before training	Evaluation after training	Variation %
Legalization of mines	5.2	12.5	7.3
Gold Production	47.1	54.2	7.1
Protection of Water and Forest	25.7	76.4	50.7
Use of Mercury	8.9	52.1	43.2
Health and Sanitation	21.2	62.9	41.7
Mean	22.2	53.4	31.3

Results of evaluations - 05



Pool for amalgamation of concentrate

Construction of latrines

Garbage disposal

Use of retorts to burn amalgam and recover Hg

Sluice box removed from river / barrier to retain sediments

Triple barrier to retain sediments

Preparation of seedlings for rehabilitation of degraded areas

Example of area (open pit) before rehabilitation

Old open pit in process of refilling

Example of area after rehabilitation (Cashew nuts)

Example of area after rehabilitation (Neem)

Example of area after rehabilitation (Mahogany)

Conclusion

1. Four studies (socio-economic, environmental-health, legal, microcredit) conducted, 4,200 miners trained, 141 sites evaluated, 20 good practices promoted

2. At least 9 environmental / health practices had substantial impact: reactivation and recycling of mercury, use of retorts (60), pool for amalgamation, old pits refilling, containment of sediments, garbage disposal, latrines, biosand water filters.

Conclusion

3. Gold production: tests for increasing gold recovery and reprocessing of tailings have to be a permanent activity

4. Legal aspects: it's not enough to train miners to comply with legal requirements. Necessary alternative solutions to simplify processes to make formalization viable

5. The improvement of grades (31.3%) represents changes in behaviour and is the best evidence that miners respond to training and education