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Global Policy for Local Livelihoods: Phasing Out Mercury in Artisanal and Small-Scale Gold Mining

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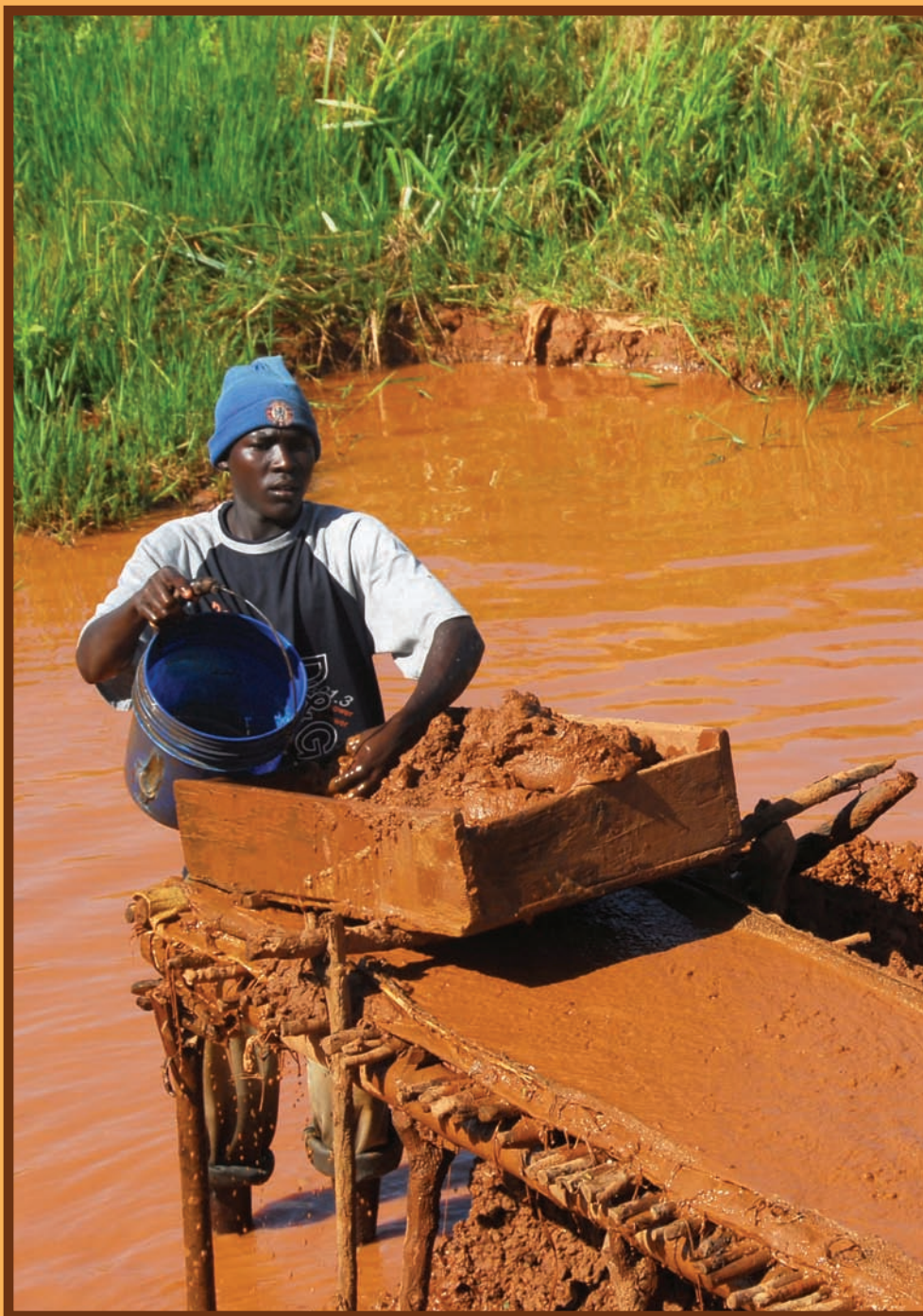
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Global Policy For

Phasing Out Mercury in Artisanal and Small-Scale Gold Mining

Human relationships with gold and mercury are as complex today as they were 5,000 years ago when mineral extraction began.¹ They are neighboring elements in the periodic table, and when mercury (Hg, 80) interacts with gold (Au, 79), it forms an amalgam that liberates gold from the ore. Miners for millennia have capitalized on this interaction to satisfy a constant demand for gold. However, human valuation of mercury has changed significantly over time. Originally it was perceived as a highly beneficial substance; today the international community recognizes its toxicity and is negotiating a global mercury convention to protect human and environmental health that will open for signatures in 2013. While the handful of multinational gold mining corporations dominating the industry have switched from mercury amalgamation to more capital-intensive cyanide methods, up to 30 percent of the world's mined gold is supplied by the artisanal and small-scale gold mining (ASGM) sector that continues to rely on mercury.² ASGM releases up to 1,000 tons of mercury into the environment each year, making it the largest source of emissions from intentional use and the second largest source of anthropogenic emissions globally (see Figure 1 on sources of atmospheric mercury emissions).³

ASGM provides subsistence livelihoods to approximately 15 million people in more than 60 mainly developing countries (see Figure 2 and Table 1 on mercury used in the ASGM sector in different regions of the world). The miners, including 4 million women and 1 million children, in these mainly informal and rudimentary enterprises continue to use mercury in



Local Livelihoods:

by Kristin Sippl and Henrik Selin



amalgamation because it is the easiest and cheapest way to extract gold from ore (see Figure 3 on multistep use and emissions of mercury in the ASGM process).⁴ However, this practice poses significant local and global risks, as the burning of amalgam vaporizes 20 to 30 percent of the mercury into the air surrounding the miner, and the discharge of tailings into waterways enables the remaining 70 to 80 percent of the mercury to bioaccumulate in aquatic food webs.⁵ Further, this practice tends to take place in ecologically sensitive and often transboundary regions (e.g., lakes, riverbeds, and rainforests). Scientific studies demonstrate that mercury is a strong neurotoxin with the ability to adversely affect human and wildlife development and health at both high and low doses. Once released by human activities, it can take more than 2,000 years for mercury to return to sediments.⁶

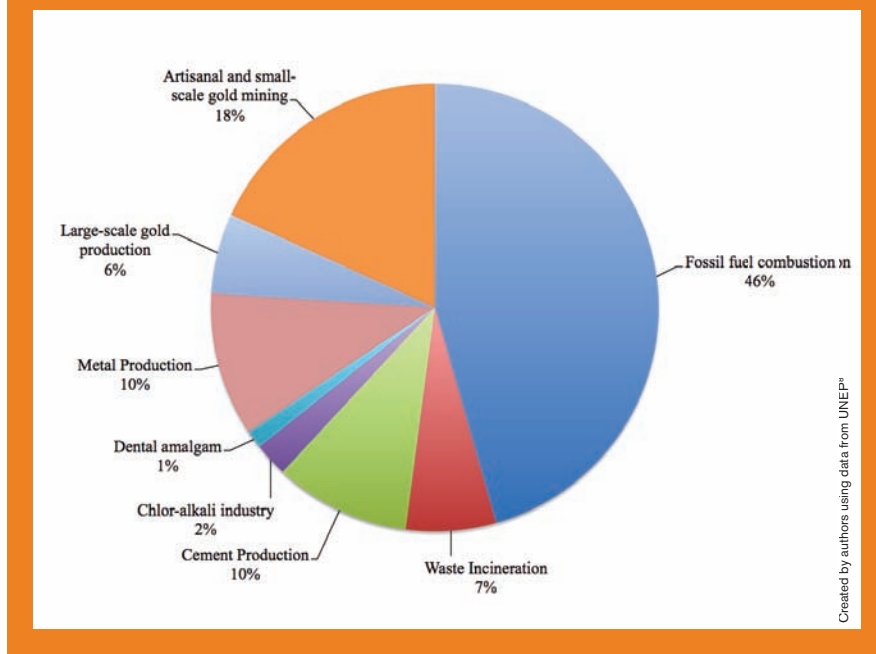
Changing sources and trade restrictions have contributed to a rise in the price of mercury alongside increases in gold prices in recent years (see Figure 4 on trends in mercury and gold prices). Mercury used in ASGM in developing countries was frequently imported from industrialized countries, which obtained their supply by mining cinnabar and recycling wastes.⁷ As a result of mercury mine closings and export bans by the European Union (2011) and the United States (2013), mercury is increasingly coming from other places. Currently, import of mercury for use in ASGM is more often than not banned under domestic law, but acquiring mercury for other uses including dental amalgam mostly remains legal and is increasingly the route of entry

*Shinyanga, Tanzania March 18, 2010:
Tanzania is the third largest gold producer in
Africa after Ghana and South Africa.*

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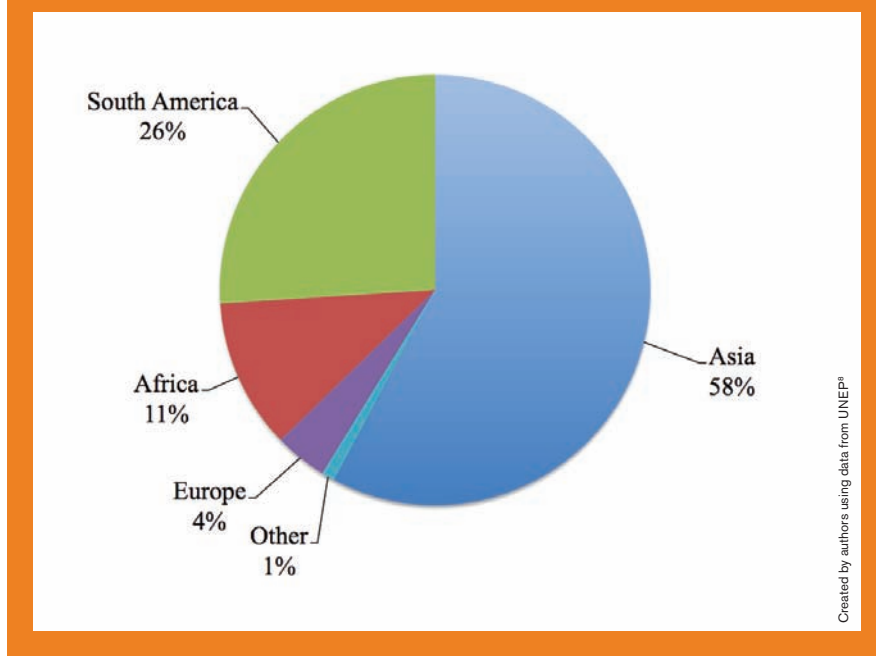
Figure 1: Atmospheric Mercury Emissions by Sector, 2005



for mercury used in mining.⁹ Once the mercury is imported, dealers buy mercury from dentists and sell it to miners, or give it for free on the condition that the miner sells the gold back to them at

an agreed-upon (much below market) price.¹⁰ With the relatively high price of gold, it is easy for middlemen to turn a profit, and mercury emissions continue unabated.¹¹ These black-market

Figure 2: Mercury Consumed by ASGM by Region, 2005



conditions for both mercury and gold trap miners in poverty and harm human health worldwide while the mercury and gold traders benefit financially.

The international community has worked on mercury use in ASGM since the early 1990s.¹² The mercury convention will build on these efforts, including activities initiated under the ongoing Global Mercury Partnership Programme, involving coalitions of governments, intergovernmental organizations (IGOs), and nongovernmental organizations (NGOs). This effort led by the United Nations Environment Programme (UNEP) seeks “to protect human health and the global environment from the release of mercury and its compounds by minimizing and, where feasible, ultimately eliminating global anthropogenic mercury releases to air, water and land.”¹³ The mercury convention will embrace a similar objective. Reducing mercury in ASGM is one of seven priorities for action under the Global Mercury Partnership Programme, and the inclusion of ASGM in the mercury convention enjoys widespread support from potential signatories and a wide range of stakeholder groups. However, even when states voluntarily become parties, many environmental agreements suffer from significant implementation gaps and associated compliance problems due to a lack of human, economic, and technical capacity to take necessary domestic action. Addressing these kinds of capacity problems is crucial to the successful implementation of the mercury convention and fulfillment of its goals.

The fact that many countries with ASGM communities will struggle to comply with convention-based obligations raises important questions about how to go from global policy goals to on-the-ground improvements, and draws attention to the importance of effective capacity building and technology transfer. Therefore, this article explores a basic but significant question: How can international efforts focusing on ASGM ensure that phasing out mercury both protects human health globally and supports livelihoods locally?

Table 1. Top Mercury Consumption by ASGM, by Region and Country,* Mg yr⁻¹

Asia	641.8	South America	258.5
China	444.5	Columbia	75.0
Indonesia	145.0	Brazil	45.0
Mongolia	11.5	Peru	30.0
Cambodia	7.5	Philippines	25.0
Kyrgyzstan	7.5	Ecuador	15.0
Vietnam	7.5	Guyana	15.0
Myanmar	6.5	Venezuela	15.0
Tajikistan	4.0	Bolivia	7.5
Malaysia	3.5	French Guiana	7.5
India	1.5	Mexico	7.5
Thailand	1.5	Suriname	7.5
Laos	1.3	Chile	4.0
		Guatemala	1.5
Africa	69.0	Nicaragua	1.5
Zimbabwe	25.0	Panama	1.5
Kenya	7.5		
South Africa	7.5	Europe	11.0
Burkina Faso	5.0	Russia	11.0
Ghana	4.5		
Mozambique	4.0	Other Regions	6.5
Togo	4.0	Papua New Guinea	3.0
Madagascar	1.5	United States	1.5
Mali	1.5	Australia	1.0
Senegal	1.5	Canada	1.0
DR Congo	1.0		

Table created by authors, data from M.M. Veiga and K.H. Velmer¹⁴

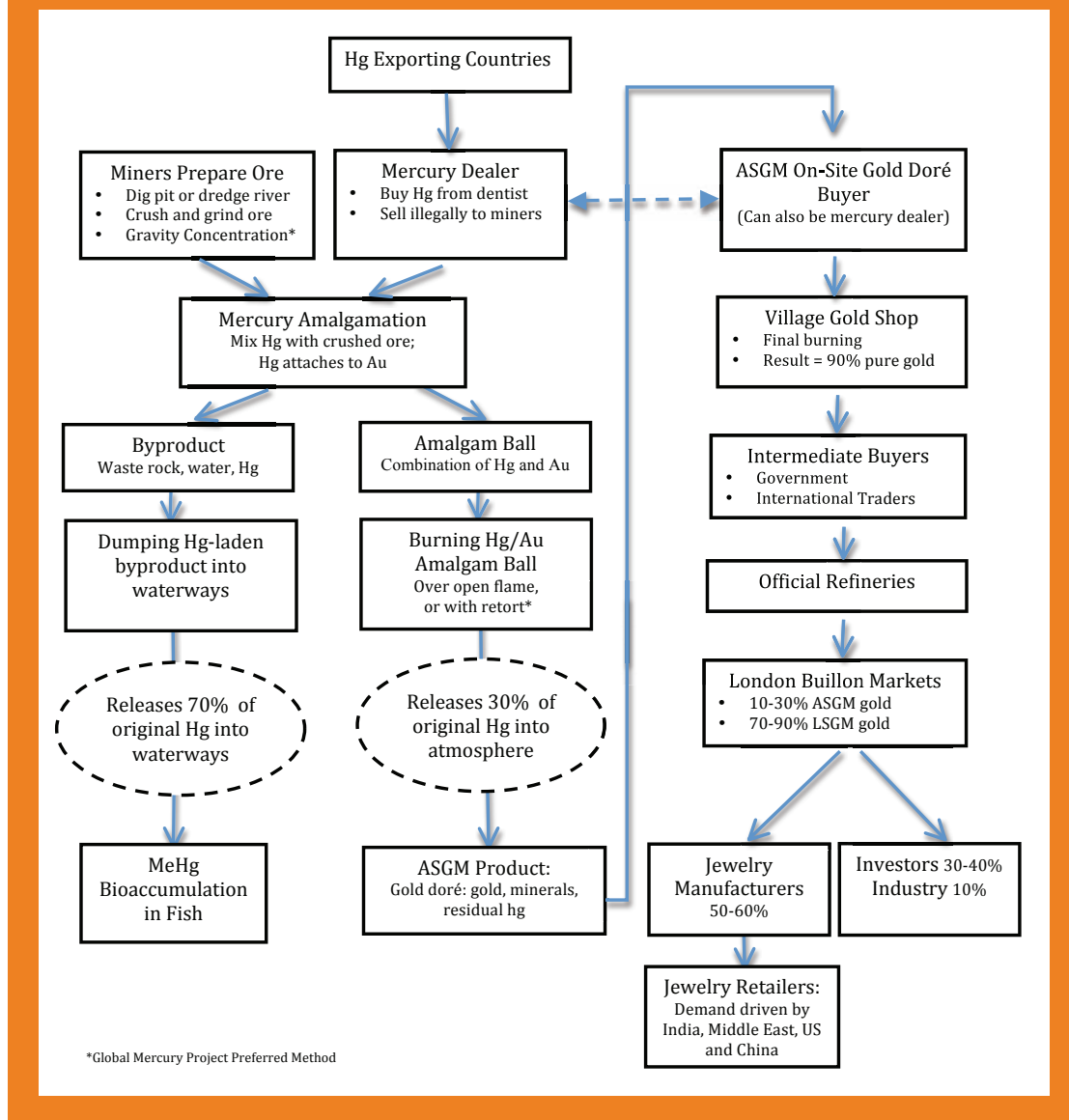
*Listed only countries above 1.0 Mg yr⁻¹. There are a dozen or so countries below 1.0 Mg yr⁻¹.

The article draws on insights from past efforts to analyze present and future capacity building and technology transfer needs. The next section examines important aspects of capacity building and technology transfer programs, followed by a discussion about lessons from past actions with respect to different mercury abatement measures to better protect human health and the environment. This includes combinations of actions to reduce mercury use and emissions from ASGM in the immediate term, and more long-term activities to move beyond mercury. The final section explores broader linkages between global policy and local livelihoods and their implications for continuing sustainability efforts.

Capacity Building and Technology Transfer

In support of global policy goals, capacity building is a complex activity enabling individuals and communities to strengthen and maintain their ability to set and achieve their own development aspirations.¹⁵ Sometimes occurring as a distinct aspect of capacity building, technology transfer involves the physical movement of technology as well as the communication of technical and scientific knowledge from one place or organization to another.¹⁶ In the 1970s and 1980s, many international capacity-building and technology-transfer activities in the environment field and beyond were characterized by experts from northern industrialized countries spending short periods of time in southern developing country communities to conduct training and introduce new ideas and systems, then going back home again with few continuing connections or commitments. Not surprisingly, many of these efforts failed to have any real impact. In response, it is now widely recognized that capacity building and technology transfer require a comprehensive and long-term approach where programs and activities take into account local situations and conditions—there is not a simple one-

Figure 3: The ASGM Process and Gold Supply Chain



size-fits-all approach to capacity building and technology transfer.¹⁸

On mercury abatement, IGOs such as UNEP, the United Nations Development Programme (UNDP), the United Nations Industrial Development Organization (UNIDO), and the United Nations Institute for Training and Research (UNITAR) serve important coordinating functions and have also been involved in the design and local implementation of capacity-building and technology-trans-

fer programs. National governments in industrialized countries are important funding partners and their national foreign aid and environment agencies may also work on specific projects. National governments in developing countries are responsible for legal, political, and administrative issues relating to domestic mining practices, chemicals regulation, and workforce protection. NGOs such as the Alliance for Responsible Mining, the Artisanal Gold

Council, and the Blacksmith Institute raise awareness among northern and southern stakeholder groups, lobby for artisanal miners at international conferences, connect firms involved in mining technology development to technology transfer programs, and support IGO and national-level sustainable development programs more broadly.

The Global Mercury Project launched in 2002 implemented several capacity building and technology trans-

Figure 4: Price of Gold and Mercury, 2000–2011

Created by authors, data from US Geological Survey⁹

fer pilot programs in Brazil, Lao PDR, Indonesia, Sudan, Tanzania, and Zimbabwe.²⁰ These project programs were funded by the Global Environment Facility (GEF) and implemented under the auspices of UNDP and UNIDO. A review of the program results shows that success rates were mixed. While some progress was made in advancing awareness and abatement options toward less mercury use and discharges, there were also important obstacles to progress, including insufficient domestic government support. Moving forward under the mercury convention, the Global Mercury Partnership Programme, and any other collaborative venues, it is important to recognize that different capacity-building and technology-transfer needs are connected. However, the local contexts in which these activities are carried out can differ significantly.

Insights from over two decades of international collaborations on ASGM demonstrate that a coordinated and flexible approach should consist of a mixture of efforts that aim both to reduce mercury use and emissions, and to move beyond mercury.

Reducing Mercury Use and Emissions Today

Opportunities exist for immediately reducing mercury use and emissions. UNIDO estimates that it is possible to reduce mercury use in ASGM by at least 50 percent from 2007 levels by 2017.²¹ The capacity-building and technology-transfer measures to achieve this need to support education about mercury's harm, promote dissemination of alterna-

tive technologies, and assist in clarifying national legal conditions.

Education About Mercury's Harm

It is obvious: For people to take basic protective measures, they must first recognize that something is hazardous or otherwise problematic. ASGM mercury abatement is often challenging because a majority of miners are unaware that mercury harms their health or have misconceptions about its risks.²² In communities all over the world, miners have been using mercury-based methods for generations, reinforcing the perception of usefulness and safety. Global Mercury Project interviews revealed that some communities believed that only strong smelling substances caused harm and that odorless mercury vapors were not only safe but beneficial.²³ In Suri-



Artisanal gold mined in Guinea.

name, miners expressed concerns about several occupational health hazards, but concerns about mercury exposure were not among them.²⁴ It can also be very difficult to distinguish mercury-related effects in environments where malaria, sexually transmitted diseases, contaminated drinking water, and malnutrition all can cause symptoms similar to those of low-level mercury intoxication. Consequently, there is still a great need for basic education on the hazards of mercury in local ASGM communities.

Education efforts can build on insights from recent mercury and public health efforts. It is clear that education programs must take into consideration local cultural, social, and economic conditions so that mercury-related information melds with traditional routes

of information transmissions. Also, sensitivity to community literacy rates, values, and income levels are important.²⁵ To connect with often illiterate populations, at least five communication routes that can be used in combinations with each other may be helpful: billboards and signs in cities, in medical clinics, and at roadsides; radio and television commercials during popular shows; comic books; community workshops; and household visits and surveys.²⁶ Communication can be made more effective by tailoring content to values that resonate with different populations. In Ghana, for example, miners were particularly sensitive to messages emphasizing mercury's impact on children.²⁷ In Brazil, brochures linking mercury to impotence were "extremely

effective" in increasing interest of male miners in retorts.²⁸ Also, it can be important to present a positive image of community members who act responsibly, especially if these are community leaders.²⁹

Dissemination of Alternative Technologies

Increasing knowledge of risks will do little to improve human health and welfare unless these awareness-raising efforts are coupled with education about appropriate and available tools for changing existing mining patterns. That is, awareness-raising programs should link mercury education with information on how to obtain and use retorts, the key existing piece of technology for

decreasing mercury demand and emissions. Retorts are small, round, oven-like enclosures in which the mercury amalgam can be burned. By creating a closed system, retorts not only capture 95 percent of mercury vapor and allow mercury recycling, but also enable more gold extraction by reducing spattering. However, many early efforts promoting retorts were problematic; they introduced retorts that were opaque when miners wanted them transparent; tarnished the gold so that it fetched lower prices; were too cumbersome and fragile for use in the field; and were too expensive to acquire (\$200 to \$500).³⁰

Today, there are better and cheaper retorts made from stainless steel, glass, plumbing pipes, kitchen bowls, and sardine cans. These range in price from about \$5 to \$50 (although total investment costs may go up if gas burners or other accessories are needed). Many miners remain unaware of the existence of these relatively cheap and workable retorts. And even once there is a demand for appropriate and affordable retorts, protection depends on miners adopting and using them correctly. In Tanzania, two community leaders suffered numerous setbacks in getting the retort to function properly, which discouraged others from adoption and launched rumors about retorts' futility. Miners in several locations also took retort lids off too early, letting the majority of mercury escape, highlighting the need for careful training on the proper use of new technology.³¹ Firms, universities, NGOs, and government aid agencies have manufactured and distributed retorts in the past and could do so again in the future, but new job opportunities for former miners and mercury dealers may be created if retort manufacturing and training are locally based.³²

Clarifying National Legal Conditions

The mercury convention will introduce obligations and commitments on parties, including measures to address mercury use and emissions from the ASGM sector. The ability to effectively make the mercury convention part of

national law and ensure maximum compliance is dependent on having well-developed domestic laws for hazardous substances management more broadly. Activities by UNEP and UNITAR as well as by donor countries initiating programs and workshops to strengthen developing countries' national legal and administrative abilities to meet treaty

Efforts to move beyond mercury may involve both phasing out mercury in mining and shifting to nonmining activities.

obligations are often a critical aspect of capacity building.³³ Such a strengthening of domestic law and administrative capabilities aids both treaty implementation and national management with the purpose of better protecting human health and the environment. In addition, improving administrative abilities is not just of relevance to national policymakers and regulators, but also involves training and empowering local-level officials. Furthermore, one possible positive aspect of the mercury convention may be that it induces countries, as part of their domestic implementation, to legally recognize the ASGM sector.³⁴

Laws in many mineral-rich countries currently deter ASGM because of miners' tendency to encroach upon the concessions of large multinational firms.³⁵ To attract firms paying concessions fees and comprising a significant percentage of a country's gross domestic product, governments often outlaw ASGM, or make the process of obtaining an ASGM permit so cumbersome that miners are deterred from seeking one.³⁶ In other cases, it is the ASGM miners who choose to mine illegally, since laws are seldom enforced and they prefer not to pay taxes and fees. This competition over ever-dwindling gold deposits can induce violent conflict between large-scale firms and small-scale miners, but cooperation can occur too when firms incorporate ASGM into their corporate

social responsibility programs, rent miners parts of their concessions, or grant them access to abandoned lots.³⁷ Convention-affiliated laws could mandate such cooperation, facilitate permit acquisition, guarantee low tax rates for ASGM, or otherwise resolve perceived conflicts of interest. As long as ASGM miners lack legal protection, they are

exposed to mistreatment and exploitation that prolong human suffering and perpetuate the pollution-poverty cycle.

Moving Beyond Mercury

Ultimately, implementation of the mercury convention and improved protection of the environment and human health will only occur if more short-term focused efforts are complemented by careful assessments of how communities and regions can transition to mercury-free economies. Efforts to move beyond mercury may involve both phasing out mercury in mining and shifting to nonmining activities.

Phasing Out Mercury in Mining

The elimination of mercury use should be the goal of any abatement activity, including those taking place under the mercury convention. Of course, domestic policy change will be easier if local level demand for mercury ceases. Even if the activities discussed earlier lead to practices that are better from an environmental health perspective than current ones, there will still be a smaller but nevertheless worrying mercury problem. For example, although retort use addresses the problem of vapor and reduces demand thanks to recycling, there can still be significant discharges



A 320 kg transparent Plexiglass cube with drops of mercury inside hanging in the Idrija Municipal Museum located in Gewerkenegg Castle in Idrija, Slovenia. The Idrija mine was once the second oldest and largest mercury mine in the world before it closed in 1995.

into waterways. Such pollution can damage ecosystems and also lead to high mercury levels in fish consumed by humans. Thus, there is a need to explore ways to transition away from mercury use altogether while at the same time enhancing local conditions and supporting community development. It should be recognized, however, that a phase-

out of mercury will be more difficult in some regions and countries than others due to combinations of geological and socioeconomic factors.³⁸

For example, transitioning to mercury-free mining is easier in cases where gold deposits are alluvial (particles from riverbeds) as opposed to veins underground, as alluvial ores are

most amenable to low-cost, mercury-free methods such as traditional gravity concentration and panning.³⁹ Mercury-free mining technology and methodology for other ore types do exist, but are more expensive (\$50 to \$175 per piece of equipment).⁴⁰ Cyanide leaching is the mercury-free method used by large-scale mining firms, but this is far out of



reach for most ASGM operations due to high infrastructure costs. It also still carries different but significant pollution problems.⁴¹ As the price of mercury rises, ASGM miners are increasingly using adapted cyanidation methods. This poses problems because the combination of cyanide and mercury in water systems enhances mercury's ability

to transform into methylmercury. Thus, unless all members of an ASGM community adopt mercury-free methods at once, swapping one hazardous substance for another might make the situation worse and create additional risks.

Shifting to Nonmining Activities

Contamination is only one of several problems associated with ASGM (others include water siltation, deforestation, and child labor). Therefore, opportunities to shift to other forms of sustainable livelihoods should be sought where conditions are not conducive for mercury-free mining and for all locations as a solution to the longer term problems of nonrenewable resource extraction. One possible option is turning open pits left by large-scale mining into fish farms. While fish farming can pose environment and human health problems of its own (e.g., fish virus transmissions, chemical additive issues, and overloading local waterways with nutrients), the type that could be created by reclaiming old mines would solve many of these problems because they would be self-contained. NGOs, private investors, or mining firms as part of their corporate social responsibility obligations could train miners in the creation and maintenance of fish farms, and could assist in linking output to local and international markets. Many local communities are in need of clean protein sources and at least some international markets are responding to consumer demand for sustainably sourced fish.⁴²

Of course, aquaculture is a viable alternative only in some instances. Other options may include nontimber tree products (e.g., fruit, seed and leaf products), batik textiles, and organic and fair-trade certified agriculture products (e.g., coffee). However, as in the case with gold, reliance on agricultural commodities can still leave communities vulnerable to large international price fluctuations. Also, as Marcello Veiga, a technical advisor with the Global Mercury Project, has put it: "Mining *is* the alternative livelihood."⁴³ Miners can earn three to five times the income of

other sectors, and often already engage in farming or small enterprises on the side to supplement income streams. Finding options with high enough earnings to entice miners who in many cases live in economically weak regions to switch can be difficult. Furthermore, where there are alternative jobs, miners are often rejected due to their "unlawful" activities in the informal ASGM sector. This, again, highlights the importance of national legal reforms as part of a comprehensive political effort to address mercury use in ASGM.

Global Policy and Local Livelihoods

Ideally, the mercury convention will simultaneously help transform a significant portion of the international gold supply chain and improve the quality of life of millions of people worldwide. Convention-associated policy and management changes could facilitate the transition of some ASGM miners to legal, mercury-free operations, and of others to alternative livelihoods. In reality, however, global environmental agreements stipulate broad policy goals, but are much weaker on instruments ensuring national compliance and local welfare. These responsibilities still fall on the state. Unfortunately, it is well documented that many national governments come up short in this regard, even when they have the best of intentions. Acknowledging these realities, the previous discussion explored how efforts focusing on ASGM can ensure that phasing out mercury both protects human health globally and supports livelihoods locally. Creating sustainable livelihoods is a complex and difficult process that requires active and continuous involvement of a wide set of state and nonstate actors, ranging from the global to the local.

Both the implementation of the mercury convention and local sustainability transitions can be aided by capacity building and technology transfer. One institutional tool to improve such activities across multiple scales

of governance could be engaging the Regional Centers operating under the Basel Convention on hazardous wastes and the Stockholm Convention on persistent organic pollutants. Their potential to support program coordination and coherence across states as well as on-the-ground activities by IGOs and NGOs is discussed during the mercury convention negotiations.⁴⁴ International organizations can also fulfill important functions of monitoring and reporting national compliance, as global conven-

programs could assist, too, although there is still a lack of data on how effective these are in the mining case. Microfinance relies on collective action and steady loan repayment, but miners can be hesitant to form cooperatives and their income can be sporadic.⁴⁹

Using a market-based mechanism such as commodity certification could offset part of the costs of ASGM transitions that address interwoven issues of livable wages, child labor, worksite safety, community health, and ecologi-

ers of the origins and consequences of their purchases. Because much of the mercury released in gold mining accumulates in fish, the jewelry choices of people all over the world are de facto connected to their exposure to mercury through the tuna and other fish served on their dinner plates. The success of the mercury convention depends on the effectiveness of local-level actions targeting mercury use in ASGM. These, in turn, must be taken in the context of the broader need to generate safe livelihoods as part of societal transitions to more sustainable local and global communities. It is only through a holistic approach supported by a wide range of public and private sector actors that the economic, social, and environmental outcomes sought in the mercury case and beyond can be achieved.

Defining “ethical” consumption and production can be very controversial.

tions and policy goals need constant attention if they are likely to be fulfilled. NGO-run “name and shame” campaigns have proved helpful in the past in pressuring firms and countries to comply with international standards.⁴⁵ In other words, convention implementation issues are closely tied to efforts seeking to improve human well-being both locally and globally.

Of course, capacity building and technology transfer depend on financial and human resources. The Blacksmith Institute estimates a cost of \$30,000 to \$90,000 per ASGM intervention, depending on mining community size.⁴⁶ The Global Mercury Project found that Tanzanian miners were willing to pay between \$4 and \$24 for an effective retort, making current iron pipe and kitchen bowl retorts within economic reach.⁴⁷ Based on an estimated 15 million mercury-using ASGM miners and an average cost of \$20 per retort, it would require \$300 million to produce one basic retort for each miner in the world. This is a very small sum compared to current funding discussion under, for example, the climate change regime. Field data from the public health sector show that technology adoption in low-income communities is most successful when technologies are disseminated at no or very low cost.⁴⁸ Public-private partnerships and microfinancing

cal protection. In 2009, the Alliance for Responsible Mining partnered with the Fairtrade Labeling Organization to create the new “Fairtrade and Fairmined Gold” label. This effort is partly based on the success of Oro Verde, a Colombian organization created in 1999 through an alliance of local community groups and the Environmental Research Institute of the Pacific. Oro Verde certifies ASGM miners who follow environmentally sound ancestral extraction techniques, and sells their specially labeled gold directly to jewelry retailers using channels fostered by the alliance. The miners get a 2 percent premium on the international price of gold, and the Oro Verde organization receives a 15 percent premium, which is reinvested in community development. In 2009, Oro Verde won the UN SEED award for promoting sustainable development, and 1,300 individuals now earn relatively clean and safe livelihoods through the program.

In contrast to the more demanding Oro Verde label, the Fairtrade and Fairmined Gold certification allows for the “responsible” use of mercury and cyanide. Defining “ethical” consumption and production can be very controversial, as can the design of governance mechanisms to support “fair” trade.⁵⁰ Nevertheless, such movements can raise awareness among consum-

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22. S. J. Spiegel and M. M. Veiga, "International Guidelines on Mercury Management in Small-Scale Gold Mining," *Journal of Cleaner Production* 18 (2010), 375–385; M. M. Veiga and K. H. Telmer, "World Emissions from Artisanal and Small Scale Gold Mining," in N. Pirrone and R. Mason, eds., *Mercury Fate and Transport in the Global Atmosphere* (New York: Springer Science+Business Media, 2009), pp. 131–172; G. Hilson, C. J. Hilson, and S. Pardie, "Improving Awareness of Mercury Pollution in Small-Scale Gold Mining Communities: Challenges and Ways Forward in Rural Ghana," *Environmental Research* 103, no. 2 (2007): 275–287. For development economics literature on misunderstandings

of health issues, see A. Banerjee and E. Duflo, *Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty* (New York: Public Affairs, 2011).

23. Spiegel and Veiga (2010), note 22 above.

24. M. Heemskerck, "Livelihood Decision Making and Environmental Degradation: Small-Scale Gold Mining in the Suriname Amazon," *Society and Natural Resources* 15 (2002): 327–344. Heemskerck challenges arguments that miners are not aware of or underestimate health risks, citing their complaints of physical injury from hard labor, malaria, and the psychological difficulty of working far from home. However, answers to her open-ended interview questions reported in her paper did not reveal particular concern among miners about mercury exposure.

25. Banerjee and Duflo (2011), note 22 above; Veiga and Chouinard (2008), note 3 above; Spiegel and Veiga (2010), note 22 above. See also G. Hilson, "Abatement of Mercury Pollution in the Small-Scale Gold Mining Industry: Restructuring the Policy and Research Agendas," *Science of the Total Environment* 362 (2006): 1–14;

26. Ibid. See Hilson et al. (2007), note 18 above, for discussion of radio's potential. For development economic findings, see Banerjee and Duflo (2011), note 18 above.

27. G. Hilson and S. Pardie, "Mercury: An Agent of Poverty in West Africa's Small-Scale Gold-Mining Industry," in G. Hilson, ed., *Small Scale Mining, Rural Subsistence and Poverty in West Africa* (Warwickshire: Practical Action Publishing, 2006), pp. 55–67.

28. J. Hinton, M. M. Veiga, and A. Veiga, "Clean Artisanal Gold Mining: A Utopian Approach?," *Journal of Cleaner Production* 11 (2003): 99–115.

29. Ibid.

30. Ibid. See also Spiegel (2009), note 10 above.

31. J. Jönsson, P. Appel, and R. T. Chibunda, "A Matter of Approach: The Retort's Potential to Reduce Mercury Consumption Within Small-Scale Gold Mining Settlements in Tanzania," *Journal of Cleaner Production* 17 (2009): 77–86; Spiegel and Veiga (2010), note 18 above.

32. Ibid. Actors previously involved in retort design, dissemination, instruction: University of Sao Paulo (iron retort), German Agency for Technical Cooperation (now GIZ), Thermex (German Firm), MIT's Intermediate Technology Development Group (ITDG) (now Practical Action). See also M. M. Veiga, "Retorts: Many Options and Barriers," UNIDO (2005), and http://www.globalmercuryproject.org/documents/non_country%20specific/Retorts.pdf.

33. N. E. Selin and H. Selin, "Global Politics of Mercury Pollution: The Need for Multi-Scale Governance," *Review of European Community & International Environmental Law* 15, no. 3 (2006): 258–269; H. Selin, "Global Environmental Governance and Regional Centers," *Global Environmental Politics*, 12, no. 3 (2012, forthcoming).

34. Earth Negotiations Bulletin, Summary of the Third Meeting of the Intergovernmental Negotiating Committee to Prepare a Global Legally Binding Instrument on Mercury: 31 October–4 November 2011, International Institute for Sustainable Development, November 7, 2011. <http://www.iisd.ca/vol28/enb2808e.html>.

35. G. Hilson, "'Fair Trade Gold': Antecedents, Prospects and Challenges," *Geoforum* 39 (2008): 386–400; J. Childs, "Reforming Small-Scale Mining in Sub-Saharan Africa: Political and Ideological Challenges to Fair Trade Gold Initiative," *Resources Policy* 33 (2008): 203–209.

36. Ibid.

37. T. Hentschel, F. Nruschka, and F. Priestler, "Global Report on Artisanal and Small-Scale Mining," Working Paper 70, Mining, Minerals and Sustainable Development (MMSD) Project, International Institute for Environment and Development (IIED) (London: 2002); R. K. Amankwah and C. Anim-Sackey, "Fostering Cooperation Between Small- And Large-Scale Gold Miners in West Africa," in G. Hilson, ed., *Small Scale Mining, Rural Subsistence and Poverty in West Africa* (Warwickshire: Practical Action Publishing, 2006), pp. 67–75.

38. Spiegel (2009), note 10 above; Jönsson et al. (2009), note 31 above.

39. Hinton et al. (2003), note 28 above; Spiegel and Veiga (2010), note 22 above; Jönsson et al. (2009), note 31 above.

40. The firm Cleangold, for example, produces an array of sluices for specific ore types that cost between \$50 and \$175. Cleangold, Products. <http://www.cleangold.com/cleangold/products.html>.

41. Hinton et al. (2003), note 28 above; Jönsson et al. (2009), note 31 above.

42. F. Otchere, M. M. Veiga, J. Hinton, R. Farias, and R. Hamaguchi, "Transforming Open Mining Pits Into Fish Farms: Moving Towards Sustainability," *Natural Resources Forum* 28 (2004): 216–223; Wholefoods, Values and Actions, <http://www.wholefoodsmarket.com/values/seafood.php> (accessed February 13, 2011).

43. S. Siegal and M. M. Veiga, "The Myth of Alternative Livelihoods: Artisanal Mining, Gold, and Poverty," *International Journal of Environment and Pollution* 41, no. 3/4 (2010): 272–288.

44. See H. Selin (2012), note 33 above; N. E. Selin and H. Selin (2006), note 33 above.

45. A. Sagar, "Capacity Development for the Environment: A View for the South, A View for the North," *Annual Review of Energy and the Environment* 25 (2000): 377–439. Examples of NGO "name-and-shame" campaigns: Extractive Industry Transparency Initiative (EITI), Toxic Release Inventory, PROPER in Indonesia, No Dirty Gold. For NGO action on child labor, see Human Rights Watch, "A Poisonous Mix: Child Labor, Mercury, and Artisanal Gold Mining in Mali" (New York City, New York: Human Rights Watch, 2011).

46. UNEP, "Global Forum on Artisanal and Small-scale Gold Mining, 7–9 December, 2010, Manila," International Negotiating Committee 1, January 20, 2011, <http://www.unep.org/hazardoussubstances/GlobalForumonASGM/tabid/6005/Default.aspx>; Blacksmith Institute, "Global Scope of Mercury Pollution" (2010), <http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/INC2/Blacksmith%20Institute%20Mercury%20Summary.pdf>.

47. Jönsson et al. (2009), note 31 above

48. Banerjee and Duflo (2011), note 22 above.

49. Banerjee and Duflo (2011), note 22 above; Spiegel (2009), note 10 above; Childs (2008), note 36 above.

50. UN SEED awards promote the development of sustainable small-scale livelihoods. See <http://www.seedinit.org>. Common challenges to market-based methods of improving global supply chains include the breadth and depth of consumer demand, fluctuating commodity prices, and the fate of small-scale producers unable to comply with labeling standards. In the case of ASGM, legalization, collectivization, transience, geological conditions, and basic capacity levels present significant obstacles to certification. For more information on Fairtrade gold, see: Fairtrade Gold, <http://www.fairtrade.org.uk/gold/>; Oro Verde, http://www.greengold-oroverde.org/loved_gold/; Alliance for Responsible Mining, <http://www.communitymining.org>.