Global Mercury Project

Project EG/GLO/01/G34:
Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies

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Lao People's Democratic Republic (PDR)
Final Summary Report

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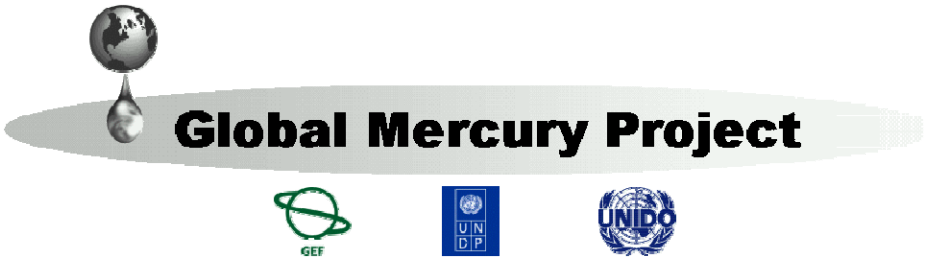

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Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies

Lao PDR Summary Report

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Introduction and Overview

Background

Artisanal and small-scale gold mining (ASM) is a poverty-driven activity that provides an important source of livelihood for perhaps 10 – 15 million people, but is also one of the major global sources of mercury contamination. It is estimated that artisanal gold miners produce up to 800 tonnes of gold annually, but releasing as much as 800-1000 tonnes of mercury to the environment in the process. These activities are frequently accompanied by extensive environmental degradation and deplorable socio-economic conditions.

The use of mercury to recover gold, a process known as amalgamation, is a common and simple gold extraction process that has been used for centuries. However, it is only relatively recently that the hazards of mercury have been understood and how ASM activities can contaminate air, soil, rivers, lakes and their fish communities with mercury, both locally, and ultimately, on a global scale. The health of the miners and other people living within the area is adversely affected primarily through inhalation of mercury vapour, and the consumption of mercury contaminated fish. Environmental and health impacts of amalgamation by the artisanal gold miners and their effects on international water bodies are similar in nature in most developing countries and solutions to these problems require concerted and coordinated global responses. The Global Mercury Project (GMP) was initiated to begin this global response to address environmental impacts resulting from mercury released by the artisanal mining sector. This report addresses the GMP's efforts to introduce technology, educate miners and reduce mercury use and loss to the environment in Lao People's Democratic Republic (Lao PDR).

2003 Environmental and Health Assessment in Laos

Very little information about ASM and mercury exists for Lao PDR, where the Mekong River forms the westernmost border of most of the country (Figure 1). This large river, bordering several other countries including Cambodia, Vietnam, Thailand and Myanmar is a significant trans-boundary river that discharges to the Gulf of Thailand and international waters. Loss of mercury to this waterway and its downstream transport potentially endangers people and fish-eating wildlife over a wide geographic area. Thus, in 2003 an Environmental and Health Assessment (EH&A) was conducted in the Champat and Pak Ou districts on the Mekong and Nam Ou rivers with the aim of identifying mining and environmental hotspots in project demonstration sites, assessing the extent of environmental pollution in surrounding water bodies and the level of human exposure. This was accomplished from biological samples including medical exams, blood, urine and hair testing of mining and non-mining communities.

Chomphet and Pak Ou Districts are located north of Luang Prabang where there are about 500 part-time small-scale gold miners that live in eight villages composing the study area. Rice farming is the primary occupation in the region and mining only takes place during the dry season between January and June, when access to deposits in the river is possible. This is common for all alluvial mining activities in Laos, regardless of geography because of the wet versus dry season dynamics of river hydrology. Mining only occurs during the dry season when water levels are low. Mining is typically very rudimentary with entire families including children, excavating alluvial material by hand with bowls, buckets and chisels. On the Nam Ou, gold

flakes are coarse and are separated from other heavy sand particles by drying and mouth blowing. No mercury was used here. On the Mekong River, fine gold particles are amalgamated in the river using large wooden pans with small amounts of mercury. Roasting is performed by women along the riverbank over an open fire or in their kitchens. Overall gold production is relatively low and is estimated at only 3 kg/year in total from this area. The amount of mercury used is also relatively low, at approximately 2-2.5 kg/year, or less than 50 g per household per mining season.

Given the low amount of mercury use/loss and the large size of the Mekong River, no environmental contamination in water, sediment or fish was identified and levels were considered background. None of the miners or their family members was considered to have been adversely affected by mercury because exposure was so low. It is partly for this reason that further effort was not expended in this area and instead, devoted elsewhere where mercury use was much greater.

Revised GMP Focus in Lao PDR

Given the recent increase in ASM in different regions of Lao PDR, UNIDO's focus shifted from the EH&A location to address other areas where mercury use was much greater and to gather information on ASM activities and mercury use. The specific objectives of the program in Lao PDR were as follows:

- Increase awareness of the GMP objectives to local government agencies, and where possible, local communities involved in small-scale gold mining using mercury;
- Introduce appropriate ASM equipment to the Department of Geology and Mines to increase capacity;
- Introduce new legislation specific to artisanal and small-scale mining (ASM) activities;
- Understand the extent and magnitude of small scale and intermediate gold mining activities in Lao PDR and the Mekong basin.
- Involve other stakeholder groups (e.g., federal, regional and local government, UN agencies, NGOs, etc.) to assist in implementation of GMP goals.
- Recommend policies that will insure that human, animal and aquatic ecosystems are protected from mercury contamination and other mining waste.

An important component of the revised focus was to undertake a country-wide investigation to determine the spatial extent and magnitude of ASM activities in Lao PDR and implications on the Mekong River basin. Partnerships and coalitions were developed with international, national, regional and local stakeholders to optimize acquisition, understanding and reliability of information related to this task. Liaison and consultation with the following national and international organizations was accomplished: World Wildlife Fund (WWF), International Union for the Conservation of Nature (IUCN), Mekong River Commission (MRC), Care International (CARE), Australian embassy, Wildlife Conservation Society, World Bank (WB), and the Japan International Cooperation Agency (JICA). A summary of participants in each of the many workshops held around the country during 2006/2007 are presented in Appendix 1.

Implementation of GMP Objectives

Results of field visits and assessments concluded that Luang Prabang, the site of the original EH&A was not appropriate for implementation of technology introduction and a health awareness campaign. Mining activities here were seasonal, itinerant, inconsistently practiced,

and had low to nil mercury use. Furthermore, the recent increase in tourism in the Luang Prabang area had encouraged many people to abandon mining in favor of providing garden produce and fish for sale to restaurants.

Artisanal or subsistence level gold mining in Lao PDR is not considered illegal. No license is required and the government levies no tax or fee. However, the recent increase in mining activity and the possible introduction of more sophisticated technologies have suggested that some mining ventures could no longer be considered artisanal. Thus the central government has considered mechanisms to apply a tax. An 'official' moratorium on all non-licenced mining activities was enacted by the Department of Geology and Mines in July 2005 while decisions were being made. Nevertheless, traditional, mostly alluvial mining at the family and community level continued and more sophisticated mining operations were recently introduced and have expanded in isolated areas, presumably with funding and technology from entrepreneurs from other countries such as Vietnam and Thailand.

Since 2005, UNIDO had been informed by the DGM that there are other areas in Laos where mining had recently increased, both alluvial and primary ore (i.e., hard rock) and where mercury is being used. Subsequent field investigations, with Earth Systems Lao (ESL), the local contractor, focused on identifying locations, with the participation of DGM, where technology introduction and health awareness campaigns would be more appropriate, result in greater benefit to local communities and reduce environmental mercury contamination.

Extent of ASM in Lao PDR

One of the primary objectives of the GMP in Lao PDR was to determine the spatial extent and magnitude of ASM or small-scale mining activities in the country. There is very little information available on the extent of mining and particularly, the use of mercury in gold mining. Mercury is readily available in Lao PDR, where in town centers it can be purchased directly from gold shops for about US $60 per kg. Regional sources of mercury include China and Kyrgyzstan. It is likely that the transport of mercury from these mines to ASM areas in Lao PDR involves numerous 'middle-men' and an informal trading network. Mercury was reported to enter Laos via Vietnam and Thailand.

Earth Systems undertook a country-wide investigation, with the assistance of other non-governmental organizations (NGOs), such as World Wildlife Fund, Mekong River Commission and others, to inventory small-scale gold mining and mercury use. A complete summary of their findings are presented in Appendix 2 of this document.

Non-Mechanized Mining – Non-mechanized ASM activities were reported by provincial government officials in eleven (11) of the seventeen (17) provinces in Lao PDR involving upwards of 8,000 people, although data were not available for all provinces. The areas reported to have the highest intensity of artisanal mining included:

1. Bolikhamxay Province, in the Lak Sao area (near Nakadok Village) (Figure 2);
2. Attapeu Province along the Sekong River (Sanamxai District) (Figure 3).

Bokeo and Luang Prabang provinces also reported significant numbers of people involved in artisanal mining. For reasons outlined earlier, mining is not the primary source of income in the villages, but is supplementary. This estimate of artisanal miners is under estimated because of limited capacity for field monitoring of mining activities by government authorities, absence of licensing procedures, and the itinerant and subsistence nature of mining. A recently published

World Bank study has independently estimated that there are between 7,000 and 15,000 people involved in artisanal gold mining in Lao PDR (Mindeco, 2006).

Mechanized Mining – ASM activities involving some form of mechanization, including pumps, ball mills, and dredges was reported by provincial government officials in nine (9) of the seventeen (17) provinces in Lao PDR and was estimated to employ upwards of 1,000 people. The highest intensity of small-scale mining activity was reported in:

1. Attapeu Province along the Sekong River ;
2. Bolikhamxay Province, in the Lak Sao area near Vietnam; and
3. Xiengkhouang Province.

Similar to non-mechanized operations, the number of miners is underestimated because of limited field monitoring of mining activities by government authorities and unclear licensing procedures for small-scale miners and hence limited data.

All small-scale mining activities were reported to have ceased following release of the Ministerial Notice in July 2005. However some provincial authorities, in particular Attapeu and Xiengkhouang, requested the DGM to consider the resumption of small-scale mining to enable the return of valuable provincial revenue streams from these activities.

Provincial government officials confirmed the following general characteristics regarding ASM over the last three years:

i. Growth in the sector has increased but still primarily occurs during the dry season from January to June.

ii. Mining deploys both mechanized and manual technologies - methods vary depending on the type of resource exploited. The mechanized exploitation of alluvial deposits typically involves barges fitted with excavators, conveyors, and sluices. The exploitation of primary ore deposits typically involves manual excavation methods, mechanized crushing, sluices and copper plates.

iii. There is limited knowledge or consideration of health, safety and environment issues.

iv. Non-mechanized activities are subsistence related and primarily undertaken by local residents (rather than migrants), on nearby land, to supplement agricultural income.

v. Mechanized activities proceed without formal licensing or regulation, by local investors with support from foreign investors from neighbouring countries including China, Vietnam and Thailand. Migrant workers frequently participate in this activity and it tends to be less seasonal and less subsistence related.

vi. Mercury use was confirmed in four (4) of the ASM mining areas. Mercury use was confirmed in five (5) of the small-scale, mechanized mining areas. Use of mercury in ‘open circuit’ sluice boxes was confirmed in Attapeu, Bolikhamxay and Xiengkhouang provinces.

Artisanal miners commonly add mercury to the gravity concentrate. It was reported that some miners recover mercury during the burning of the amalgam using traditional methods such as bamboo retorts, however open burning of the amalgam is more common.

Small-scale mining operators in Attapeu, Bolikhamxay, and Xiengkhouang provinces are allegedly using mercury in 'open-circuit' sluice boxes for the processing of crushed primary ore (Appendix 2). In the Nakadok Village implementation area, copper plates covered with mercury are used to capture fine gold particles from crushed ore. Tailings from these operations, which are likely to contain elevated levels of mercury, are contained in ponds, but during the rainy season will overflow and ultimately will likely be discharged to aquatic environments.

In addition to the regional workshops and field visits to the ASM focal areas, NGOs and private companies working within Lao PDR were contacted to gather further information on mining sites in Lao PDR.

NGOs witnessed mining activity in the following areas during their field work:

- Alluvial mining in Sepone District, (near Sepon Mine – large scale gold mine) Savannakhet Province. Traditional methods are used, although the extent of mercury use is unknown. Identified by Handicap International France.
- Alluvial mining in Kengbit Village, Khamkeut District, Bolikhamxay Province. Traditional methods, mercury use unknown. Identified by Wildlife Conservation Society.
- Alluvial mining on Nam Kading River, near Phon Ngam and Phon Si Villages, Pakkading District, Bolikhamxay Province. Four gold dredges in operation, mercury use assumed, but unconfirmed. Vietnamese owned. Identified by Wildlife Conservation Society.
- Alluvial mining on the Sekong River, Attepeu Province using suction dredges as a joint venture between the State Geological Exploration Unit (on technical matters), and Sitthisay Saysana Company. Twenty-five operating units are reportedly underway and a number of new mining projects are planned. Environmental Impact Assessment (EIA) regulations state that an EIA should be conducted and approved and certificate issued prior to implementation. This procedure has not been followed in this case with contracts signed and implementation underway prior to submission of an EIA report. Subsequent comments provided by PSTEO to the EIA document have been provided, however the status of amendments is unknown. Approximately 5 hundred cubic meters of aggregate are excavated per hour, yielding 0.6 – 2.5 g of gold per m^3, depending upon location. Mercury is then used during the extraction process. It is mixed with the concentrate derived from the sediment. The recovered amalgam is then heated with acid to dissolve the mercury and purify the gold. After the gold has been extracted, most of the mercury is then recovered through a simple recovery process using precipitation by aluminum foil. Though largely re-used, the mercury acid mix derived from the extraction process may be released in small amounts into the environment through; evaporation from the heating process (unless a fume cupboard is used); as a residual quantity left behind from the recovery process; and, by accidental spillage. This information provided by Mekong Wetlands Biodiversity Conservation and Sustainable Use project.
- Alluvial mining on Mekong River near Phakhao Village, Meung District and Hatsa Village, Paktha District in Bokeo province. Traditional panning methods without the use of mercury Identified by VECO (Vredeseilanden).

GMP Project Implementation Sites

Two case study areas were selected for implementation in Lao PDR. These sites were eventually chosen by UNIDO and ESL based on information provided by the DGM and NGOs

where there was reported to be significant mining activity. The specific implementation areas (Figure 1) are:

- Lak Sao area, Khamkeut District, Bolikhamxay Province, mid-eastern Lao PDR, near Vietnam (Figure 2); and
- Sekong River, Sanamxai District, Attapeu Province southern Lao PDR (Figure 3).

Criteria applied in the selection of these areas included:

i. Political support at the central and provincial level;

ii. Reported mercury use in the conduct of mining activities;

iii. Recognized environmental and social impacts arising from mining activities and hence an anticipated willingness for mining communities to adopt interventions proposed under the GMP; and

iv. Potential for these focal areas to be suitable case studies for other mining communities in Lao PDR.

The first round of field activities was held in January 2007 to coincide with the start of the mining season and involved a reconnaissance survey of existing ASM activities and confirmation of the work program. Two subsequent field visits were made in February and March 2007, each meant to customize and focus technology introduction and health awareness campaign activities.

Key implementation features of the technology and health awareness programs are the direct involvement of district and provincial government staff, conduct of site visits by government and mining representatives from other provinces to the focal areas, and preparation of literature and visual media for distribution to government and mining representatives from other provinces.

A description of mining activities, extent of mercury use and loss relative to gold production and sources of mercury loss from each of the implementation areas is described below.

Lak Sao, Bolikhamxay Province

Lak Sao is situated in central Lao PDR, approximately 50 kilometers from the Vietnam border (Figure 2). Mining activity in this area was initially discovered when water quality tests, as part of a resettlement program for the Nam Theun 2 Hydroelectric Dam, determined elevated mercury in streams. In 2005 there were at least three different hard rock (‘primary’) mining operations in the area, as well as artisanal alluvial mining by villagers.

In addition to ASM, a Chinese company has been granted a license for small-scale primary ore mining. After this, village activity increased, possibly motivated by activities of the Chinese company. Villagers began to mine the primary ore deposits in groups of 10-15 people using rock crushers bought from Vietnam. Migrants moved in from other areas to participate in mining.

The DGM estimated that at the height of activities, between 500-1000 people were involved in gold mining. The number of gold shops in nearby markets increased from four in mid-2004 to 15 by December 2005. This mining occurred for approximately 6 months in 2005, until miners were asked to stop mining the primary ore deposits. They returned to alluvial mining near their village, but in a very organized manner and with almost total village involvement. The Lao military had also been issued a primary ore mining license, and established two camps of approximately 25 people each in the area. The July 2005 ban on small-scale mining activities targeted mechanized activities and did not really halt non-mechanized artisanal mining which is a subsistence activity and much more difficult to monitor or control.

In the area surrounding Lak Sao there are five ASM areas that involve exploitation of both alluvial and primary deposits. These activities are concentrated around the village of Ban Nakadok. Currently, 1500-2000 people are believed to be involved in ASM activities including local residents, and both local and foreign companies, in addition to the military mining concession in the area.

With respect to the criteria outlined above for the selection of focal areas, the Lak Sao area near Nakadok Village, Bolikhamxay Province was selected because:

i. There is strong support by the provincial and district government for implementation of the GMP. Specifically the provincial government has requested: clarification with respect to licensing procedures for ASM; a better understanding of the nature and extent of impacts arising from mining activities.

ii. Mercury use was reported in both alluvial and primary deposits, including the use of mercury in 'open-circuit' plate amalgamation.

iii. Environmental impacts associated with mining in the Lak Sao area, came to the attention of the government following a water quality and sampling investigation of the Nam Pan undertaken by the Nam Theun 2 Power Company (NTPC).

There are 6 villages near the town of Lak Sao that have been granted a 6 hectare concession by the Prime Minister's Office. This happened in January 2007 without the knowledge of the DGM. It has been estimated by the Watershed Management Protection Authority (WMPA), that approximately 20 ha are currently actually being mined. The 6 villages are Ban Nakadok, Ban Thongkhe Khae, Ban Nahay, Ban Vang Kor, Ban Namouang and Ban Nathorn (Figure 2).

Traditional alluvial mining has been practiced here using pans for more than 100 years. Gold in the Nam Thop River was coarse enough to allow miners to remove it from the concentrate with their fingers. However, much of the coarse gold has been extracted by a Chinese company that began mining in the area approximately 5 years ago.

Now, both alluvial and primary ore deposits are mined. Primary ore mining is now preferred because it provides greater profit. This has resulted in nearly a complete shift away from alluvial mining. Primary ore mining requires an economic input that requires the coordinated efforts of many impoverished people, or external investment or seed money.

Alluvial deposits are mined by panning heavy sediment with mercury to amalgamate gold using traditional wooden pans. During the February 2007 field visit there was only one group of people alluvial mining. The amount of mercury used in primary mining is thus quite small and probably amounts to 1 to 2 kg annually. It is not known how much gold is produced using this method, nor an accurate estimate of mercury loss.

Primary ore deposits have been mined for approximately 3 years, though activities have recently intensified. At one primary ore mining site next to the former village of Na Feuang, miners removed ore from a hillside using steel bars and hammers. The ore was crushed with a hammer before being transported in bags approximately 1km to the river where the ore was fed into a combination mill / mercury sluice machine used to extract the gold. The machines consist of a motor, a crushing machine, and a sluice box containing copper plates covered with mercury. Water was pumped from the nearby river into the machine.

These machines are imported from Vietnam and cost approximately $600. As a result of the expense, these machines are often bought cooperatively by the households. During the site visit, it was not possible to get an exact number of the machines in operation, or how many of

the six villages own such machines. Villagers are aware that using the mechanized mining equipment is illegal (i.e., since July 2005) thus few details were provided. Tailings from these machines are not treated and are discharged directly into the environment. Miners reported that they run the machines continuously for 8 hours each day, and remove the amalgam every two days. No detail on the amount of gold mined was provided, party because of the legality issue, for potential tax reasons and because they do not want to attract other miners to the area. Miners did mention that when they are lucky they have pieces of amalgam the size of an egg, perhaps 300 gm.

Mercury amalgam is burned over an open flame without the use of retorts and in very enclosed spaces. Small amalgams are also burned on a spoon over a kitchen fire, inside the house. This process only takes a few minutes, but no precautions are taken while burning the mercury. Miners travel to Lak Sao to sell their gold, and purchase mercury at the same time. Over a very short period of time mercury became unavailable in gold shops, and had to be procured from a Vietnamese equipment shop (selling other mining equipment such as mills and generators) at a price of $60 USD/kg.

Recently, ESL and UNIDO learned about a new primary ore mining site which changed the focus of technology introduction and health awareness training at the field level for province. The site is located near Nakadok village, on a concession previously mined by a military mining company, where as previously mentioned, the Prime Ministers office had granted a 6 ha concession to six villages. The permission does not identify the exact area of the concession, does not have a validity period, and does not identify what equipment the miners may use, and does not cite any legislation or allocate responsibility for managing the mining activity in the area.

Although it is difficult to estimate the amount of mercury being lost to the environment, a simple ballpark estimate can be made. We estimated that approximately 40 mills are in operation in the Nakadok Village implementation area. The mills have a capacity of 1.0 to 1.5 tonnes per day. However, the limiting factor for gold production is the quantity of ore that can be mined. Thus, mills were in operation only about half of the time. Gold grade was reported to be 7 grams per tonne and that 3 grams of mercury were used to capture 1 gram of gold, a ratio of 3:1 Hg to Au. We are also aware that some visible, high grade ore is recovered and sometimes processed in the home, so gold grade may be closer to 10 gm/tonne.

Mercury lined copper plates are used to capture fine gold. These plates are actually quite effective. A sluice box was set up and operated at the distal end of the copper plate sluice and very little mercury was lost. Thus, most Hg is lost during the amalgamation process rather than being lost in the tailings. However, burning of large amalgams (up to 300 gm) releases a considerable amount of mercury to the environment. These mercury amalgams are burned in extremely close, enclosed and confined spaces because of the secrecy of the operations.

Assuming that 1.5 tonnes per day are processed, with a gold grade of 10 gm per tonne, with a mercury loss to gold production ratio of 2:1 to 3:1 (according to the miners), this amounts to 30 – 45 gm of mercury loss per operation per day. Assuming that there are 20 mills in operation, this amounts to 600 to 900 gm of mercury loss per day from this area.

The main form of sustenance of the villagers in this area is farming, so primary mining may only occur over a five or six month period. Assuming that mills are in operation for half of the time over a five month period, assuming a six day work week, each mill is in operation for 75 days. Thus, total mercury loss is approximately **67.5** kg per mining season (i.e., 75 days x 0.9 kg Hg loss/d). This estimate is may be conservative and the actual amount of mercury loss might be

higher. The miners have only recently begun to exploit this area and have not been active here long. However, there has been a considerable investment of funds and infrastructure, so it can reasonably be assumed that mining will continue at least until the rainy season and will re-start the following dry season, in January 2008.

Although the Head of Nakadok Village reported that villagers are familiar with the dangers of mercury and how to protect themselves we saw little or no evidence of this. We were advised that all Village Heads had held meetings with their villagers as requested by the Project and the DGM, to disseminate information mercury safety and awareness donated by the Project. However, after visiting the field and speaking with miners, we determined that this had not been accomplished. Notwithstanding the apparent lack of education, we did observe a burner covering his face with a cloth – demonstrating that he is aware that mercury holds some dangers, but was unaware that a cloth will not protect him from mercury. Burners do not understand what safety measures should be taken to protect against mercury exposure. Thus, the Mercury Health Awareness Campaign for the miners and families working at the primary ore mining site was held near Nakadok Village in February and March 2007.

Problems to be addressed at the primary ore mining site included:

- Lack of concern for environmental protection (including water sanitation)
- Lack of environmental rehabilitation
- Lack of plans for tunneling or mapping of tunneling
- Lack of structural reinforcement of tunnels
- Lack of fresh air in tunnels
- Lack of personal safety equipment (hard hats, cloves, earplugs, etc)
- Miners burning amalgam in enclosed areas
- Miners using mercury coated copper amalgamation plates in sluices
- Miners likely burning inside their homes at night
- Likely use of explosives for mining

Sanamxay, Attapeu Province

The region of Sanamxay, Attapeu Province in southern Laos was chosen as our second implementation site (Figure 3). This was decided based on reports of both large scale mining as well as ASM activities on or near the Sekong River based on observations by WWF and feedback from regional DGM staff during a workshop in Pakse.

Field demonstrations took place in areas where a Lao-Chinese company, Sittxay Company had already excavated sand from the Sekong River in Attapeu. Demonstrations were carried out over 2 days at 4 sites with the assistance of provincial DGM staff. Both sites for retort demonstration were held in the villages nearby to sluice demonstration sites. Short technical presentation on equipment including high-banker screen sluice, tray sluice, plumbing pipe retort and kitchen bowl retort were demonstrated. Details of implementation of technology demonstrations, brochures and health awareness are detailed in the main document prepared by Earth Systems.

Participants were enthusiastic about the new technology and were immediately able to operate the sluice boxes without difficulty. Miners suggested adding a rock separator (screen) to the tray sluice, similar to the high-banker sluice design. A water pump for washing the sand on the sluice was also suggested. The sluice box was much more efficient and faster than panning and was quickly adopted by local villages. Some villagers who had not mined in several years considered re-starting mining again, using the new technology. At the same time, a presentation on the health hazards of mercury and how to work safely with mercury was held villages Ban Oudomsouk and Ban Hat Xaykham. The plumbing pipe and kitchen bowl retorts were demonstrated to villagers to demonstrate mercury recover.

After the demonstrations, the Permanent Secretary of the Sanamxay District Office was briefed on Project activities. We were advised that there are at least 15 villages further down the Sekong River where there is active gold panning during the dry season. This is a traditional activity that has been carried out for many years. It is unknown whether some or all of these communities use mercury. Introduction of the manual sluice is expected to proliferate to other communities because it is a large step forward in the amount of material that can be processed each day, and significantly increase the amount of gold acquired. It is very important that retort technology also keep pace with the sluice technology to ensure that a greater problem is created where one did not exist before. Amalgamation probably occurs in or near rivers, thus there is inevitably some loss of mercury to the aquatic environment.

Unfortunately, the scope of ASM activities and extent of mercury use is not known at this time, as this was not a specific goal of this aspect of project implementation. However, the DGM may be able to provide some technical support in the future.

A group of women at the demonstration noted that they had not previously heard of the health hazards of working with mercury. Women burned amalgam in a spoon over an open kitchen fire (indoors), and then proceed to eat with the same spoon. They realized how dangerous their behavior had been with mercury and were interested to learn how to work safely with mercury.

It was discussed that Local government will continue the technology introduction and health awareness initiatives. Barriers to continuing the initiatives include limited financial and human resources at all levels of government in Lao PDR.

It is unknown if there are gold shops in the vicinity of these villages. Given their small size, it is unlikely. Gold is probably purchased by traveling gold buyers. It is not known if they also provide mercury.

Awareness Campaign and Materials

Awareness campaign activities in Lao PDR were numerous and varied and took the form of:

- Workshops with government agencies including Department of Geology and Mines, Health, Environment, Science, Technology and Environment (STEA),
- Workshops with non-Governmental agencies including World Bank, World Wildlife Fund, Australian embassy, Wildlife Conservation Society, Mekong River Commission, Japan International Cooperation Agency (JICA) and CARE
- Workshops and meeting with local government officials in regional centers
- Direct interaction with miners and their families and involved workshops, demonstrations, distribution of awareness campaign materials including posters,

brochures, technology demonstrations, one-on-one consultation and on-going training by ESL staff or DGM staff in the field

- Brochures and posters (see Appendices 2 and 3), informational sessions, group meetings, question and answer sessions and direct interaction with the mining community, especially in the Nakadok area, site of the largest ASM activities.
- Training of local DGM and health officials during site visits to each province.

Brochures originally prepared in English were adapted to the local situation and translated into Lao language. These included Mercury and Family Health, Protect Your Water and How to Get More Gold. Examples of the translated materials are provided in Appendix 3. Posters were specifically designed and prepared for our implementation sites, printed (500 copies) and were spread throughout the implementation areas. Copies of the posters are depicted in Appendix 4.

Health Awareness

Regional workshops were held in three areas – Southern (Pakse), Central (Vientiane), and Northern (Luang Prabang) Lao. An International Stakeholders Workshop was also held in Vientiane (Appendix 1). The workshops increased the awareness of GMP objectives to Central and Local Government, small scale mining companies, and artisanal and small scale gold miners. During the workshops, health awareness materials were presented and disseminated.

Most participants were unaware of the negative effects of mercury on the body, and many were unaware of the way mercury is used by local miners to process gold. The Health Awareness Campaign provides participants with a reason to adopt the new technology, and is therefore an integral to its successful introduction. The workshops succeeded in increasing participants' knowledge regarding methods of mercury poisoning, how mercury can enter and persist in the environment, symptoms of mercury poisoning, who is most sensitive to mercury poisoning, and how to protect oneself and one's family from mercury poisoning.

A specific Mercury Health Awareness Campaign was developed for miners working in the primary ore mining area in Bolikhamxay led by Dr. Vilayvone from the Ministry of Health. Other team members included the Earth Systems Lao, and the Environmental Management Unit from the Science Technology and Environment Agency.

The health campaign was held over three days. Miners at the primary ore mining site near Nakadok were divided into three groups, each participating in the campaign on separate days. On each day, a morning session was held for both men and women, and a separate afternoon session was conducted for women and children. Approximately 100 people attended the session. Questions surrounded the potential health effects of mercury and whether there were any treatments or cures for poisoning. Most miners admitted to a lack of concern about mercury as they had more immediate health issues to deal with such as accidents, diarrhea, malaria and sexually-transmitted diseases. Health materials were left with the Bolikhamxay Provincial Department of Hygiene and Disease Prevention to continue with awareness training.

Brochures (Mercury and Family Health, How to Get More Gold, Protect Your Water and Mercury in Gold Shops; Appendix 3) and posters (Appendix 4) were translated into Lao language and presented at each of the regional workshops. Brochures, posters, cd's and informational sessions were provided to the central government Lao PDR DGM, Bolikhamxay Provincial DGM, and Attapeu Provincial DGM as well as international organizations, WWF, Care and SEM2. Five hundred posters of each theme were produced and distributed.

Technology

In the earlier stages of the project it was agreed with the DGM that the technical focus of the project will be artisanal alluvial mining only. In Lao PDR this takes place at the lowest possible technological level where sluice boxes and retorts are unknown.

Alluvial sluice boxes

To improve gold recovery and income for the alluvial miners, it was decided to introduce hand-fed sluice boxes for pre-concentration. We did not introduce larger sluices, with water pumps because we did not want to create a larger problem than currently exists. Different models were built, one high-banker type with screen, one “in-the-stream” type and zig zag. Eight sluices constructed of wood or metal were provided using only locally available materials. Each type of sluice was simple to use and efficient at recovering coarse and fine gold. The government of Lao PDR was provided with five sluice boxes in Vientiane Central DGM (2), Luang Prabang DGM, Nakadok Village, and Sanamxay District Office DGM. Although the miners liked and understood the technology, no follow-up report on results and acceptance has been determined because of the recent introduction of the technology and conclusion of the project.

Retorts (alluvial mining)

Following the general philosophy of the GMP, it was decided to introduce the most simple retorts, plumbing pipe and kitchen bowl. Materials for their construction were not easily available, especially in remote areas. A common problem is the very small amalgams produced during one day of work, which can be as little as one third of a gram. Neither the kitchen bowl nor small plumbing pipe retorts are suitable for these tiny amalgams. Therefore, several models of mini-retorts were made, where a bended tube wherein a thread was lathed was closed with a bolt and used as a retort. At the time of writing of this report, no information on how these mini-retorts performed, or if the miners are using these or similar models.

Even for larger amalgams, neither the plumbing pipe retort nor the kitchen bowl retort proved very successful. The metal tubes and fittings to construct the plumbing pipe retort were difficult to find outside of Vientiane, because most tubes and fittings in the country are made from plastic. Also, the tubes and fittings are galvanized with zinc, which when heated forms a zinc-amalgam, which sticks inside the retort and impairs gold recovery. New retorts must be treated with hydrochloric acid, but this too is difficult to find. Furthermore, mercury vapor emissions still occur, making this type of retort an only apparently safe type of device.

Retorts (primary mining)

The primary gold rush site near Lak Sao is technologically much more advanced than the manual alluvial operations. Kitchen bowl and pipe retorts were clearly insufficient and primitive. Consequently, two types of retort were constructed to fit their needs. The first option was a small mobile lathed retort from black or stainless steel with a good blower. To provide an adequate heat source different sizes of Chinese gasoline torches were used It is however not clear, if these burners are easily available outside Vientiane.

Legislation

A significant gap in dealing with ASM in most countries is the lack of legislation specific to small-scale miners, mining activity and in particular, the use of mercury. Over the past two years the World Bank has been developing a new Mining Policy for Lao PDR, however, the focus is on

larger, commercial scale mines as the country moves to exploit its natural resources to reduce poverty in the country. There is very little text dealing specifically with ASM and mercury. Given the importance of introduction of legislation specific to ASM is a primary goal of the GMP, this provided us with an opportunity to introduce legislation to the central government for inclusion in the new Mining Policy. The legislation took the form of “Codes of Practice” and used the mining area in Nakadok Village, Bolikhamxay as an example of an area where the Codes of Practice could be phased in. Codes of Practice were developed within the context of three themes: 1) Mine Safety; 2) Environmental Protection; and 3) Protection of Human Health. The Codes or Practice, as submitted to the central Department of Geology and Mines and as translated into Lao language, are presented in Appendix 5.

Photos of lathed retort in burning pipe produced in Vientiane with Chinese gasoline burner

The second option is a large stationary fume hood style retort, to be used by all miners. This retort was also built in Vientiane with locally available materials and transported to the mining site close to Lak Sao. The stationary retort is composed of a burning chamber, condensation pipes, a mercury collection chamber, charcoal filter and a burner with blower. The fan creates suction, drawing mercury gas into the tubes where it is condensed. The charcoal filter captures any truant gases. A separate building was constructed to house the retort in the Nakadok Village area. Mercury recovered from the retort will be recycled and sold to miners at lower than market price to encourage its reuse. Profits will be used to purchase materials such as fuel and wages to operate the facility at no cost to the miner, thereby ensuring incentive. At the time of writing of this report it was not known if this has been successful due to recent implementation of the retort in the mining community. The assistant country focal point, Mr. Eravanh Bougnaphalom of central DGM was trained on operation and maintenance of the stationary retort.

Photo of Stationary Community Retort Installed in New Mining Area near Nakadok Village

Photograph of Condenser Tubes Inside Stationary Retort

In the Sanamxay area of Attapeu Province demonstrations were carried out over several days at four sites to present technical materials, introduce sluice and retort technology, provide technical guidance manuals and materials for sluice box and retort construction, guidelines for safe handling and use of mercury and codes of practice.

Primary concentration

In the primary mining site near Lak Sao, small wet operated hammer mills are used in combination with amalgamation plates. Milling is fine and throughput is low, and only small amounts of mercury are scratched from the plates. Nevertheless, some loss of floured mercury or mercury adhered to fine solids does occur. Carpeted sluice boxes have been introduced with the aim of replacing copper plates; however, it will take some time for the transition to be made, if attempted because the miners need to prove to themselves that they can capture as much or more gold with the sluice box as they did with mercury lined copper plates.

Because of the limited time in the field, we were not able to successfully replace copper plates with sluice boxes. We have left responsibility for this change in technology with the Department of Geology and Mines, both at the local and central levels. Legislation introduced to the Lao PDR government stipulates that copper plates should be phased out, after a grace period and be replaced with sluice boxes.

Achievements and Challenges

Health Awareness

Key achievements of the Health Awareness Campaign included:

1. Mercury health awareness materials such as brochures and posters were disseminated at the Regional Workshops held in Northern, Central, and Southern Lao PDR attended by 70 people, including participants from: Central, Provincial, and District Government from the Ministry of Energy and Mines (Department of Geology and Mines - DGM); Dept. of Foreign Cooperation; Dept. of Public Health; Provincial Science Technology and Environment Office; Southern Geological and Mining Sector; Lao National Mekong Committee; representatives from private sector mining companies; and local artisanal miners.
2. Mercury health awareness materials were disseminated at the International Stakeholders Workshop in Vientiane. Participants included the Australian Embassy; CARE Laos; Japan International Cooperation Agency (JICA); Mekong River Commission (MRC); World Bank (WB); Wildlife Conservation Society (WCS); and World Wide Fund for Nature – Greater Mekong Programme (WWF).
3. Mercury health awareness materials (brochures, posters, and technical guidelines) were disseminated to villagers and miners in both implementation areas during several field visits to areas with mining activity.
4. Development and implementation of a targeted Mercury Health Awareness Campaign for the miners and families of the newly formed village in the primary ore mining area near Nakadok Village in Bolikhamxay Province. Ministry of Health personnel were trained to deliver the awareness training so that this activity could continue after the GMP project.

5. Dissemination of technology and health awareness posters (Mercury and Family Health; and Retort Use) to each province of Lao PDR through field visits and DGM's annual conference.
6. Introduction of legislation specific to Mine Safety and Protection of Human Heath in the specific context of ASM (Appendix 5).

The key challenges faced during implementation of the Health Awareness Campaign can be summarized as follows:

1. It is difficult to communicate the potential impact of mercury exposure because the health effects of mercury exposure are not manifest for a long time, difficult to diagnose, and are often masked by other conditions.
2. Miners in Lao PDR have more immediate health concerns, such as malaria, malnutrition, and unexploded ordinance and these tend to take priority over long-term health concerns.
3. Raw materials for manufacturing retorts tend are difficult to acquire and capital funds of villagers are limited, and often represents too large an investment.

Technology

Key achievements of the technology introduction include:

1. More efficient and safer gold mining technology (sluice boxes and retorts) was introduced at the Regional Workshops held in Northern, Central, and Southern Lao PDR
2. During the Regional Workshops, technology demonstrations were undertaken to introduce workshop participants to carpet sluice boxes and plumbing pipe retorts. Participants from Bolikhamxay and Attapeu invited the Project to visit mining areas in their provinces and introduce this technology.
3. Introduction of the stationary retort to the primary ore mining area near Nakadok Village in Bolikhamxay Province, including capacity training for Central DGM to use and introduce the retort.

The key challenges faced during technology introduction are:

1. Materials required for the plumbing pipe retort were not always locally available. Metals pipes, where available are coated with zinc, which must first be removed.
2. Bowls available in most rural markets are not suitable for the kitchen bowl retort because they are the wrong shape, having a flat bottom which causes evaporated mercury to re-condense and drip back into the crucible instead of being removed to the sand.
3. Technology introduced by the project is in competition with technology introduced from neighbouring countries, such as the copper plates introduced from Vietnam. Given the significant financial investment to purchase this equipment, miners are unlikely to switch to different technology introduced by the project if more funds are required.

4. There is considerable outside influence on technology from other countries such as Vietnam – it is difficult to overcome this influence without a long-term and dedicate effort.

Infrastructure and Logistics

Key challenges regarding infrastructure and logistics are:

1. The Government of Lao PDR has limited human and financial resources to support implementation of project initiatives. While financing provided by the project has helped overcome financial barriers during project implementation, this is expected to be a major barrier to ongoing work, such as continued health awareness and technology introduction.
2. There is limited technical expertise among staff at the Ministry of Energy and Mines, Science Technology and Environment (STEA) and Health departments. Lack of expertise and lack of time by those few qualified people is an impediment to progress.
3. Artisanal and small-scale mining is perceived as an activity that is difficult to manage, requiring significant resources to do so properly, and providing little benefit in return. Without sufficient resources, regulation of this activity will have limited success.
4. The Government of Lao has a complex system of communication between agencies. Lack of communication within and between departments leads to an *ad hoc* and ineffective system of governance.
5. Internal communication within Ministries is also difficult, and as a result, staff involved in the project can be misinformed or uninformed of information relevant to the project. This difficulty also applies to communication between Central Government and Provincial / District Government staff.
6. Villagers were hesitant to provide information on small-scale mining when Government personnel were present because, following the Ministerial Notice, all small-scale mining activity is illegal. Note: In Lao PDR, it is necessary to involve Government in field visits and community consultations.
7. Given the short mining season (roughly January – April) there is limited time available in the field during which to effect change.

Key achievements regarding infrastructure and logistics include:

1. A series of field visits to government identified areas with increased mining activity and successfully introduced new technology to Village Heads and miners of 11 villages in 2 provinces including Bolikhamxay Province (6 villages), with 115 participants and Attapeu Province (5 villages), with 75 participants.
2. Communication between Central and Local DGM was improved as was capacity to carry out technology demonstrations and health awareness campaigns.
3. An inventory of existing and new mining areas was identified based on feedback from government officials and a network of NGOs and external agencies operating in Lao PDR (Appendix 2).

4. Legislation specific to ASM and small-scale mining and mercury use was introduced at the Central government level and has been carried forward to become part of the new Mining Law being prepared by the World Bank.
5. NGOs and other agencies have become aware of the GMP objectives and are sensitive to ASM activities and mercury use. GMP objectives have been incorporated into their own activities.

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