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SQUEEZING GOLD FROM A STONE

Addressing the Toxic Health Risks and Pollution Caused by Mercury Use in the Small Scale and Artisanal Gold Mining Sector

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UNITED NATIONS ENVIRONMENT PROGRAMME

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Squeezing gold from a stone:
How to Reduce Toxic Health Risks and Pollution Caused by Mercury Use in the Small-Scale & Artisanal Gold Mining Sector

Chasing today's higher gold prices, as many as 20 million people in more than 70 countries are being lured to small-scale and artisanal gold mining (ASGM) to try to escape from poverty.

But this gamble has high stakes. Many small-scale and artisanal miners are using mercury, a persistent and toxic chemical, to extract gold from ore. During the process mercury escapes into the environment, posing grave, and often irreversible, health threats not only to miners but also to some of the world's most vulnerable populations—women and children. And this invisible threat is reaching well beyond the mining camps as the mercury travels through the world's air and waterways and into fish globally.

Fortunately, low-cost technologies available now have the potential to reduce mercury pollution in the sector dramatically. By supporting miners with knowledge and resources to adopt these new technologies and with the right policies in place at the local, national and global level, we can stem a significant source of global mercury pollution now.

Swift action by UNEP member states will have an immediate impact in reducing the amount of mercury released by ASGM and dramatically benefit health and economic well being of miners, part of a global agreement to control mercury pollution.

There is nothing small scale about mercury pollution produced by artisanal and small-scale gold mining (ASGM).

ASGM refers to gold mining by individuals or small groups using basic equipment and/or light machinery. Producing about 12 percent of the world's gold (330 tonnes), the artisanal and small-scale mining (ASGM) sector is directly supporting an estimated 10 to 20 million miners and indirectly supporting an estimated 50 to 100 million more people around the globe—the biggest gold rush in history.[1]

The rapid growth in the sector is fueled largely by swelling gold prices, which have risen from US$10 per gram in 1997 to more than US$30 per gram in 2009[2]. For the miners, the record gold prices offer an opportunity for bringing new wealth into impoverished communities that often fail to attract other industries.

One of the by-products of a booming ASGM sector is mercury pollution. Mercury is used to bind with gold particles in ore to create an amalgam. When the gold-mercury amalgam is heated to burn off the mercury, leaving the gold behind, the vapors are directly inhaled by miners, exposing them and others in the mining communities to grave health risks.[3]

Mercury is a potent neurological toxicant that interferes with brain functions and the nervous system. It is particularly harmful to babies and young children. Low-level exposure to infants during gestation is associated with reduced attention span, fine-motor function, language, visual-spatial abilities (such as drawing) and verbal memory.[4] In adults, mercury can cause numbness and tingling, vision abnormalities, and memory problems.[5]

Marginalized people and communities are disproportionately affected by mercury pollution in AGSM.

ASGM cuts across many development issues, including poverty, economic deleopment, gender, and biodiversity. Programmes focussed on reducing mercury use can serve as a positive entry point for broader engagement in development and act as a mechanism to encourage poverty alleviation and rural economic growth while improving health and the environment.

Women: Gender issues are prominent in ASGM: Women of child-bearing age have high risk from mercury's effects, yet are often marginalized from the benefits of wealth created by mining.[6]

Children: One to two million children may be involved in ASGM, starting with children as young as 3-year-olds and working within or outside of a family unit. Not only does this work expose them to hazardous conditions, but it also can divert them from education.[7]

Marginalized communities: In many countries, ASGM is practiced by small, dispersed groups, acting outside a formal legal framework. The mining communities are often underserved by governments, often receiving no government assistance, leading to poor social conditions.[8]

In addition, when gold reserves are exhausted, the community must deal with the environmental degradation and increasing poverty. Gold mining's dispersed and transitory nature and the difficult conditions in these communities present challenges for dealing with the environmental and socio-economic problems they face, particularly mercury.

One study of Peruvian children of ASGM miners found that nearly 85 percent of the sampled children had dangerous levels of mercury in their bodies.[9]

Case Study: Zimbabwe

Zimbabwe's Kadoma-Chakari region is one of the country's largest gold belts, but mining activities release a significant amount of mercury into the environment and, according to the Global Mercury Project (GMP), "Urgent action is required to significantly reduce exposure of workers, their families and the local environment to mercury." This is an extremely poor area, with no adequate health care facilities and little access to drinkable water. Poverty "is the main reason for the region's disastrous health and environmental problems." The GMP team found high mercury levels close to processing areas, and noted that one village was using tailings material to build roads, raising mercury concentrations all through the village. Although mercury in fish is often the main pathway for human exposure, however, in this case mercury vapor was the cause of illness. The report calls for region to be given access to alternative technologies and best-practices education, as well as basic healthcare.

Source: Global Mercury Project, *Environmental and Health Assessment Report/Removal of barriers to the introduction of cleaner artisanal gold mining and extraction technologies* (Vienna, Austria: 2006), 6, 8, 10, 18.

Mercury pollution spills far beyond mining communities to affect biodiversity and our global environment.

Despite the small scale of individual operations, ASGM is a major source of global mercury pollution. Recently, UNEP estimated that ASGM uses 640 to 1,350 tonnes of mercury a year, averaging 1,000 tonnes a year—roughly one-third of total global use.[10] Unlike other industrial uses of mercury, all of what is used by ASGM ends up in the environment. Approximately 40 percent is released into the air, with most of the remaining 60 percent making its way into waterways and onto the land.[11] In many countries, ASGM is the largest single source of mercury emissions. Because mercury can travel globally, mercury released by ASGM ends up polluting air, water and fish all around the world.[12]

ASGM can also threaten biodiversity through deforestation and water pollution that destroys ecosystems and habitat for local wildlife. Miners sometimes work in protected biodiversity areas because these areas are typically remote, and are not otherwise exploited for minerals.[13]

Case Study: Mozambique

A pilot project in Mozambique by the Global Mercury Project and Mozambican government promoted safer and better use of mercury in ASGM. Open-air burning of amalgams had been a major problem, but the project, supported by the Blacksmith Institute, taught miners and their families about ways to cut mercury emissions, including retort technologies. The retorts were home-made from salad bowls and showed that mercury emissions could be lowered to allow 95 percent of mercury to be used again. The retort technology's low cost—under US$4—appealed to miners, particularly given the savings derived from reusing costly mercury.

Source: Samuel J. Spiegel and Marcello M. Veiga, 2006 Strategic Plan on Policy and Governance, (Global Mercury Project, 2006),.50f

Challenges to *eliminating* mercury use

Governments have agreed through the UNEP Governing Council to develop a legally binding instrument on mercury to reduce risks to human health and the environment, taking into account the circumstances of countries. The intergovernmental negotiating committee is to develop a comprehensive and suitable approach to mercury to reduce the demand and releases of mercury from all sources, including ASGM.

*Governments have requested UNEP to continue and enhance, work to conduct awareness-raising and **pilot projects** in key countries to reduce mercury use in artisanal and small-scale gold mining through the Global Mercury Partnership.*

Cost effective alternative methods exist that can eliminate or greatly reduce the quantity of mercury used in ASGM, however, due to the imminent threat to ASGM to miners and their families, as well as the significant and growing emissions to the global environment, adoption of these methods must urgently be accelerated now.

There are compelling reasons why mercury is currently favored by miners over other methods of gold extraction, including ease of use, ready accessibility and relatively low cost. Because mercury techniques yield gold rapidly, mercury puts cash in miner's pockets quickly. Further, mercury amalgamation allows for a completely independent processing: the entire mining process can be accomplished by just one miner, unlike more expensive and technically sophisticated methods.[14]

Though other methods may be more effective in theory, mercury amalgamation is generally a practical and efficient method under the conditions typically found at ASGM sites.[15] For miners to implement replacement technologies, the replacement needs to produce as much gold or more for similar financial and time investments for the miner. As well these replacement technologies need to initially fit into a similar labor structure.

Reducing mercury emissions and exposures through ready-to-go technical solutions

Use non-mercury methods

In some cases, it may be possible for miners to transition away from mercury-based extraction processes altogether. Gold from certain types of ores can be extracted effectively by non-mercury methods alone. Specially designed equipment may be effective in particular settings, such as the use of magnets to enhance gold recovery in ores that are associated with magnetite, a mineral commonly found in gold deposits. Centrifuges can also be used and shaker tables can enhance separation. Although these methods can be effective with particular ores, they often require special knowledge, equipment and skilled operators to maximize gold recovery and minimize losses due to inefficiencies in the process.[16]

Stop the practice of whole ore amalgamation by replacing it with gravity and other methods.

One of the worst and most wasteful uses of mercury in small scale gold mining is whole-ore amalgamation, where mercury is mixed with all of the ore mined. One alternative is to pre-concentrate the ores, using gravity-based separation methods such as sluices and centrifuges, before using mercury. By doing so, the miners can mix mercury with a much smaller amount of ore that contains a higher concentration of gold. Amalgamating concentrates, rather than the whole ore, greatly decreases the overall amount of mercury required to extract the same amount of gold.

Reduce emissions by using retorts in the field and by using mercury vapor capture systems in shops that refine local gold.

Emissions from burning amalgam can be reduced using a device called a retort, which captures the mercury vapor without dissipating it into the air. The recovered mercury can be reused preventing purchase of new mercury, and its capture dramatically reduces the exposure of miners and their families to mercury. Various types of retorts are available, both manufactured and those constructed of locally sourced, inexpensive materials.[17]

Using retorts, or other mercury vapor capture systems, can reduce mercury losses by as much as 95 percent.

Gold produced by ASGM miners is often further refined locally in the shops of gold buyers, trading agencies, and jewelry makers which releases mercury and exposes the shopkeepers and urban neighborhoods to harmful effects of mercury. Gold shops can also be fitted with inexpensive mercury vapor capture systems to minimize emissions.[19]

Re-activate and re-use mercury.
Used mercury recovered after processing does not amalgamate gold as well as new mercury due to impurities accumulated during the amalgamation process. Because it is not as effective at capturing gold, miners often discard this "dirty" mercury into the environment. However, this can be easily and cheaply prevented. Dirty mercury can be reactivated inexpensively in the field using salt water and a 12-volt battery.[20] By reactivating, miners can use the mercury indefinitely, which means much less mercury is used overall. Miners also save money, since they don't have to buy new mercury and reactivated mercury gets more gold.

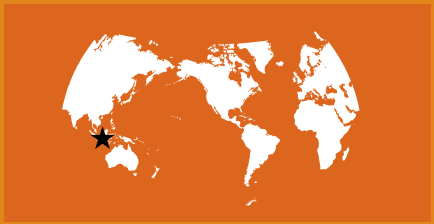
Dirty mercury can be reactivated inexpensively in the field using salt water and a 12-volt battery.

Case Study: Peru

The gold product from ASGM still contains mercury when sold to "gold shops." When the gold is refined by these shops, mercury is emitted into the shops and into residential areas surrounding the shops. The U.S. Environmental Protection Agency, with its contractor, the US Department of Energy Argonne National Laboratory worked together with local, state and national governments in Peru to develop an emissions control system that is affordable for the majority of gold shops, can be easily built using local materials, and is low maintenance. Field tests in Puerto Maldonado and Laberinto, located in Madre de Dios, a major gold producing region from ASGM of Peru, showed that mercury levels were reduced about 80%. Calculations estimated that use of the technology could prevent about 10 kilograms of mercury emissions per shop per year. The technology is now being disseminated through a series of workshops and demonstrations around the country, hosted by the Ministry of Energy and Mines of the Government of Peru.

Source: **Artisanal and Small Scale Gold Mining National Strategic Planning**. Powerpoint presentation by Vilma Morales (Government of Peru), at the Ad hoc open-ended working group to prepare for the Intergovernmental Negotiating Committee on Mercury. Information session, 21 October 2009.

Technology for the Capture of Mercury Aerosol Emissions in Artisanal and Small Scale Mining Gold Shops. Powerpoint Presentation by Luis E. Fernandez, Loren Habegger, and Marilyn Engle. 2009.



Case Study: Indonesia

A study of more than 200 square kilometers in the Galangan area of Central Kalimantan in Indonesia found the area was "extremely environmentally degraded from deforestation, desertification, and mercury contamination as a result of artisanal gold mining." Substantial dredging, amalgamation, and amalgam burning have resulted in mercury pollution—including into ponds used for bathing, laundry, fish raising and, cooking and drinking water. Moreover, the urban area of Kareng Pangi, where amalgam is burned in gold shops, is "quite contaminated with mercury because none of the many gold shops have any environmental controls and no retorts are used." In 2006 the GMP helped install mercury vapor capture systems in the shops in Kareng Pangi; three years later, a visit to the town found that the fumes hoods were still in operation, a testament to their practicality and effectiveness.

Source: Global Mercury Project, *Environmental and Health Assessment Report/Removal of barriers to the introduction of cleaner artisanal gold mining and extraction technologies* (Vienna, Austria: 2006), 6, 8, 10, 18.

Other solutions

Other chemicals besides mercury can be used to extract gold. Cyanide leaching, for example, is the predominant method used by large-scale industrial gold mining. Cyanidation has a number of strong points, including speed, efficiency and also some environmental advantages relative to mercury. For example, cyanide degrades quickly in the environment, whereas mercury is highly persistent. On the other hand, cyanide is extremely toxic. If not handled properly, it is dangerous to miners and, if discharged into streams, can kill aquatic life. Furthermore if used with mercury, it forms compounds that can easily be transported with water spreading mercury contamination. It can also convert mercury into a form that is more easily absorbed into the food chain. In addition, if small-scale miners use mercury before cyanide leaching, the residual mercury can react with the cyanide, preventing it from leaching gold and decreasing the gold recovery.[21] This "worst" practice—the use of both mercury and cyanide—must therefore be avoided.

There are a number of recommended practices for cyanide leaching to protect health and the environment, including safe cyanide storage and handling, monitoring for cyanide escape, promotion of recycling, proper storage of cyanide and proper mixing of solutions.[22]

Will these simple steps really address the problem?

From a technical point of view, shifting to non-mercury and lower-mercury practices can effectively reduce mercury consumption quickly. In fact, the UNEP Global Mercury Partnership has estimated that three steps alone—elimination of whole-ore amalgamation, use of mercury vapor capture systems, and reactivation—could dramatically reduce mercury use and release. If all miners were educated about these practices and adopted them, eliminating whole ore amalgamation could cut global mercury consumption by 36 percent, controlling emissions through mercury vapor capture systems could cut consumption by as much as 32 percent, and reactivating or cleaning mercury for re-use could cut mercury consumption by 25 percent.[24] UNEP Global Mercury Programme's ASGM Partnership has set a realistic goal of reducing mercury use in ASGM by 50 percent in 10 years, mainly by working toward these three approaches.[25]

Three steps alone—elimination of whole-ore amalgamation, use of mercury vapor capture systems and reactivation—could reduce dramatically reduce mercury use and release.

The challenge of realizing these potential reductions lies in the need to reach out to the dispersed and informal community of miners, to education them about these methods, and to overcome the financial and social barriers that undermine their adoption.

While the restrictions on supply and trade of mercury will likely increase the price of mercury and thus provide an incentive to miners to change their practices, at the same time, it is imperative to provide miners with the knowledge and support to help them cope with these changes while still realizing the economic benefits of gold production and to avoid creating or promoting a "black market" for mercury.

The international community can help to meet this challenge by facilitating the development of effective models that couple inexpensive, efficient technical solutions with innovative education and exchange programs along with policy development that allows widespread adoption of the new methods.

Reducing mercury use may require financing mechanisms to make technical implementation feasible.

Many of the alternatives to mercury use require modest investments in new equipment, such as sluice boxes or centrifuges to concentrate gold. However, because of the informal nature of communities, miners often do not have access to traditional forms of credit. Providing miners access to credit and other financial resources will be a critical aspect of encouraging adoption of new technologies.

Developing a market for fair-trade and fair-mined certified gold can provide strong incentives for miners to adopt cleaner standards of production. Fair-trade and fair-mined certified gold offers other advantages as well, including acting to raise consumer awareness of ASGM issues. As a trade—instead of aid—mechanism, it provides a business model that offers a sustainable positive change in the industry.

The demand for fair-trade and fair-mined certified gold rests on the knowledge of consumers about the health and environmental hazards of ASGM, especially mercury use. Raising awareness among consumers about ASGM in major gold-consuming countries and recognizing ASGM as a critical part of the global gold industry is key to creating broad market demand for gold that is produced with minimal health and environmental impacts.

By supporting these market-based efforts through policy and financial means, the international community can help move ASGM into an era of increased sustainability, profitability, and environmental awareness, while dramatically lowering the consumption and release of mercury.

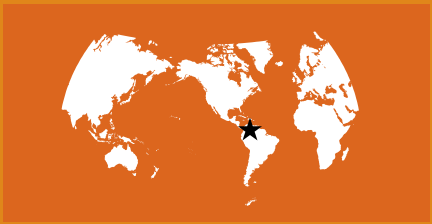
On a local and national level, governments can create a policy environment that allows miners to operate legally, facilitates access to credit and permits formal links to government assistance and outside organizations that can educate miners on improved technologies.

Reducing mercury use requires policies that enable miners to move to more sustainable methods.

As the international community focuses on mercury in ASGM as part of the broader commitments to reduce global mercury pollution, the negotiation of a legally binding instrument will create dialogue about a framework of goals that will allow businesses, NGOs and local governments to engage the ASGM sector to profitably transition away from mercury.

Trade policy to restrict global mercury supply is one potentially key aspect of the legally binding agreement. Restrictions on new mercury mining and export bans will reduce the supply of mercury, which will in turn increase its price and reduce accessibility. Rising mercury prices will give miners an incentive to conserve mercury. Further, relative scarcity of mercury will make miners more receptive to information on how mercury can be reduced and recycled.[26]

On a local and national level, governments can create a policy environment that allows miners to operate legally, facilitates access to credit and permits formal links to government assistance and to outside organizations that can educate miners on improved technologies. For example, in some countries, organizing mining activities through creation of miners' associations, has given miners a legal standing that allows them to operate inside the system, allows positive relationships to be created, and gives them formal mineral rights.



Case Study: Latin America

The Alliance for Responsible Mining (ARM) and the Fairtrade Labelling Organizations International (FLO) have developed a Standard for responsible artisanal and small-scale gold mining and to support and enable producers to deliver certified metals and minerals through economically just supply chains to the market. ARM-FLO's Fairtrade and Fairmined Gold standard includes requirements for reduction, mitigation and safe use and storage of mercury and cyanide, as well as an extra premium for producers who implement mercury-free and cyanide-free processing methods. ARM has finalized Fairtrade and Fairmined Gold pilot projects in Latin American, and is beginning in Africa. Overall, ARM's pilot projects produce some 333 kilograms of gold per annum and involved producer organizations in Peru, Ecuador, Bolivia, and Colombia. The first certified gold will be launched to market in the autumn of 2010.

Source: Alliance for Responsible Mining, http://communitymining.org/

Swift action by UNEP member states is needed for an immediate reduction in ASGM mercury pollution

The international community is now negotiating a legally binding instrument to control global mercury pollution—a positive and necessary step toward global mercury pollution reduction.

Yet more must be done while negotiations are underway to address the urgent and growing problem of mercury pollution in the ASGM sector. As called for by the UNEP Governing Council Decision 25/5, countries where ASGM is a major source of mercury emissions, with the assistance of countries willing to provide technical and financial support, must begin to raise awareness and implement pilot projects to lower mercury use in ASGM while the instrument is under negotiation.[28]

Specifically, member states, possibly with the financial and coordinating assistance of the Global Mercury Partnership, should act to reduce the release of ASGM mercury by supporting projects to:

- review and compare successful legal frameworks, which can serve as models for successful ASGM policies worldwide;
- develop and test technical solutions, and design ways to remove barriers to their use by miners;
- pilot/demonstrate financial approaches, such as microcredit or other mechanisms to support purchase of better technologies; and
- help to dramatically scale up successful programs to match to magnitude of the problem, including widespread technical education, community capacity building to encourage local innovation and horizontal (miner to miner) knowledge exchange.

Endnotes

1 United Nations Environment Programme (UNEP) (2008), "The Global Atmospheric Mercury Assessment: Sources, Emissions, and Transport," p. 13, 17, Retrieved October 6, 2009, from http://www.chem.unep.ch/MERCURY/Atmospheric_Emissions/UNEP%20SUMMARY%20REPORT%20-%20CORRECTED%20May09%20%20final%20for%20WEB%202008.pdf

2 GoldPrice.org, "Gold Price per Gram," Retrieved October 6, 2009, from http://goldprice.org/gold-price-per-gram.html

3 K.H. Telmer and M.M.Veiga, 2008. "World emissions of mercury from artisanal and small scale gold mining," in *Mercury Fate and Transport in the Global Atmosphere: Measurements, Models and Policy Implications* (Interim Report of the UNEP Global Mercury Partnership, Mercury Transport and Fate Research Partnership Area, 2008), p. 101. http://74.125.93.132/search?q=cache:http://www.hgwatch.net/asgm_paper_files/world_emission

4 Sylvaine Cordier, Micheline Garel, Laurence Mandereau, HerveH Morcel, Philippe Doineau, Sylvie Gosme-Seguret, Denise Josse, Roberta White and Claudine Amiel-Tison (2001). "Neurodevelopmental Investigations among Methylmercury-Exposed Children in French Guiana," Environ Research Sec. A 89:1-11. http://www.sciencedirect.com.proxy2.cl.msu.edu/science?_ob=MiamiImageURL&_imagekey=B6WDS-461K48V-1-1&_cdi=6774&_user=1111158&_check=y&_orig=search&_coverDate=05%2F31%2F2002&view=c&wchp=dGLbVlW-zSkWA&md5=a8af63869a40a5d3a97281b541d4ff2e&ie=/sdarticle.pdf

5 G. Drasch, S. B˙ose-O'Reilly, C. Beinhoff , G. Roider and S. Maydl (2000). "The Mt. Diwata study on the Philippines 1999—assessing mercury intoxication of the population by small scale gold mining," The Science of the Total Environment 267: 151-168. http://www.sciencedirect.com.proxy2.cl.msu.edu/science?_ob=MImg&_imagekey=B6V78-42FS27X-D-K&_cdi=5836&_user=1111158&_orig=search&_coverDate=02%2F21%2F2001&_sk=997329998&view=c&wchp=dGLbVtb-zSkzS&md5=46feb8ca90d3b58008e5cbaaf2643398&ie=/sdarticle.pdf

6 Jennifer J. Hinton, Marcello M. Veiga and Christian Beinhoff (2003), Women and Artisanal Mining: Gender Roles and the Road Ahead," in *The Socio-Economic Impacts of Artisanal and Small-Scale Mining in Developing Countries* (eds.) G. Hilson, Pub. A.A. Balkema, Swets Publishers, Netherlands, 2003. http://siteresources.worldbank.org/INTOGMC/Resources/336099-1163605893612/hintonrolereview.pdf

7 Jennifer Hinton and Christian Beinhoff, "Report to the UNEP GC Meeting, Nairobi, February 2005, on Mercury and Artisanal Gold Mining," (Global Mercury Project report to the U.N. Environmental Program Governing Council meeting, Nairobi, Kenya, February 2005), 12.

8 UNEP, 2008,

9 Counter, S.A., Buchanan, L.H., and F. Ortega, 2006. Neurocognitive screening of mercury-exposed children of Andean gold miners. Int J Occup Environ Health 12:209-214.

10 Telmer and Veiga, 2008.

11 Ibid.

12 UNEP, 2008.

13 G. D. Peterson and M. Heemskerk (2001), "Deforestation and forest regeneration following small-scale gold mining in the Amazon: the case of Suriname," Environ Conservation 22:117-126.

14 UNEP Global Mercury Partnership (2008), "Draft Business Plan of the Artisanal and small Scale Gold Mining (ASGM) Partnership Area," Retrieved October 6, 2009, from http://74.125.93.132/search?q=cache:bXX2EnTAANMJ:www.chem.unep.ch/MERCURY/UGMP/INF%25201.doc+%22Business+plan+of+the+Artisanal+and+Small+Scale+Gold+Mining+%28ASGM%29+Partnership+Area%22&cd=1&hl=en&ct=clnk&gl=us

15 Ibid.

16 Marcello M. Veiga , Stephen M. Metcalf, Randy F. Baker, Bern Klein, Gillian Davis, Andrew Bamber, Shefa Siegel and Patience Singo (2006), "Manual for Training Artisanal and Small-Scale Gold Miners," UNIDO, pp. 90-91, 104-105, Retrieved October 7, 2009 from http://142.103.159.167/documents/non_country%20specific/training%20manual%20for%20miners%20Marcello%2015.pdf

17 Samuel J. Spiegel and Marcello M. Veiga, (2007), "Report on the Policy and Governance Initiative: Enhancing Multi-Stakeholder Approaches to Address Mercury, Small-Scale Gold Mining and the Institutional Dynamics of Change," Global Mercury Project, p. 58, Retrieved October 7, 2009 from http://www.globalmercuryproject.org/documents/non_country%20specific/Sam%20Policy%20and%20Governance%20Final.pdf

19 Telmer and Veiga, 2008.

20 F. Pantoja and R. Alvaarez (2000), "Decrease of pollution by mercury in gold mining in Latin America," in: *Mine Closure in Iberoamerica*. (eds.) Villas Boas R.C., Berreto M.L., CYTED/IMAAC/UNIDO: Rio de Janeiro, pp. 178-190.

21 Marcello M. Veiga, Denise Nunes, Bern Klein, Janis A. Shandro, P. Colon Velasquez and Rodolfo N. Sousa (2009), "Mill leaching: a viable substitute for mercury amalgamation in the artisanal gold mining sector?" Journal of Cleaner Production 17: 1373-1381.

22 Veiga et al., "Manual for Training," pp. 90-91, 104-105.

24 Telmer and Veiga, 2008.

25 UNEP, 2008, "Draft Business Plan."

26 Telmer and Veiga, 2008.

27 Jason T. May, Roger L. Hothem, Charles N. Alpers and Matthew A. Law (2000), "Mercury Bioaccumulation in Fish in a Region Affected by Historic Gold Mining: The South Yuba River, Deer Creek, and Bear River Watersheds, California, 1999," U.S. Geological Survey, Open-File Report: 00-367 http://ca.water.usgs.gov/archive/reports/ofr00367/ofr00367.pdf

28 United Nations Environment Program (2009), "Proceedings of the Governing Council/Global Ministerial Environment Forum at its twenty-fifth session," Retrieved October 6, 2009 from http://www.unep.org/GC/GC25/Docs/Proceedings-English.pdf

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About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development. The Division works to promote:

> sustainable consumption and production,
> the efficient use of renewable energy,
> adequate management of chemicals,
> the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

- **The International Environmental Technology Centre** - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
- **Sustainable Consumption and Production** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- **Chemicals** (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- **Energy** (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

UNEP DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.

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Low-cost technologies available now have the potential to reduce dramatically mercury pollution in the small-scale and artisanal mining sector. By supporting miners with knowledge and resources to adopt these new technologies and with the right policies in place at the local, national and global level, we can stem a significant source of global mercury pollution. Swift action by UNEP member states will not only have an immediate impact in reducing the amount of mercury released by ASGM and dramatically benefit health and economic well-being of miners, but will also provide support to a global agreement to control mercury pollution

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