Global Mercury Project

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

INDONESIA
COUNTRY REPORT

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

Indonesia Country Report

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I. Overview

UNIDO has selected Indonesia, along with Laos, Brazil, Sudan, Tanzania, and Zimbabwe as pilot countries, to implement field activities for the Global Mercury Project (GMP). The main objectives were to assist countries in assessment of mercury contamination from current ASM activities, introduce cleaner extraction technologies, develop capacity and regulatory mechanisms that will enable the sector to minimize negative environmental and health impacts. The project also aims to increase awareness among miners, gold shop owners, government institutions, community based organizations and general public of the health risks of mercury exposure, use in gold extraction process.

Environmental and health assessments were conducted during the first phase of GMP (2003-2004), to identify hot spots, determine baseline condition and ensure that the following activities were tailored to the target population (Gunson *et al*., 2006). Based on analyses of soil, sediment, water and fish samples, Galangan located in Central Kalimantan and in Talawaan-Tatelu in North Sulawesi were identified as environmental "hotspots" (Figure 1). The health assessment included sampling and analyses of blood, urine and hair samples of miners, residents of the mining camps and villagers. In addition, a series of amnestic/clinical/neurological/toxicological tests were conducted to identify mercury intoxication. Symptoms such as ataxia, tremor, pathological reflexes, hand coordination and difficult to concentrate were documented during clinical tests. Results of the health assessment confirmed the presumption that miners and others have significant body burden from mercury exposures. Some have shown the typical symptoms associated with damage to motor neurological functions. Two major exposure pathways were established: inhalation of mercury vapor releases during burning of the gold-mercury amalgam, and by ingestion of mercury contaminated fish caught from the rivers or grown in the amalgamating ponds. Additional minor exposure pathway is from skin contact when miners use bare hands to add mercury to the gold concentrate. Field activities for the following phase were planned for these two sites.

However, prior to launching the second phase, Talawaan-Tatelu site was replaced with Tanoyan based on the request of the Head of Provincial Mining Department in North Sulawesi. Since both sites are using similar mining technology, it was assumed that the two communities are facing similar issues. Talawaan-Tatelu is located in Minahasa District while Tanoyan is in Bolaang Mongondow District, separated by a distance of approximately 250 km.

An additional site in Central Kalimantan was added based on a request from a local non-governmental organization in Kumai, Central Kalimantan. Although there was no prior environmental or health assessment for Sekonyer River, it was assumed that the sites are highly contaminated with mercury from small scale mining activities that have been going on for the last

20 years. Aspai and Rasau mining camps on Sekonyer River are located approximately 300 km from Galangan in Central Kalimantan Province. Hence, the GMP Indonesia team has a total of three sites in the portfolio, each with different cultures, infrastructure, processing methods, understanding and knowledge of health risks, government capacity, affluence and other unique sets of issues.

Following a period of interval, the second phase of GMP began in mid-2005 with selection of partners to implement awareness campaigns in the selected sites. Meetings with multi-stakeholders at the national and district levels were conducted to establish enabling conditions, in addition to getting the necessary approval and support. Since capacity building is an important component, three Training-of-Trainers (ToTs) were held in 2006. Two were held in Rungan Sari, Central Kalimantan and one was held in Kotamobagu, North Sulawesi. Additionally, an introductory workshop on cyanidation process was held in Pasaman, West Sumatra, following a request from the Pasaman District's environmental agency. The trainings provided health and technical information, in addition to teaching skills necessary to motivate behavior change in miners and vulnerable population. Trained health and technical experts were deployed to educate target populations during the six to eight months interval in 2006-2007.

The campaign aimed to raise awareness of health risks to mercury and cyanide exposure as well as change behaviors of miners and others who handled mercury or exposed to mercury unknowingly. It included frequent field visits, direct presentations, and combined with saturation style media campaign aimed at target populations identified previously. Trainers demonstrated a variety of equipments and gold processing techniques using Transportable Demonstration Unit (TDU) as an educational platform. At the conclusion of the project in February 2007, quantitative and qualitative indicators have been collected to assess changes in awareness and or behaviors of the target populations within the project sites.

As a part of the capacity building and policy development initiatives, the GMP team has been working with the Katingan District Government in Central Kalimantan to develop new laws and policies to assist miners and the community as a whole. Starting in 2005, the team initiated discussions with local stakeholder on policy concerns related to mercury and ways to strengthen laws and governance institutions to support the sustainable management of artisanal and small-scale gold mining. A key policy recommendation was to develop a legal framework to formalize the rights of indigenous miners. In 2006, the District Government established a legal framework that created a licensing system to register miners. By early 2007, a workshop was conducted with government officials focusing on how to obtain commitments by related agencies to reduce mercury exposure and prevent mercury loss from gold processing. A final policy workshop in March 2007 established plans to formally introduce the Regulation on Mercury Management in 2007. A micro-

finance study was also conducted, based on consultations with banks and other stakeholder groups, identifying possibilities for utilizing economic loan facilities to support technology improvements.

Policy consultations were also held at the national level, with authorities in the Ministry of Environment and the Ministry of Energy and Mineral Resources, as well as the provincial government level. These consultations underscored the importance of building strong relationships and successes at the local governance level, recognizing that governance of small-scale mining (and many other sectors) has mainly been decentralized in Indonesia. It was emphasized that other regions of the country should learn from the knowledge and lessons acquired in the pilot regions.

This report describes the preparation, implementation, monitoring, and closure activities of the awareness campaign, the pre-feasibility study of microfinance and development of policy conducted by GMP and its implementing partners in Galangan and Sekonyer River in Central Kalimantan and Tanoyan, North Sulawesi. GMP team for Indonesia, including the Country Coordinator, Assistant-to-Country-Focal Point and many technical advisors were actively involved in the management, providing technical and administrative support as well as representation of UNIDO in the field.

Each project site is presented separately. The quality of data varied from one site to the next, for example in North Sulawesi the focus was on raising the awareness not on technology introduction since most miners are using already switching to cyanidation process. A description of the project site, mining practice, gold recovery, as well as mercury contamination is followed by complete description of campaign activities and the accomplishments at the closure of the project. Assessment of relative success using quantitative/qualitative indicators is also presented to the extent that is possible. Finally, recommendations for future project are drawn from lesson learned extracted from all sites in Indonesia.

II. Implementation of GMP Awareness Campaign

II. 1. Galangan, Central Kalimantan

II.1.1 Introduction

Gold mining in Galangan, also known as Ampalit or Hampalit, has been going on for more than 20 years. It was formerly an operational area for PT Hampalit Mas Perdhana, a mining company that ceased to operate in 1997. ASM activities that sprang up around the company's concession quickly took over exploiting the gold deposit. It is located approximately 100 km from Palangka Raya, the capital of Central Kalimantan Province, but only 10 km directly to the south of the town of Kereng Pangi, a jump off town that provides services for Galangan and many other mining camps in the region (Figure 2). Galangan gold field is located approximately 1 km from the vast Katingan River

covering over 200 km2 area and extremely degraded from deforestation, desertification and mercury contamination as a result of artisanal gold mining. A recent assessment derived from satellite imagery reported that between 1999 to 2002 mining operation claimed a rate of growth of 8 km2 per year and only 30% (2.4 km2) of that has been mined effectively, leaving the remainder as overburden pilling. (GMP website, 2007).

Mercury contamination in the study area stems from processing ore in the mining field of Galangan and from amalgam burning in township of Kereng Pangi. The awareness campaign has targeted approximately 9,500 permanent resident of the urban center and 5,000 non-permanent residents from the surrounding goldfields of Galangan.

Miners working in this area are mostly men in their twenties originally from villages in Java and other provinces in Kalimantan. Men from the same village usually form a group of five, hired by processing unit owners, toiling 8 to 10 hours per day for six days a week under supervision of a location unit boss. This operation has a high turn over rate, with 9 to 12 months interval. Ninety percent of the miners in the field have work for one year or less. Fresh labor pool usually appears after the end of Muslim fasting month of Ramadan.

At the peak of gold rush in the late 90s, the area attracted more than 10,000 miners. However, in 2006 only 1,000 migrant miners were operating 250 sluice boxes in Galangan. Some long term miners migrate to new locations with greater yields, such as Kelaruh Lake located south of Galangan, accessible only by motorcycle and canoe. Others have switched to work for zirconium mining and processing that provides less but stable income.

II.1.2 Gold Mining and Production

Gold is found in the Quarternary-Tertiary (Pleistocene) alluvial-quartz ore deposit located beneath the primary or secondary forest. Miners often seek new deposit on recent clearings, following the footsteps of illegal loggers. Gold grade from Galangan is estimated around 0.07g/ton (GMP Website, 2007).

Miners in this area use hydraulic monitors to strip the subsurface soil and formed excavation pit 10 to 30 m deep. Slurried material is then pumped to the surface where it is passed over carpeted sluices. Gold and other heavy minerals are trapped by the carpet. At the end of the day, the carpets are rinsed over a bucket to collect the gold concentrate. On the average, one operating unit yield is around 10 g of gold per day (with a wide range of 5 to 50 g/d).

Approximately 200 to 400 g of mercury is added to the gold concentrate followed by manual mixing in a bucket and gold pan. This is frequently conducted in the flooded open pits or constructed ponds by the camps. Mercury is squeezed through a synthetic piece of cloth to acquire gold-mercury amalgam and miners have to return the unused mercury. The amount of mercury consumed in this process is equal to the amount that forms the amalgam and the amount lost to the tailings. It was estimated that 75% are bound to the amalgam and 25% lost to tailings.

Based on mass balances calculated from the analysis of amalgamated waste material and interviews with the miners, the ratio Hg lost:Au produced in Galangan is estimated to be 1.3:1 (Telmer, 2007). The amalgam formed consists of half gold and half mercury. Observations in the field and gold shops confirmed this equal values of Au:Hg in the amalgam.

In Galangan, the mercury is always supplied free of charge, and individual miners have no control over the amount of mercury prescribed for use. Gold shop operators in Kereng Pangi supplied mercury and retained the right to purchase the gold amalgam produced at that location. Tightly-controlled syndicates service each location and it is obligatory for miners to use their services. Under tight supervision of unit bosses, miners cautiously return the excess mercury containing trapped fine gold to be recovered by the supplier.

Subsequently the amalgam is burned to obtain gold. Only 40% of amalgam produced is pre-burned near the mine sites. Unit bosses deliver 60% to gold shop operators in town for further processing. Burning generally occurs within a chimney with no filter, ventilation, worker protection, or external exit for fumes and takes place in the presence of women and children who are unaware of the health hazards posed by inhaling gaseous mercury.

II.1.3 Mercury loss

Quantitative data of amalgam burned in the gold shops have been collected to determine mercury emitted at each establishment on a daily basis. There was a wide degree of variation between shops, depending on relationships each had established with network of miners and what percentage of gold was delivered as unburned amalgam. Estimated daily emission ranged from 17 g to 488 g, with an average of 143 g per day. Collectively, the thirty five gold shops in the town of Kereng Pangi emit over 1,500 kg of mercury per annum in gaseous form (Table 1). Since the gold shops are located in the centre of the town near a central market, residents are exposed to relatively high concentration of gaseous mercury.

Furthermore, over 700 kg of mercury is combusted in the field as a result of the trade to these gold shops, as 40% of the amalgam received by gold shops is pre-burned. This increases the total

quantity of mercury combusted annually to 2,200 kg. In addition to the release of the mercury bonded in the amalgam, mercury is also released into the tailings wastes of the gold sluices during the amalgamation process. However, the amount is much less than mercury loss from burning the amalgams. Miners are very careful when they add mercury to the gold concentrate. Any excess mercury is retuned to the supplier. It is estimated that a total of 3,000 to 4,000 kg of mercury was released in the study area during 2006 from both sources.

A recent demand for zirconium has an implication on the distribution of mercury contaminated tailing beyond the gold mining camps. After the gold is amalgamated, miners retained the mineral-rich tailings to collect the zirconium sand. Prior to packing zirconium to ship for overseas buyers, it is processed at a few operational units in town. Some burned the tiny globules of mercury found in the sand, adding to the mercury emission from gold shops. It is reported that a few Chinese ports have rejected shipments from Kalimantan since high level of mercury was detected in the zircon shipments.

II. 1.4 Campaign Activities

Yayasan Tambuhak Sinta (YTS), a local non-governmental organization based in Palangka Raya, was awarded a contract to implement campaign activities specified in the project's Term of Reference provided by UNIDO. The project was conducted for nine months from June 2006 to March 2007 in four phases including preparation, implementation, monitoring and documentation. It was culminated with a wrap up workshop to disseminate the results to all stakeholders involved in Katingan District.

A baseline study was performed to profile the mining community and to assess the current levels of awareness about mercury health hazards in the fields and in urban center. It was conducted using structure-interview approach from random samples of all target populations prior to launching of the campaign. The interview was replicated for comparison at the end of the campaign. The data obtained before and after the campaign provides measurable success indicators.
To provide local government officers with the skills necessary to conduct training in the field, as well as a working knowledge of the appropriate technology, a second Training-of-Trainers event was held in September 2006. In addition, trainers learned the necessary social marketing skills to effectively deliver messages to the target audiences.

The awareness campaign focused on several stakeholders, targeting the general public, schools and clinics, communities, miners and families, gold shops, rig owners, and the government, clustered into three main groups. The primary target of mercury handlers were miners, suppliers and, processors. Secondary target of people exposed to vapors including residents of Kereng Pangi. A

tertiary target was residents who resided at a distance from emissions but whose health was nonetheless impacted upon.

YTS has developed a saturation style media campaign that utilized billboards, posters, flyers, stickers and broadcast media to spread a health warning about mercury to the community. Five UNIDO booklets were translated and also adapted to the local dialect. Separate materials and messages were directed to specific target audience. A strong visual identity and message was created for the campaign, incorporating catch phrases and easy to remember logos and slogan (Figure 3). These elements were incorporated in all of the media materials, creating a strong and unified media campaign that enhanced and supported all of the field activities. In an effort to inform the campaign and its progress to all stakeholders, four issues of bimonthly newsletters were published in English and Indonesian languages. The extent of campaign activities was captured in a documentary video.

A public launch in September 2006 marked the start of the campaign. It was well attended by key figures, government and around 500 community members. The program incorporated educational and entertaining elements to transmit key messages to a wide cross section of the community. During the launch, equipments for the Transportable Demonstration Unit (TDU) were on display. Immediately after, field work commenced in the town of Kereng Pangi and the goldfields of Galangan.

In town, the primary target for behavior change was the thirty five (35) gold shops operators. Participatory discussions related to reducing levels of mercury emissions from the gold shops into the urban atmosphere followed screening of educational and documentary films. Gold shop operators provided valuable technical feedback with regards to adopting cleaner technology of the prototype fume hood presented. Early in the campaign, five skilled trainers visited individual gold shops to promote heavily the use of locally made stainless steel (Fauzi's) retort along with three alternative models and the prototype fume hood. One shop operator agreed to install the prototype fume hood for trial. Later in the campaign, the trainers also promote a condenser/filter system to modify the existing chimney, adapting the fume hood technology.

Through the course of the program, trainers established a friendly rapport with gold shop operators that overcame the barriers of hostility and suspicion through non-confrontational support for their activities, while suggesting alternative approaches to mercury use.

Since the amalgam delivered is usually small (1 to 10 g) and required immediate processing, it became evident that many operators were reluctant to use closed retorts. An effective solution using the principle of the fume hood technology was developed by adding on a condenser/filter system to

the already existing chimney in a gold shop. Soon after a few operators adopted this condenser/filter system, others became interested and request to be fitted. Towards the end of campaign, trainers have devoted additional time focusing on promoting the condenser/filter system).

Advice, information and guidance on health matters related to mercury exposure and intoxication were provided to school children through lectures, screened films, and distribution of booklets to raise awareness issues on mercury as well as on HIV/AIDS. To encourage wider exposure, an art competition with mercury reduction message was held for elementary, junior and senior high school students. Women who attended the regular health clinic for mothers and infants (*Posyandu)* were educated on the health impact of methyl mercury in fish. In addition, door to door campaigns distributed flyers in the areas of town where miners live.

In parallel with urban activities, trainers went to five camps in Galangan gold fields (Figure 1) to demonstrate all stages of gold production from concentration, separation, amalgamation, retorting and refining. Trainers established each camp for one week with several follow-up visits. From these base camps, trainers visited other mining camps in the surrounding area. Thus, the TDU was not restricted to one location but roved about to visit mining camps as they re-established themselves especially after the heavy smoke and fire.

A variety of portable equipments assembled for TDU (Table 2) were demonstrated to miners in the camp. In the evening miners and camp residents screened awareness films, followed by discussions of mercury contamination and health risks with the trainers. Distribution of booklets were accompanied with explanation by trainers

Demonstrations in the gold field including improved sluice-box design, amalgamation drum, as well as how to operate retorts and get more gold from the amalgamation process. Trainers have demonstrated two types of sluice boxes, four types of retorts, a step pump and concentrator and the portable magnetic CleanGold© sluice. Advice to construct an amalgamation pond to contain mercury contamination was also provided.

A significant amount of research and experimentation went into designing and building fumehood, condenser/filter system, retorts and sluice boxes. Solutions to technical challenges in the field were formulated by consultations with miners and gold shops operators, as well as valuable inputs from technical experts (Dr. KevinTelmer, University of Victoria; Dr. Hermann Wotruba and Lars Weitkaemper, University of Aachen; Randy Baker, Azimuth Consulting and Dr. Marcello Veiga, CTA). YTS has redesigned the campaign strategy and developed research and experimentation approach to obtain the appropriate technology intervention.

With supervision from YTS, students from a technical high school in Palangka Raya built two prototypes of fumehoods based on rudimentary sketches provided by UNIDO. Locally-available materials were used for the fume hoods and other TDU equipments to the extent possible.

II.1.5 Policy Development and Microfinance Activities

As a part of the capacity building and policy development initiatives, the GMP team has been working with the Katingan District Government in Central Kalimantan to develop new laws and policies to assist miners and the community as a whole. Starting in 2005, the team initiated discussions with local stakeholder on policy concerns related to mercury and ways to strengthen governance institutions to support the sustainable management of artisanal and small-scale gold mining.

The policy discussions recognized that there are many factors that should be taken into account when identifying how to remove barriers to the adoption of improved methods, including:

- building good governance institutions that provide sustained education and training services and that are responsive to the concerns of grassroots operators
- developing clear and simple laws enabling informal rural miners to be become legalized, recognizing artisanal and small-scale mining as a poverty alleviation activity
- developing clear policies on mercury use and technology standards, particularly to prevent mercury emissions in urban gold shops and in rural mining areas, that are appropriate and effectively embraced by grassroots operators
- developing clear policies on mercury trade that can be easily understood and implemented
- developing a clear governance administrative framework with responsibilities delegated

From consultations conducted in 2005, a key policy recommendation was to develop a legal framework to formalize the rights of indigenous miners. In 2006, the District Government established a legal framework that created a licensing system to register miners.

By early 2007, a workshop was conducted with government officials focusing on obtaining commitments by related agencies to reduce mercury exposure and prevent mercury loss from gold processing. A final policy workshop in March 2007, involving over 40 government officials in consensus-building discussions, established plans to formally introduce the Regulation on Mercury Management in 2007. The regulation covers minimum technology standards addressing mercury use in gold shops as well as in the mining areas. The policy address measures on technology design, occupational and public safety measures, as well as measures to regulate mercury trade.

Representatives from 5 government departments (Environment, Health, Education, Mining, and Industry and Trade) coordinated an action plan to address field implementation strategies.

A micro-finance study was also conducted, involving consultations with banks and other microfinance institutions, to identify possibilities for utilizing economic loan facilities to support technology improvements. Microfinance refers to finance services such as credit and savings for low-income people, and has been applied in a variety of development contexts globally to empower the poor. This study explored the feasibility of applying microfinance scheme for artisanal gold mining in the District of Katingan, based on field trips for collecting primary data and information on the business structure of grassroots operations.

The general conclusion of the above pre-feasibility study was that the application of microfinance to support technology improvement for poor miners in Katingan would encounter several challenges: high risk of business, unorganized groups of people, and nomadic behavior type of communities with shifting profession. These challenges, under the status quo, prevent many miners from being able to access micro-finance services. It was concluded that encouraging microfinance effectively would require special development funds to identify and work with target groups for training - on business management, loans and repayment strategies - and in some cases, may need to partially bare some of the financial risk so that local banks are able to extend services.

II.1.6 Accomplishments

YTS has combined a campaign to raise the awareness with technology intervention that resulted in adoption of cleaner technology, as well as significant changes in attitude and behavior of the target populations. Result of the final survey has shown that a positive increased in awareness among miners and members of the community has occurred after the campaign activities. Emission of mercury contaminating the urban environment is also reduced as the result of promoting a piece of equipment as an add-on to an existing system. Implementation and behavior/technology indicators have been collected to provide general evaluation.

For the duration of campaign, the project has delivered its message to well **over 1,500 members** of the town community through combined activities of the launch; continual consultations with gold shops operators, information sessions at mothers' groups; film screening nights and seminars. Additionally over 600 students participated in learning exchanges and in the making of poster-art competition at three local schools.

Through the educational platform of TDU, trainers provided consultation and advice on both health issues and technical issues to **over 1,000 members** of the mining community during the initial field

campaign and the follow-up visits. Thus, **over 2,500 people** received information and advice by direct consultation.

A total of 3,000 booklets were printed and distributed to target audiences during the course of the project. In addition, **500 awareness booklets on HIV/AIDS** provided by UNAIDS/Family Health International (FIH) were distributed to teenagers in the junior and senior high schools during an AIDS awareness seminar held by the health trainers;

A two minute health advisory, warning people to avoid mercury exposure, was broadcast **150 times per month,** and a half-hour interview segment with the local doctor and trainer was broadcast 12 times a month. Thus, a total of **450 advisories, plus a total of 36 half-hour interviews, were broadcast on the local radio from December 2006 until the end of February 2007**. Radio Zona based in Kereng Pangi has approximately **2,400 listeners living in mining communities within 50 km radius** in Katingan District.

Building local capacity in the form of Training of Trainers (ToT) was conducted twice, with the assistance of experts from UNIDO. The main objectives were to provide local government officers and others with the skills necessary to conduct training in the field, as well as a working knowledge of the appropriate technology. **Fourteen** government officers from the Mining, Environment, Health, Education and Industry and Trade Departments have received training. **Four** community based organization or cadres of women's health group, **two** members of other NGOs have also participated in the training.

At least **five Fauzi's retorts** were purchased by rig owners in the field by the end campaign in February 2007. Purpose-built amalgamation pond was adopted widely. This practice has dual purposes of prevent mercury-contaminated tailing from dispersing into the waterways as well as to retain the secondary minerals trapped for sale to the zircon industry.

However, the campaign was most effective at addressing the issue of amalgam burning in the urban environment. Gold shop operators have expressed strong desire to work together with trainers to improve their existing system for safer work place as well as gained financial benefit from harvesting recycled mercury. One gold shop operator who tested the first prototype fume hood reported of harvesting recycled mercury around 5 kg per month. A total of **17 out of 35 gold shop operators in Kereng Pangi** have installed the water condenser/filtration unit to modify their system. Unfortunately the project ended before data on total recycled mercury could be collected from all shops. Based on the calculation from similar technology used in the fume hood prototype, the condenser/filtration unit can captured **500 to 600 kg of mercury annually,** significantly reducing mercury emission in town (Table 1)

A significant increase in the level of awareness in regards to mercury health hazard has been reported. The majority **(60%)** of gold shop owners interviewed (20 out of 35) have understood the health risks associated with mercury exposure. In the field, the awareness was elevated by **72% among miners and 76% among women** with supporting roles in the field.

The significance of the new legal and policy measures that were proposed and adopted by the District Government of Katingan should be measured over a period of time. In 2005, one of the most important recommendations was to develop a clear and simple policy to allow illegal miners to become legalized workers, recognizing artisanal and small-scale mining as a poverty alleviation activity. **In 2006, the Government introduced a new law - "Regulation on People's Mining" (Law No. 3 of 2006) - creating a licensing system and policy framework for small-scale miners.** One necessity for success is to educate miners and provide incentives showing miners why it is beneficial to register. The government can play a key role by discussing this with miners, gaining more inputs, and monitoring compliance. Registering legally will help miners obtain secure land rights and improve their role in the economy. The registration process also aims to ensure that miners manage the environment responsibly - a crucial aspect. Some of the most important parts of the regulation are as follows:

1. The area that a people's mining permit given to an individual may cover a maximum of 5 (five) hectares.
2. A cooperative may be provided with a people's mining permit covering an area of a maximum of 25 (twenty five) hectares.
3. An individual that has already had a people's mining permit is no longer allowed to have another permit unless his or her previous permit has expired [or is no longer effective].
4. A people's mining area shall be situated on land and shall be at least 200 meters away from the bank of a river.

Significantly, in March 2007, a government policy was adopted to specifically address mercury. The Bupati hosted a workshop with the Global Mercury Project team and over 40 officers in the Katingan District Government, from 5 departments. This process of consensus-building reinforced the shared commitment to reduce mercury use in mining and eliminate certain hazardous ways of using mercury. **The Government established plans to formally introduce the Regulation on Mercury Use and Management in 2007.** This regulation focuses on mercury use in gold shops and mercury use in mining. The regulation covers minimum technology standards and associated occupational, public health and environmental safety measures, as well as measures to regulate mercury trade. **One of the major new developments is that it establishes the legal standard that all gold shops must use proper fume-hoods.**

The regulations on mercury include mechanisms for community-based monitoring and self-enforcement; owners of mines and gold shops, miners, and other mercury-users share responsibility for safe management. It was agreed at the meetings that the government policies should prioritize education and knowledge dissemination before any strict legal enforcement is to be implemented.

The government committed a portion of financial resources in its 2008 budget towards educating and training the community further on technology issues. The Bupati announced the intention to reach out to all the gold shops in the district to implement technology transfer, and to reach out to mining areas as well. Ongoing monitoring should be conducted to evaluate the success of the implementation of these new policies.

II.1.6.1 Peripheral Benefits

UNIDO's health and technical booklets in Indonesian language attracted a high level of interest from the outset. At request from mining community outside the study area, 100 booklets were distributed 200 km to the north in the upper Kahayan river region, 180 km to the south east in the lower Kapuas river region, and a further 100 booklets along the road to Kalanaman village. Katingan District Mining Office took their own initiative to promote the use of retorts in the field Kelaruh, as well as in Kalanaman. The project supported this local initiative with follow-up visits to communities along the road to Tumbang Samba. One gold shop received equipment to modify its fumehood as a result.

Another potential peripheral benefit of the GMP intervention centers on the issue of secure land titles. The new Regulation on People's Mining, as adopted in 2006, provides a way to regulate mining and provide formal rights for indigenous mine workers. If it is implemented and managed successfully, this policy could help to prevent or resolve land disputes and conflicts between miners and other developers, and generally provide a more secure environment for registered indigenous miners to pursue sustainable operations, under a system of formal legal entitlement. Becoming legal could also potentially help miners to access education, health, technological and financial services that are usually available only to formal sector workers.

II.1.6.2 Indications that Awareness will be Sustained

Due to the high turnover of miners towards the end of 2006, much of the mining community had been replaced by new immigrants by January 2007. Interestingly, the comparison study found that new arrivals were now often aware of mercury hazards, despite having had no contact with the TDU. Apparently, word-of-mouth is perpetuating the message within the community despite the

high labor replacement rate. However, without a continuation of awareness-raising activities and the active promotion of retort and fumehood technology, the heightened level of awareness will be subject to entropy.

Fortunately, strong commitments to further the aims of the project were obtained from five District level departments during the wrap-up workshop in February 2007. The wrap-up workshop sought to develop partnerships and a coalition among stakeholders through an open forum that encouraged contributions promoting the concept of recycling and the use of intermediate technology. The departments of Mining, Industry, and Environment discussed how to promote the recycling technology of fumehoods and retorts, and the departments of Health and Education discussed how to educate the mining community to handle mercury as a toxic substance. At the conclusion each department provided meaningful statements that will translate into local action plans and new government regulations.

II.1.7 Challenges

The TDU concept has a lot to offer miners, as it takes the activity directly to the field and allows for direct interaction. Unfortunately, without prior field-testing of the equipments, implementation easily devolves to experimentation. Early in the campaign, significant effort was devoted to improve the existing technology to increase gold recovery. This was based on the assumption that miners in Galangan have not used optimum technology. After many trials using improved sluice boxes, it was evident that miners already utilized efficient concentrating technology to recover larger gold particles from the ore (which constitutes the bulk of the gold in the ore). Recovery of fine gold is essentially beyond the miners' present economic means.

Miners who are working under the control of a boss usually cannot control the amount of mercury used for amalgamation, as the labor structure does not give them this authority. The current practice of supplying free mercury benefits location and rig bosses since they have the rights to collect fine gold from excess mercury. Intervention is not just about introducing an efficient technology, as there are several concerns that must be addressed relating to labor organization. It is difficult to alter the on-going mercury supply mechanism. Due to this fact, the introduction of amalgamation barrels did not receive positive responses.

Due to prevailing superstitions and the practice of 'black magic' by local shamans, there is a common misconception that the application of mercury to the skin, or drinking doses of it while reciting a mantra, can make a man stronger. Reportedly, some miners do rub mercury directly onto their skin in a ritual practice, in the belief that this will protect them, make them stronger, and perhaps even invulnerable to attacks by knives and bullets. Most community members are aware of

this practice and can cite examples of people who have done it. Several individuals were encountered who had themselves drunk regular doses of mercury. This cultural anomaly is the cause of a widespread disbelief in the community that mercury is dangerous to human health, because these individuals are evidently healthy.

Gold shop operators resisted the idea of using closed retort because they believed it is impractical, required too much time to operate, and gold is lost if burned for too long. They also believed the sellers will want to see the maturity of the gold as the amalgam burns and would feel cheated otherwise. Trainers failed to convince the shops to adopt retort; instead, an intermediate technology as built on to the existing chimney to reduce mercury emission.

Another challenge was that on-the-ground technical support was lacking during preparation phase. The project trainers were not trained to experiment with technology, and a significant amount of time was taken away from reaching the target population by having to experiment with technology. In this respect, it was learned that local processes of “learning-by-doing” should start early in the process to ensure maximum efficiency in the intervention.

Although significant progress has been made with regards to the development of policy and governance issues, there are also several challenges that should be recognized. In many developing countries, new policies often have the potential to be “on-paper” developments with little on-the-ground impacts. It is important to recognize that the government departments in Katingan, after serving as leaders in the GMP training and leading policy workshop discussions, developed a well-coordinated action strategy to implement the policies on technology education and promotion. Furthermore, they devoted financial resources from the government budget to support the implementation of the policies. However, there is often a view in communities that government agencies are too bureaucratic and ineffective in service delivery. Overcoming the factors that contribute to these challenges is an important part of the development process. The continued involvement of government workers in field training and education services may help in building a strong sense of local leadership, trust and community organization.

The recent decentralization of powers from the national to district governments in Indonesia means that the local levels now have considerable responsibility over mining issues. District Governments now have new responsibilities and are building new experiences. There are many challenges associated with newly formed governments – building solid administrative capacities, etc.

The perception that indigenous people’s mining is an “illegal” activity is also a serious challenge in Katingan and across Indonesia. Although much of the GMP campaign focused on urban gold shops (legal businesses), a very significant amount of mercury is used in mining areas. The new policy

adopted (discussed above) to legalize people's mining is an important step towards incorporating indigenous mining into a poverty alleviation framework. Yet, the management of "illegal" gold mining remains an issue that requires further analysis and discussion because there are many conflicting perceptions; these affect how miners are (or are not) involved in development programs.

II.2 Project Site B: Tanoyan, North Sulawesi

II.2.1 Introduction

Implementation of follow-up health awareness and technology introduction took place in the Tanoyan, situated approximately 15 km south of Kotamobagu, Bolaang Mongodow District, North Sulawesi and 200 km southeast of Manado, the Province's capitol (Figure 4). Mining activity started in 1986 and has continued unabated over the last 20 years. Access to mining shaft and ore processing operations are moderately challenging. The majority of miners are local residents from nearby villages; however, some are itinerant migrants who have travelled a long distance from other provinces.

Although rice farming is the primary income source for most people in the Tanoyan area, there are perhaps several thousand people who make their living full-time by small scale gold mining. The mining area is spread out within the headwaters of the Tanoyan River and its tributaries (e.g., Ongkag Mongondow) and is surrounded by rice paddies, coconut plantations and cornfields. Local streams are used to draw water to flood the paddies. During rainy season, the streams overflow and flood the surrounding landscape, including paddies, potentially introducing mercury contaminated sediments from mining operations. These ponds are also used to grow fish.

Health conditions among many workers in Talawaan are poor with a variety of problems including collapsing tunnel accidents, infectious diseases (malaria and TB), diarrhea, skin diseases and parasitism. There is no clean, safe drinking water and no safe means of disposal for mercury or any other waste. Contact with elemental mercury and cyanide is routine and burning of amalgam is common and takes place with no protection in the immediate vicinity of workers and their families. Health awareness of mercury and cyanide toxicity among miners and residents is very low. Local authorities do not have technical or financial resources to address the problem in any meaningful way.

Mineral rights to the area being mined in Talawaan belong to Archipelago Resources Pty Ltd. An Australian company with Indonesian partners PT Meares Soputan Mining and PT Tambang Tondano Nusajaya. Thus, there was a legality issue in the Talawaan area that prevented UNIDO from conducting formal training of miners in awareness of mercury contamination. Furthermore, there was a memorandum of understanding between UNIDO and the central and provincial governments indicating that an awareness campaign could be mounted in Talawaan, but that training and technological improvement would be conducted in Lanud/Perintis area in Bolaang Mongondow District. Following discussions with the Departments of Environment and Mining, it was decided that technology introduction was carried out only in Tanoyan instead of Lanud/Perintis, Bolaang Mongondow District. However, health awareness campaign material was distributed and broadcast throughout North Sulawesi, primarily in newspapers inserts and other

media (radio and TV) to make the general population aware of the health hazards of exposure to mercury, regardless of geographic location.

Historically, most of the villages exclusively used mercury to amalgamate gold during the crushing phase. Now, mercury use is less common but the amalgamation process remains the same. Miners excavate ore from deep (up to 50 m), hand dug shafts and crush the ore in stamp mills before transferring it to *trommel* (drum) mills that grind it to a fine powder. Between 0.5 and 1.0 kg of mercury is added to each trommel containing about 40 kg of raw ore with an average gold grade that ranges from <5 gm to 10 gm/tonne. Each trommel is run about 10 times, processing 400 kg of ore before the mercury/gold amalgam is removed. The amalgam is then heated with a torch, usually in the open, very near to the milling operation and living quarters of miners with no retort. The amalgamation and burning process has resulted in excessive loss of mercury and considerable environmental contamination over the last 20 years. Estimates of mercury loss during this process vary widely and depend on the amount of mercury added to each trommel, the amount of ore processed, the frequency of operation, ore type, and experience of the operator.

First introduced to the Talawaan/Tatelu region near Manado in early 2000, cyanidation process has since spread to several other provinces and is gaining acceptance. Although it was believed that cyanidation had virtually replaced whole ore amalgamation, investigations by UNIDO since 2003 have revealed that mercury is still being used at all steps of the mining process in most of the mining operations. This incomplete transition towards the cyanidation process creates conditions that favor the creation of mercury – cyanide complexes, as well as causing direct mercury contamination of soils and streams.

In North Sulawesi (Dimembe and Bolaang Mongondow Districts), there are at least 200 tanks. Approximately 80% are operational, and more are under construction. In 2003, the GMP team collected 142 samples of sediments, soils, plants, mollusks and 156 fish comprised of 11 species in the Talawaan area as part of the Environmental and Health Assessment. Mercury in stream sediments near mining operations and in biota was elevated relative to downstream concentrations and revealed a distinct gradient of mercury contamination due to mining. It is suspected that mercury concentrations in biota are exacerbated by the interaction of cyanide and mercury, which may cause mercury to become more easily dissolved and available to be methlyated and taken up by biota, ultimately becoming most concentrated in fish.

II.2.2 Gold Mining and Production

Understanding and quantifying the grade of gold and how much gold is produced in North Sulawesi has not been officially undertaken. Although there has been a transition to cyanide, mercury is still widely used. Thus, the focus of the program was not to quantify gold production and mercury use,

but on education and awareness of the health hazards of mercury use and by introducing simple technology, such as gravity concentration (to replace whole ore amalgamation) and retorts. Reducing or eliminating mercury use would have also minimized the mercury – cyanide complexes discharged to the environment.

There are many issues that dictate or govern gold production. In the Talawaan and Bolaang Mongondow districts, mine shafts are becoming too deep, and groundwater is being intercepted, making them increasingly difficult to dig. Ore is now being shipped to the Talawaan region from Bolaang Mongondow because of the shortage of local ore and the difficulty in acquiring mercury.

Gold is primarily acquired from the cyanidation process. Grain size of gold particles is exceedingly small and gravity concentration of ore has not proved successful enough to provide the miners with confidence to adopt the technology because there is still the need for 'quick cash'. It takes between one and three months to acquire enough ground ore to operate a cyanidation tank through an entire cycle and most miners do not have sufficient capital on hand to pay for day-to-day expenses and wait for profits from the operation. Most miners realize that they loose money by using mercury before sending ore to the cyanidation tank, but they simply cannot afford to wait. Wealthy operators with sufficient capital do not mercury-amalgamate ores before sending ground ore to the tongs as they know they will get all the gold without losing time and money in the amalgamation process. Those who do not have enough capital to wait for production from cyanidation tank use mercury to acquire the necessary capital needed to purchase materials (cyanide,carbon) and operate a cyanidation tank.

We estimate that perhaps up to **one-third of the gold yield** in North Sulawesi is still obtained using mercury in the whole ore amalgamation process, with two-thirds acquired in cyanidation tongs.

The operation and management of cyanidation tanks is complex. A full cycle of the cyanidation process takes about 1 month. Typically, a 20 ton tong is run between three and five times with fresh ore (much already having been amalgamated with mercury) collecting and re-using the same activated carbon for each batch. Each run takes 3 – 5 days. However, the bottleneck in gold production is ore supply and capital. Thus, tongs are run only every two to three months, and sit idle when not being used. Gold recovery from a single run in the 20 ton cyanidation tank ranges from 100 – 200 grams. If a tank is run 4 – 5 times with an average gold yield of 150 gm, this totals 0.75 kg of gold. Based on the density of slurry, number of times a tank is run, and gold recovery, we estimate the gold grade to be about 7 g per ton, not including what is recovered by mercury. Thus, gold grade probably ranges from 10 – 12 gm per ton.

Based on interviews of several independent owners and operators of cyanidation tanks, we were told that approximately 1.0 kg of gold is acquired through an entire cyanidation cycle, which is close to our estimate of recovery. Therefore, if it takes between 2 and 3 months to acquire sufficient ore to run a cyanidation tank through its full cycle, conservatively speaking, there are four runs annually times 0.75 kg of gold or 3 kg gold / tong. Assuming that 80% of the 160 tongs in North

Sulawesi are operational and each produces 3 kg of gold, this amounts to 384 kg, just from the cyanidation process. Assuming that up to one-third of the gold is acquired from mercury amalgamation, total gold production from 'legal' operations in North Sulawesi may exceed 500 kg annually.

There are many operations that operate far out of sight of government authorities in remote forested regions or in protected reserves. The vast majority of these operations produce gold exclusively with mercury, although we are aware that some of the ore from these illegal operations is transported to the tongs for further gold extraction. Thus, the true amount of gold produced is probably much more, perhaps 3 or 4 times greater. Also, the amount of mercury loss may be correspondingly higher.

II.2.3 Mercury Loss

Mercury is lost to the environment in two ways; as gaseous mercury during burning of amalgams, and adhered to fine particles in the grinding/milling process in the trommels as 'floured' mercury. When ore that has already been amalgamated with mercury is introduced into the cyanidation process, floured mercury is dissolved and can be adsorbed onto the carbon and lost when burned, or released as mercury-cyanide complexes to holding ponds. These ponds fill and overflow during the rainy season, discharging contaminants to local streams. Thus, there are several avenues for loss of mercury to the local environment. In the Manado area, the Talawaan River carries mercury contaminated water and sediment to the local marine environment where it is already acknowledged that fish are mercury contaminated. In the Bolaang Mongondow area, mercury contaminated water and sediment is carried north and accumulates in small reservoirs that have been constructed along the river, or is deposited into rice paddies during the rainy season. Although rice is not affected, these ponds are also used to grow fish and elevated mercury in fish taken from these ponds has been documented by our studies.

In the Talawaan and Kotamobagu areas, amalgamation of raw ore using mercury is common practice in many operations, although some have made the complete transition to cyanidation. Given the large area and diversity of operations it is difficult to definitively estimate mercury loss. The price of mercury has increased considerably in recent years from $10 US to at least $60 US, which has caused operators to abandon mercury or use less mercury. Also, mercury has been classified as a hazardous substance and it is becoming increasingly difficult to find in the marketplace. However, it is now illegal to sell cyanide without a license, and we are concerned that this will drive some operators back to mercury.

Based on our observations and information gathered from many operations, we estimate that between 50 to 100 gm of mercury is lost per 400 kg ore processed within individual trommels

(grinding mills). Total loss of mercury per 10 trommels is roughly 10 kg mercury per month. So, it is relatively simple to determine total mercury loss during the amalgamation process. However, there are a wide variety of frequencies that mercury is used in trommels. For example, many licenced operations use mercury in all trommels all the time. However, some operations only use mercury once in awhile for 'fast cash'. Others use mercury all the time, but only in one trommel to test the gold grade of the ore. There is a small percentage of operations that do not use mercury at all, having sufficient capitol to send all ore to the cyanidation process. Table 3 provides an estimate of the amount of mercury lost to the environment on an annual basis from the Bolaang Mongondow District, based on the frequency of mercury use in various operations (i.e., from all mercury all the time, to no mercury use). Using this calculation, we estimate approximately 2,700 kg of mercury is lost from whole ore amalgamation, not including the amount of mercury lost to the atmosphere from burning of amalgams. This is a large amount of mercury lost relative to gold produced (i.e., about 500 kg), for a ratio of mercury loss to gold produced of 6 or 7:1. However, on the sites that use mercury amalgamation only, the ratio can be as high as 20:1.

Assuming that about 390 kg of gold is produced annually in the cyanidation process which accounts for two-thirds of annual gold production, one-third, or 130 kg of gold is acquired using mercury. Assuming the mercury / gold amalgam is a 50:50 ratio, a further 390 kg of mercury is lost directly to the atmosphere.

There are a larger number of unlicensed operations in more remote areas and in a protected wildlife reserve, that still use mercury in trommels to amalgamate whole ore. While some of these operations also probably transport Hg amalgamated ore to cyanidation plants, the majority do not and the loss of mercury relative to gold produced is quite high. The number of these trommel operations is unknown, but may equal or exceed the number of licenced operations. Thus, the actual amount of mercury lost is likely much greater than 3,000 kg annually from Bolaang Mongondow District. This does not include mercury loss from the Talawaan District or other mining areas in North Sulawesi.

II.2.4 Mercury in Fish

In March 2006 there was a flood and many of the tong operations and the cyanidation ponds were flooded and released sediments to the terrestrial landscape and into streams. This prompted the Health Department to sample well water for mercury, because of their concerns about mercury loss. Results showed mercury in water exceeded 1 part per million, the human health standard, and the Health Department advised residents not to drink well water. This caused uncertainty as to whether other foods, such as rice, vegetables and fish were also contaminated. As no information existed on this, in cooperation with Sam Ratulangi University Manado and the University of Victoria, BC, fish samples were collected from streams and rice paddies impacted by mining operations. Results of this study are documented in Baker (2007).

Five species of fish were captured including Nile tilapia or nila (*Oreochromis niloticus*), Mozambique tilapia or mujair (*Oreochromis mossambicus*), silver sharkminnow or nilem (*Osteochilus hasseltii*), walking catfish or lele (*Clarias batrachus*) and Java barb or tawes (*Barbonymus goniontus*). In rice ponds, fish had up to double the mercury concentration of fish captured in streams that are directly affected by mining. We suspect that inorganic mercury from mining operations is carried or discharged (directly or atmospherically) into ponds and paddies adjacent to the river. Such ponds are good environments for mercury methylation and may be responsible for higher mercury observed here. Silver sharkminnow captured from streams near the mining area had mean mercury concentration of 0.25 ppm; in ponds the concentration was 0.5 ppm. These are high concentrations for such small (12 – 15 cm) fish. Fortunately, most people consume fish from the fish market and not the streams. Market fish are either farmed or from the nearby marine environment and presumably, have lower mercury concentrations than observed here, although this has not been confirmed.

II.2.5 Campaign Activities

The focus of activities in North Sulawesi was on awareness of the health hazards of mercury exposure because of the large number of people in the industry, the recent awareness by government authorities about mercury contamination (e.g., impacts to the tuna fishery and contamination of drinking water in Kotamobagu), and the collateral effects on the non-mining population, through fish consumption or exposure via other media. Given that there has been an incomplete transition towards cyanide and mercury is used less than historically, and given the limited funds and local expertise available, the contractor, Lestari, focussed on media campaign activities, which is their forte. Technology introductions were limited to sluice box introduction (i.e., gravity concentration) as a means of replacing whole ore amalgamation as a means of “fast cash”; and retorts, to recapture mercury during burning of amalgams. There was little effort made to improve the efficiency of the cyanidation process because of the persistent, widespread use of mercury, which was identified as a greater priority to change.

A wide variety of media campaigns were launched between August 2006 and February 2007 in all of North Sulawesi in addition to specific activities in Bolaang Mongondow District. These included brochures and posters, meetings with government offices, television, radio and newspaper articles and inserts with wide readership.

The mining communities of Tanoyan and Talawaan in particular, have adopted cyanidation as the primary means of extracting gold from raw ore. However, mercury is still routinely used in many operations and there is significant environmental contamination and direct and indirect exposure of people to the harmful effects of mercury. At the outset of the project, UNIDO attempted to assist villagers in the Tanoyan area, with optimization of cyanidation practices to recover more gold. This was a logical follow-up step to the efforts made by the US Department of Interior. However, there

were no good technical resources in the country to do this effectively. Moreover, during subsequent visits, UNIDO contractors learned that mercury was still being widely used, more so than we were initially led to believe by the miners. Thus, there was a mid-course correction to attempt to reduce mercury use through the health awareness campaign, but also by the introduction of gravity concentration.

Sluice box technology, which can be very simple and effective, was introduced to Tanoyan late in 2006. Several demonstrations were made with the cooperation of the mining community. The miners were quite curious and willing to adopt the technology, as they could see the benefits of eliminating or reducing mercury use, beyond the high price they pay for mercury. Rather than treating a few trommels, or all trommels periodically with mercury, the ground ore from all trommels could be passed over a sluice box and the larger gold particles recovered for ‘fast cash’. Thus, mercury would not be introduced into the raw ore that is sent to the cyanidation tanks.

Despite our attempts and the attempts of the miners, it appeared that gravity concentration would not be adopted. Gold particles are simply too fine to be captured by the carpeted sluice box in sufficient quantity to warrant the time and effort required to do this. Ore shipped to the University of British Columbia where further testing was done revealed that this was indeed the case – the gold particles were too fine to be captured even by more sophisticated gravity concentration means, such as a centrifuge and shaking table.

Lestari did manage to demonstrate, however, with the participation of some miners, that gold recovery by the sluice boxes was possible, at about half the yield of whole ore amalgamation with mercury – buy not consistently or reliably enough; especially with low grade ore.

Gravity concentration has not been adopted by the local community because the technology is not appropriate for this ore type. Although optimization of cyanidation technology might be the focus of future work, this does not address the need for ‘fast cash’ that is currently supplied by mercury. Testing by the University of British Columbia on ‘small-scale cyanidation’ may provide this solution.

In addition to the sluice box, retorts were introduced, both pipe and kitchen bowl retorts. The mining community was very interested and willing to adopt this technology because they appreciated the obvious benefits for minimizing exposure to gaseous mercury, and to recover mercury for re-use. Because burning of amalgams does not occur with great regularity, and is not conducted openly, in the view of strangers, the contractor was not able to determine the extent to which retorts were adopted, if at all.

II.2.6 Accomplishments

The incomplete transition to cyanidation technology, relatively advanced knowledge of the principals of cyanidation and the large infrastructure investment in this technology in North

Sulawesi precluded UNIDO from undertaking a large, technology driven program here. Instead, because of the widespread use of mercury in whole ore amalgamation practices and its dangerous combination with cyanide, we focused on health awareness over a large area both within and outside of the mining community.

Mining in the area is widespread and has been ongoing for nearly 20 years and there are likely health effects in both the mining and non-mining communities. Thus, focus of the program was on health awareness, hazards of mercury exposure, understanding mercury pathway and effects and how to protect individuals. This was accomplished through a variety of media with widespread and frequent messages.

- Two, four-page color inserts were published in the Manado Post with a circulation of 25,000.
- One hundred color and black and white booklets were printed and distributed focusing on 'Mercury and Family Health', 'How to Get More Gold' and 'Protect your Water'.
- Five hundred color posters were printed and distributed emphasizing the importance of avoiding exposure to mercury.
- Five hundred leaflets were printed detailing materials, processes and objectives of using retorts and sluice boxes.
- At least 8 radio talk shows dealing with a variety of issues involving mercury were presented with an audience throughout North Sulawesi, including Talawaan and Manado. It is difficult to say how many people listened to the broadcast, but it may number in the tens of thousands.
- Three television broadcasts were made on two stations in the Bolaang Mongondow District and in Manado involving senior officials from several government departments including Environment, Health and Mining. These broadcasts reached a wide audience in North Sulawesi. Again, although viewership is unknown, the likely audience is probably in the tens of thousands.
- Several direct meetings were held with senior government officials to appraise them of the situation, educate them and provide them with information to allow intervention.
- Several meetings with leaders of the mining community were held to provide information, answer questions, introduce technology, discuss brochures, and distribute pamphlets.

Lestari's survey indicated that there has been a great increase in awareness within the local mining community about the health hazards of mercury. Most respondents (86%) knew that mercury was bad for their health. Most respondents heard about this information either directly from the contractor (19%) or from awareness campaign media including radio (20%), TV (8%), newspaper

(4%) and posters (18%). There has obviously been an influence on government agencies as well (23%).

II.2.6.1 Peripheral Benefits

A network of journalists in North Sulawesi has been educated about ASM issues and has developed valuable experiences during the GMP campaigns reporting on gold mining – an important livelihood for the region. As a result of the campaign, these journalists will be more likely to report on environmental and health impacts of large and small scale mining activities in the future. This in turn will stimulate the public to continue putting pressure on the provincial government to regulate and monitor mining in general and control hazardous substance use and waste disposal.

II.2.6.2 Indications that Awareness will be sustained

In general, the artisanal mining community in North Sulawesi is more educated compared to other provinces in Indonesia. They were the first to experiment with and benefit from training on cyanide processing techniques. There are strong economic incentives to adopt new technology (in addition to environmental and health considerations). Operators in the area are receptive to new ideas and technology advancement as long as it will increase their profit. Because the current cyanide process is not optimal, mercury is still being used. However, when cyanide technology is improved, it would be relatively easy to convince miners to eliminate mercury altogether.

II.2.7 Challenges

In North Sulawesi, mining has been underway for 20 years, and during the last 10 years or so, there has been a transition to cyanidation. However, this transition has been incomplete and for a variety of reasons, the use of mercury in the practice of whole ore amalgamation still persists. GMP did not have sufficient resources to assist miners in improving the cyanidation process thereby eliminating the need to use mercury.

An entrenched mining infrastructure is difficult to change. The need for ‘fast cash’ by operators that cannot afford not to wait until they have sufficient capital to operate a tank, continue to use mercury. Some members of the local population, especially in Talawaan are relatively affluent because of profits generated from gold mining. Subsurface mining without a license is illegal, yet there is no motivation by the local government to halt this profitable activity.

Cyanide has recently been classified as a ‘hazardous substance’ in the Kotamobagu area. Its sale is only permitted by a single licenced outlet and it can only be purchased by a licenced purchaser. Thus, difficulty in obtaining cyanide may drive both legal and illegal mining operations back to mercury.

Although several permits are required from several levels of government to own and operate and approvide cyanidation facility, there is no enforcement and tailings ponds are perched on the edges of streams. During the rainy season, these ponds fill and overflow, discharging sediments, probably containing decyanidation by-products and mercury, into fish-bearing streams.

II.3. Project Site C: Sekonyer river, Kotawaringin Barat District, Central Kalimantan

II. 3.1 Introduction

Rasau and Aspai are two remote mining camps along the west side of Sekonyer river in Kota Waringin Barat District, Central Kalimantan province. Tanjung Puting National Park, a world famous natural reserve is located directly across, on the east side of the river. The park covers an area of 415,040 providing native habitat for the endangered orang utan (*Pogmo pigmaeus*) and other protected tropical fauna and flora species. The two sites are located approximately 5 km apart, on the south coast of the world's largest protected tropical rain forest in Kalimantan known also as Borneo (Figure 6). Since there are no accessible roads, the only reliable form of transportation for people and goods is by boat or canoe. Even though its only 60 km from Pangkalan Bun, the capital of Kotawaringin Barat District, it takes most of the day to journey to the camps since it involves land and water transportations. A short 30 min taxi from Pangkalan Bun to Kumai port town is followed by a 3 hours boat ride to Sungai Sekonyer village (pop 200), the nearest village where miners obtain supplies. From the village, it takes only 30 min to the camps.

Mining for gold along Sekonyer River has been going on for over 20 years. Miners have cleared forested area to dig deep pits on land as well as pumping sediment with dredges on the river, negatively impacting the river ecology and threatening the protected area. Occasionally miners have crossed over into the Park to explore for new deposits. Options for livelihood for most people are limited to illegal mining (gold and zircon), illegal logging or poaching, continuing the cycle of poverty and degrading the forested area further. Access to educational and health services are sporadic to non-existent. Children from mining camps do not attend school unless their families can afford to send them to Kumai, the nearest port town. Aspai, being the largest camp along the river, has about 1,000 miners and temporary occupants, while Rasau has only about 500 miners The majority are migrants from Kumai, Java, Banjar (South Kalimantan), Sumatra, Sulawesi and a few local Dayak mixed in the camp's population.

GMP has not conducted any baseline study to identify the state of socio-economic or environmental and health of mining community in this area. UNIDO grant was limited to developing activities for an awareness campaign. Friends of the National Park Foundation (FNPF), our local partner for the campaign, has initiated a study collecting data to identify the concentrations of mercury in soil, fish, and human's hair. Analyses for total mercury and methyl mercury were conducted by Dr.

Shunichi Honda from National Institute of Minamata Disease (NIMD) in Japan. The concentrations of total mercury in a few fish species frequently consumed by the locals such as *Ikan Harwan* and *Ikan Baung* were higher than the concentration for human consumption recommended by WHO. Total mercury concentration from hair of zircon miners, burners, mixers, shop owners, and housewife were relatively higher than those of other occupations. Further, the overall average total mercury concentration in this community is much higher compared to general population collected from countries around Asia (Honda, 2007). The results of fish and hair sampling and analyses also confirmed the assumption that Aspai and Rasau camps are mercury "hot spots" in Central Kalimantan. Miners and residents have been exposed to mercury inhalation and consuming contaminated fish unknowingly.

II. 3.2 Gold Mining and Production

Miners exploit alluvial deposit on land using hydraulic pumps in both camps, but river dredging (locally known as *melanting*) is practiced only in Aspai. Information about the gold grade is not available. In 2006, the average gold recovered from Rasau is estimated 4.1 gram/day/group or 1.230 kg/year/group. Since there was only 15 groups mining gold in this area, total gold produced would have been 18.45 kg for 2005. Gold is sold for approximately US $17.20/g and mercury cost US$ 86 per kg. Miners in Aspai Sebrang, an extension of Aspai camp, claimed to have recovered large amount of gold from this site (50 – 70 grams per day for about a month). It is estimated that gold production in 2006 was 7.7 gram/day/group or 2.3 kg/day/group or 32.2 kg/month total. Gold production data needs to be verified further.

Similar to the situation in Galangan, miners work in a group of 2 to 5 attending one hydraulic pump and sluice box lined with carpets, working 8 to 10 hour shifts 6 days a week. Many sluice boxes are located at the waters edge, or in some cases on the river. At the end of the day, the carpets are rinsed on to a bucket to obtain gold concentrate. Mercury is added to form amalgam by manual mixing for 5 to 10 minutes, followed by squeezing the amalgam through a synthetic piece of cloth for future use. Some small amount escaped, and along with the contaminated tailing is discharged directly into the flooded pits or river. The dredging operation has caused heavy siltation, degrading aquatic habitat and ecology of approximately 100 km down river. Amalgam is often burned either in the kitchens, living room or porches of the rig owners. Some miners simultaneously mined for zircon in addition to gold. Women in the two camps are involved in all phases of gold recovery, including burning of amalgam, unlike the more traditional practice where only men are allowed to work in the gold fields.

II.3.3 Mercury loss

Information on gold mercury use/loss is not available at this time. However, it is assumed that a mercury loss from burning the amalgam is much greater than loss from amalgamation process. FNPF conducted preliminary survey prior to campaign activities. They have discovered that **miners had no prior knowledge about the health hazards of mercury or any alternative technology to reduce exposure**. Everyone in these mining communities is unknowingly exposed to high concentration of mercury, particularly those living in the proximity of a gold shop or amalgam burning area. Health assessment to identify neuropsychological symptoms of mercury intoxication from chronic exposure has not been conducted.

II.3.4 Campaign Activities

FNPF has implemented the awareness campaign for six months starting in September 2006 to February 2007. During that time, the group made direct contact with miners and
and non-miners in the attempt to raise awareness of mercury health hazard and introduce cleaner technology. The campaign focused on broad target audiences including miners, spouses, school children, government officials, and general public in Rasau and Aspai mining camps, in Sekonyer River village, in port of Kumai and Pangkalan Bun, the capital. To achieve the objectives, FNPF has conducted numerous activities combining social marketing and demonstration of alternative technology using Transportable Demonstration Unit (TDU) as an educational platform.

FNPF has produced materials for mass media campaign. Simple and easy messages about mercury health hazard and alternative technology were broadcasted to reach the general public by Primadona, a local radio station in Kumai with listeners up and down the Sekonyer and Kumai rivers. Additional health issues such as malaria, filariasis (elephantiasis), and HIV/AIDS were discussed during the three sessions of one hour each long program. Brochures, posters, fact sheet and booklets were distributed during presentations and the campaign emphasized direct personal contact with miners, school children, government officials and gold shop owners. Information about health hazards of mercury was also developed as a curriculum for the local school. Articles on mercury use in gold mining and the result of fish analyses were published in Kalteng Post, the most prominent local newspaper in Central Kalimantan.

The most crucial activity was FNPF's team visits to Aspai and Rasau camps and direct interactions with miners. Even though the logistics to get to the camps were challenging, the team visited these camps on a regular basis. They were able to gather valuable data, built trust, and disseminated information via presentations and distributions of printed material. On one occassion, the team visited to Rasau camp together with nurses from *Puskesmas* (Community Health Center), whose mission is to reduce the outbreak of *Elephantiasis*, a serious parasitic infection. *Elephantiasis* is closely associated with mosquitoes breeding in the stagnant water of flooded mining pit.

Consultations with miners and gold shop owners were focused on improving technologies in gold processing techniques. Prior to visits, two members of FNPF attended the Training of Trainers workshop coordinated by UNIDO and YTS. Health and technical knowledge as well as skills to built equipments gained at the training were applied during the field trips to the camps.

Using TDU concept, trainers demonstrated the use of three retorts (pipe, Fauzi and kitchen bowl retorts), amalgamation drum, fume hood with filter and personal protection tool (rubber gloves). All equipments, except for the Fauzi retort and the rubber gloves, were made locally. The team combined health consultations with introduction of these equipments and techniques including Pantoja's method to reactive mercury.

II.3.5 Accomplishments

By the campaign's mid-term, a total of **4,750 brochures, 50 booklets and 25 posters** were printed in Indonesian language and distributed to the target populations mentioned earlier. **Two hundred fifty brochures and one banner** were also printed in English for International visitors to Tanjung Puting National Park. Posters containing message about mercury health hazard were distributed to schools and government offices including the National Park Services, District Health Department, Community Health Center, Department of Fisheries, Department of Environment, rig bosses and leaders in the communities. The result of hair and fish sampling and analyses was published in an article in Kalteng Post, a local newspaper with daily circulation of **24,000 readers** throughout Central Kalimantan province.

Radio Primadona, based in Kumai has broadcasted program discussing health and mining issues for a total of **three times**, each one hour long. It is estimated to reach **2,000 listeners** mostly miners living in the gold fields and mining camps.

During the campaign FNPF have trained **3 staff and 2 volunteers** about the health hazard and technology improvement. **Eight high school students** from Heal Green Conservation Club were trained to assist with gold shop survey in Pangkalan Bun. The students also **wrote and performed a play** to convey health messages in meetings with local government officials. FNPF team presented to a total of **15 government officials**; 7 from the National Park Authority, 3 from Health Department, 1 from Environment Department and 2 medical doctors from Community Clinic (*Puskesmas)* in Kumai. **One** staff from Orangutan Foundation (OTI) and **one** from Dian Tama Foundation (DTF) also received the information. Health education materials have been distributed to **583 students** during visits to the local schools.

Direct consultations and advisory regarding mercury health hazard were provided to **71 miners and 54 families or 264 non-miners** in Rasau and Aspai and other camps along Sekonyer River.

Seventeen fishermen and **one member of the local Parliament** also received the health information and the result of fish analyses. **Seven gold shop owners** in Pangkalan Bun were visited and consulted regarding the use of cleaner technology such as retort and fumehood.

Behavior change takes time. Miners, and other target populations in Aspai, Rasau, Pangkalan Bun and Kumai have learned the health hazard from mercury use and contamination in gold mining. FNPF's team reported that many miners and their families were grateful to have received this information. **One rig owner** had obtained the kitchen bowls to make **his own retort** and **one set of pipe retort** was given to a rig boss in Rasau However, due to lack of practice with real amalgam to burn, as well as insufficient information on the equipment specification from UNIDO/GMP, the effort has not produced the desired results.

Towards the end of campaign, FNPF team has randomly surveyed 20 miners and residents of the 2 camps (18 men and 2 women) to assess the level of awareness in regards to health hazard of mercury exposure and knowledge of the technological solution to reduce mercury contamination. The result shows **50.6% increase of awareness** among camp residents whilst **38.7% of increase was reported among students** in Kumai (39 total). The team did not have resources to conduct a full survey to assess changes in the awareness in all target populations.

II.3. 5.1 Peripheral benefits

During workshops to build capacity, government officials and members of other NGOs in this remote area learned *for the first time,* health issues related to mercury use in gold mining. Some were taken aback upon learning the fact that mercury intoxication can have profound health impact, especially to the development of children. Staff from Dian Tama Foundation, an NGO based in Pontianak, capital of West Kalimantan province has already expressed interest in conducting similar campaign in West Kalimantan. Other local community-based organizations facing the same issues have inquired FNPF and GMP assistant to country focal point to be included in future GMP project.

Many foreign visitors to Tanjung Puting National Park will learn about the mercury issues from park rangers previously trained. Additionally, the Fisheries District's staffs are also beginning to take interest in protecting the fishing industry from mercury contamination.

II.3.5.2 Indicators that Awareness will be sustained

The awareness campaign was well-received by the government officials including staff of the Department of Fisheries, Department of Environment and the National Park Services. Local fishermen have expressed concern about methyl mercury in fish and the potential threat to their

livelihood. A village official in port of Kumai stated his intention to alert the *Bupati* or Head of Kota Waringin Barat regarding issues related to mercury contamination.

II.3.6 Challenges

Miners have shown high level of interest in adopting new technology, primarily the retort that would recover mercury as well as reduce operational cost. However, due to the small size of amalgam and the relatively longer time needed to burn amalgam using retort, miners prefer using communal torch to burn amalgam in the open for quick result. It is understandable that they were reluctant to combine smaller amalgams belonging to several miners prior to burning. It is difficult to divide the amount of gold recovered. In some instances, demonstration of retort did not produce the expected result. In spite of difficulties producing results during the demonstration, the introduction of retorts has generated curiosity and willingness to experiment among miners.

GMP has a limited amount of fund and support for this project site. FNPF field staffs have applied their knowledge and skills gained during Trainings of Trainers. However, they did not received adequate technical support from UNIDO to implement the campaign including building TDU equipments.

Unlike Galangan or Tanoyan, these two mining camps are located in a remote area, with hardly any basic infrastructures, only accessible by boat. Cost of transportation for the field visits was very high. FNPF is a small NGO with a limited budget. When UNIDO was late in providing fund, it caused a long setback in the implementation.

In October 2006, Kalimantan faced the worst forest fires in history, damaging massive standing timber within the Park and elsewhere. The resulting smoke/haze covered an extensive area in Kalimantan and neighboring countries such as Singapore and Malaysia for several months. FNPF staff had to stop all campaign activities to work on fire management issues to protect the Park.

III. Overall Assessment

In Indonesia, the GMP managed to introduce technology and conduct health awareness campaigns on three sites, each with different cultures, infrastructure, processing methods, understanding and knowledge of health awareness, government capacity, affluence and other issues. These three sites were geographically remote and far apart including a site in North Sulawesi and two sites in Central Kalimantan, while being administered out of UNIDO office in Jakarta. Each mining community exists under vastly different organizational and government structures with diverse levels of understanding and attitudes towards mining, mercury use, legal status and environmental and human health. Despite this diversity, many achievements were accomplished. The purpose of these

interventions was to instill capacity so that the GMP objectives can be sustained and developed further within the pilot regions and beyond.

III.1 Achievements

Achievements are summarized within the context of technology introductions and sustainable awareness of the hazards of mercury exposure and implications for protection of human health and environmental health.

Health awareness

Throughout Indonesia, there is limited awareness of the potential health hazards from mercury exposure. In fact, some people believe that rubbing mercury on their skin would afford them protection and make them stronger. The level of awareness of dangers of mercury exposure was not correlated with affluence, or level of education. Even the most senior people in local government agencies were often completely unaware that exposure to mercury is harmful and that the greatest harm is caused by inhaling mercury vapor during burning of amalgams and from consuming mercury contaminated fish; not from skin contact. Health awareness was accomplished via direct and indirect interventions with miners and their families and local government authorities in mining, environment, health, education and industry and trade departments. These messages were disseminated via many different avenues including, but not limited to the following:

- Media campaign materials, appropriate for each local community, including radio and television broadcasts, printed materials such as posters and brochures, newspaper inserts, and billboards
- Capacity building within local government agencies was achieved and in Galangan, Central Kalimantan; progress will be sustained because the local leaders including the head of the District government *(Bupati)* assumed responsibility and enacted new policies (on various mining and mercury-related issues) and financial resources to promote the health and well-being of the mining community as well as those indirectly affected by mining.
- Education materials also focused on school-children, within and outside of the mining community to educate them about the routes of exposure of mercury, how to avoid mercury exposure and raise consciousness in current and future generations.
- Local people were actively engaged and involved in the project in all areas. This will increase the likelihood that capacity has been instilled in the community so that messages delivered are sustained.

Technology

Technology was introduced where appropriate, with the dual objectives of increasing gold recovery and reducing mercury. However, prior to implementation of this phase of the GMP there was no information on gold grade of different ores, efficiency of gold recovery, nor how the existing systems could be improved. Thus, there was no clear path for our contactors to take, especially given the short time-frame for implementation, and this had to be conducted via trial and error.

A significant impediment to effective technology introduction was also the insufficient amount of time, materials and expertise available to quantitatively assess gold recovery using their existing technology and deduce ways to improve on it. For example, in North Sulawesi there is an incomplete transition towards cyanidation. Initially, technology solutions were focused on improving efficiency of cyanidation. However, given the lack of technical resources (local and within UNIDO) on this aspect and the fact that mercury is still widely used, our efforts shifted towards mercury reduction and the means to avoid or reduce the interaction between mercury and cyanide in the gold production cycle.

In central Kalimantan, we learned that ore concentration using sluice boxes was efficient and that the greatest loss of mercury was primarily to the urban environment from burning of amalgams in gold shops. Therefore, technology efforts shifted away from optimization of sluice boxes towards retorts as the primary means of limiting mercury contamination. Thus, technology interventions evolved to focus on reducing the greatest point-source losses of mercury to the environment, and were less focused on optimizing gold recovery. Nevertheless, several significant improvements in advancing technology were achieved in each area.

- A complete transportable demonstrate unit (TDU) was established at six mining camps of Galangan, complete with examples of technology, health information, videos, posters and brochures and other kinds of assistance in general health awareness (e.g., malaria, HIV/AIDS, water quality, sanitation and hygiene).
- The most successful technological advances were achieved with the input and participation of local miners and gold shop operators, not via unilateral interventions by UNIDO experts.
- In Kereng Pangi, Central Kalimantan, condenser/filtration boxes that function as retorts were retrofitted into at least half of the gold shops by the end of the program, with likelihood that most if not all gold shops would adopt the technology in this community.
- Technology intervention could only be achieved within the context of appropriate cultural sensitivity. In Central Kalimantan, where the distribution and use of mercury is tightly controlled, any intervention to reduce or re-capture mercury was only achieved with the blessing of all parties involved. This effort is still on-going.
- Amalgamation drums, rubber gloves, fumehoods and retorts were introduced as means of reducing direct contact and exposure to mercury. Over time miners may adopt this new

technology. A few field demonstrations at the mining camps had not convinced the majority of miners but had certainly raised the level of interest.

III.2 Challenges

As in any developing nation, there are many challenges facing governments, non-governmental agencies, and mining and non-mining communities, apart from the issue of mercury and its potential adverse effects on environmental and human health. These are common to most countries, such as lack of expertise, an entrenched system of social disparities, a top-down hierarchy of authority that does not easily change, and so on. In the areas we surveyed in Indonesia, mining has been underway for at least 20 years and there is a diversity of situations among them. For example, in North Sulawesi, there has been an incomplete transition to cyanidation, which poses its own unique problems. In central Kalimantan, most miners are itinerant, being mostly from Java, so they do not have the same respect for the landscape that local residents might. Given that mining is the primary means of sustenance for day to day living by many people, shifting away from mining to engage in another livelihood is simply not a viable option. Challenges facing Indonesia include, but are not limited to the following:

- Absence of laws, regulations or codes or practice to regulate and control ASM activities and use of mercury and cyanide. This is a significant limitation to governmental responsibilities for monitoring, regulating and controlling ASM. (The recent decentralization of powers from the national government in Indonesia to local levels of government means that there is a new governance climate - in which many district governments have much greater responsibilities now than before. The recent policy developments in Katingan on mercury and ASM are some of the first district policy developments on these issues in Indonesia.)
- There is a lack of local government expertise, infrastructure and resources, both human and financial, to monitor operations and enforce legal requirements (if any).
- Discharge of waste products (e.g., mercury contaminated soils and sediment, mercury-cyanide complexes) to nearby aquatic environments are not adequately controlled and there is no knowledge of the potential downstream and ancillary effects of this practice.
- Dredging of rivers for alluvial gold adversely impacts water quality, notwithstanding direct loss of mercury to the aquatic environment, causing direct and indirect impacts to fish and fish habitat. This significantly affects both mining and non-mining communities for great distances downstream.
- Deforestation and destabilization of soils due to mining creates erosion and further contributes to environmental degradation of both terrestrial and aquatic environments, independent of issues related to mercury.
- Rehabilitation of mined areas by small scale operators is non-existent.

- In most areas of Indonesia, ASM is illegal, yet there is often little or no motivation by local governments to halt (or regulate) this profitable activity. Many ASM operations are conducted in remote areas, away from scrutiny. With an illegal status, or remoteness of the operation, there is generally a ‘hands-off’ attitude.
- Despite increasing awareness that exposure to mercury is harmful, effects are not immediately manifest and are difficult to detect over and above other health issues, so there is no strong motivation to change.
- Mercury and cyanide have been classified as ‘hazardous substances’ in some areas, thus there is a strong black market for these commodities that is difficult to control.
- Some technology is inappropriate. For example, pipe and kitchen bowl retorts are not ideal for burning small (1 – 5 gm) amalgams. Better technology is required to recover these small quantities of mercury that over time, add up to large amounts lost if retorts are not used. The burden of experimentation should not be left up to the contractor. This led to inefficiencies of time and funds.
- Empower the poorest workers, and enhancing their technologies, often requires the development of adaptive action-oriented education programs, new labor structures and building trust in new ways. Breaking old habits and customs can take time and often requires innovative community-based development models. Sharing knowledge between groups requires transcending well-established perceptions about development through innovation.

These issues are common in other areas of Indonesia, and are probably typical for many other countries. Although many challenges remain, significant progress, especially in the area of education and awareness of both mining and non-mining communities in Indonesia has been achieved.

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Fig1. Map of GMP sites in Indonesia: Galangan, Aspai & Rasau in Central Kalimantan and Tanoyan in North Sulawesi.

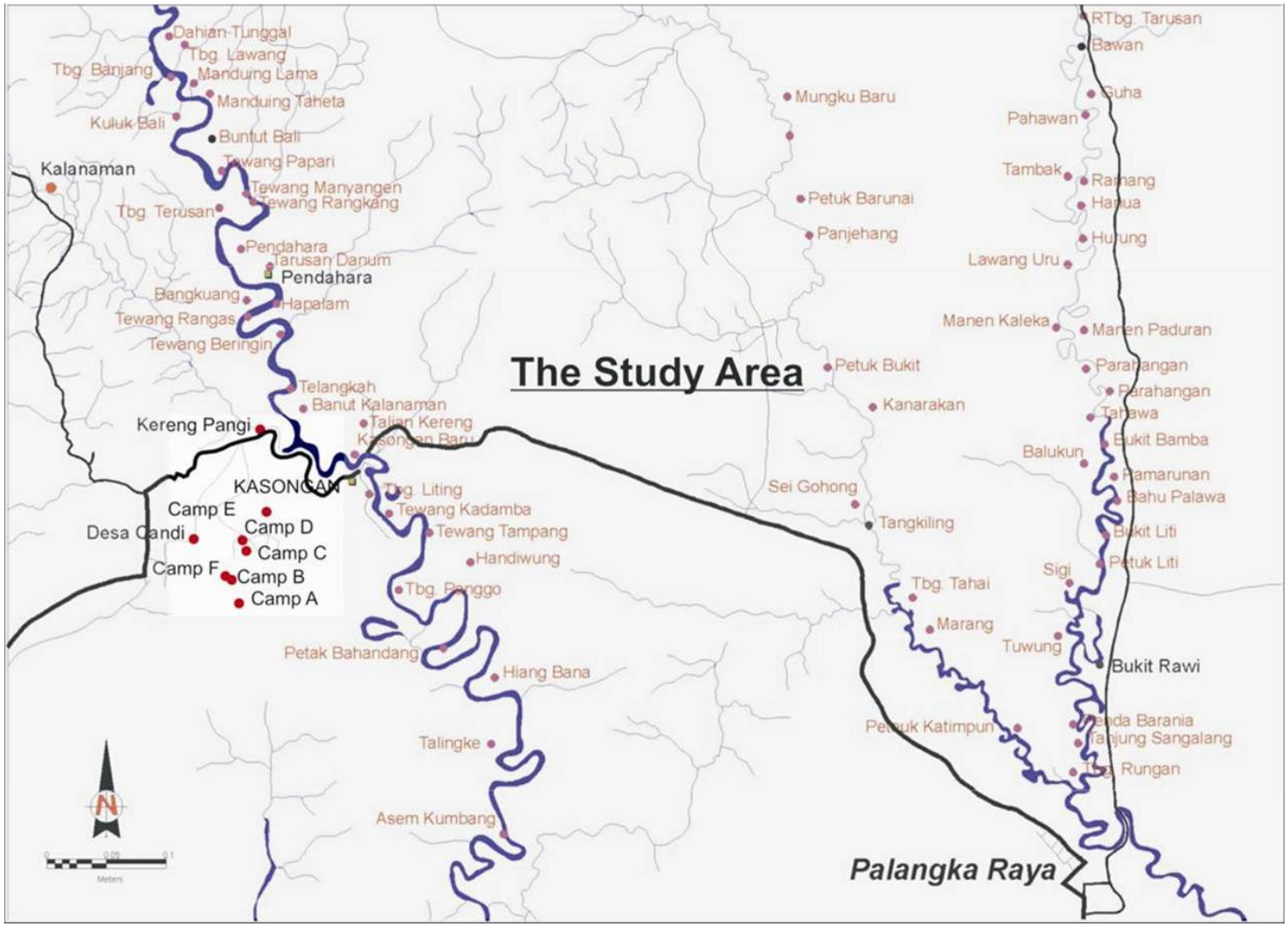


Figure 2. Map of six mining camps in Galangan and the town of Kereng Pangi, Katingan District, Central Kalimantan.

Figure 3: Examples of printed media for campaign in Galangan

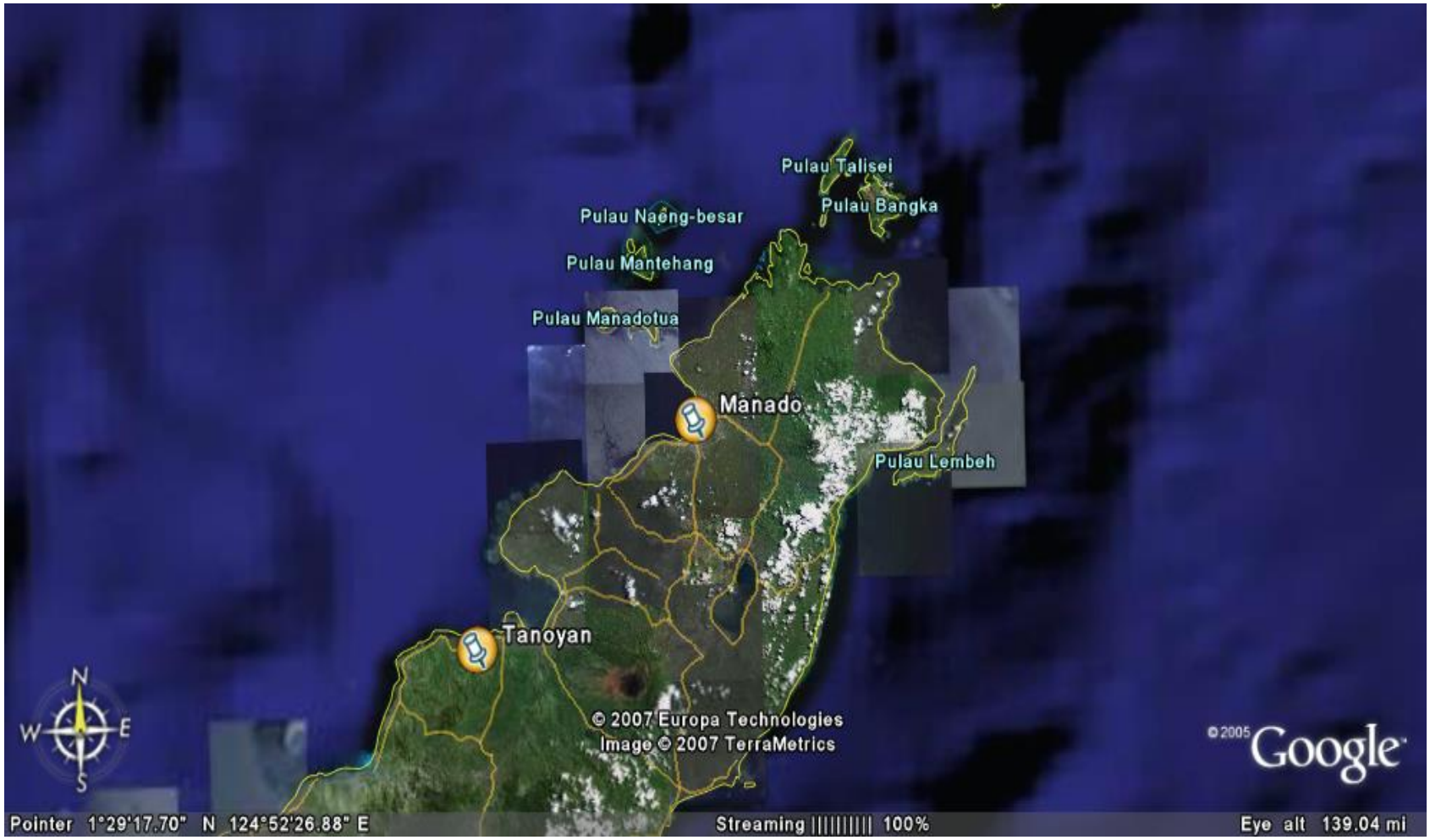


Figure 4 – Map of GMP site Tanoyan and Manado, the capital of North Sulawesi Province

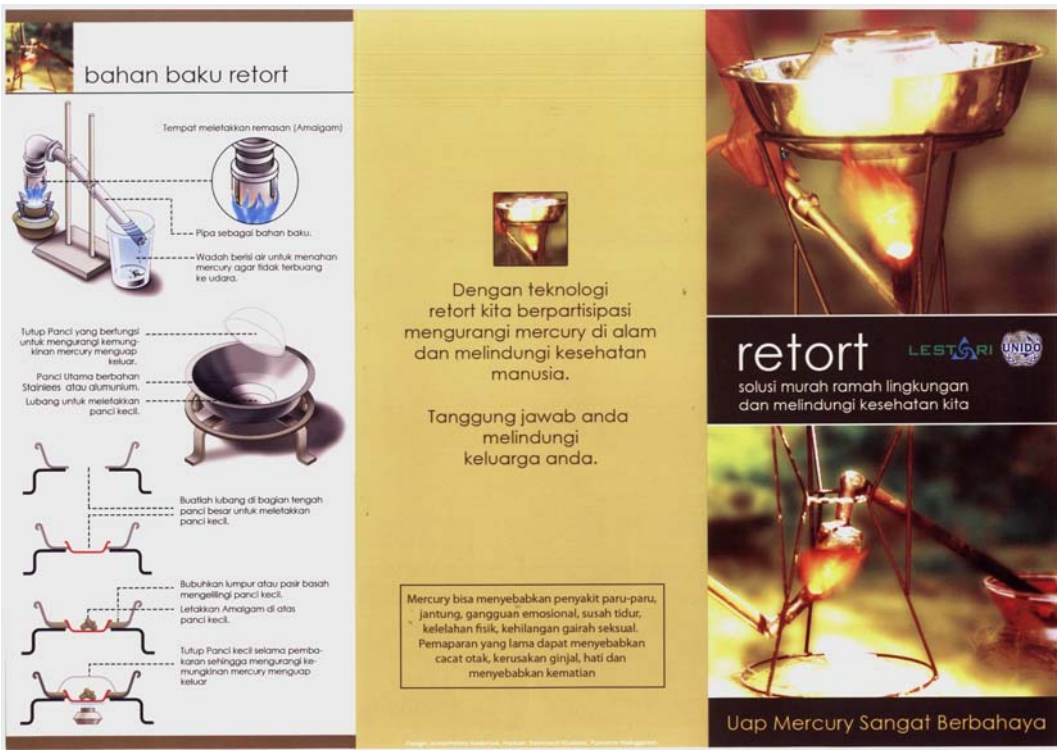


Figure 5 – Examples of printed media for campaign in Tanoyan

Figure 7. Map of Sekonyer River. Aspai and Rasau mining camps are on the middle reach of the river, opposite from Tanjung Putting National Park (adapted from Orang Utan Foundation International's website http://www.orangutan.org/).

Health risks of long-term Mercury exposure :

- Blindness, liver and renal disturbance
- Sexual dysfunction
- Brain damage & neurodevelopment effect

- Other Health risks

People can be exposed by :

- Skin absorption

- Inhalation

- Contaminated fish consumption

Contaminated fish, including::

- Amalgamation pond fish
- Large size fish that eat smaller size fish, including: Toman, shark and telang

Uncontaminated fish, including:

- Plants eater fish
- Pond fish ; mujair, seluang

Use Mercury wisely, for example:

- Use Retort to burn the amalgam
- Burn the amalgam outdoor
- Don't mix the mercury with your hand

PROTECT !!!

Your children & your family

From Mercury Exposure

GLOBAL MERKURY PROJECT

For Further Information :

Yayasan Pecinta/Penyantun Taman Nasional
(Friends of The National Parks Foundation)
Jl. Pelita No 51, Kelurahan Candi, Kec Kumai,
Pangkalan Bun – Kalimantan Tengah
Phone/Fax : (0532) 61212
www.fnpf.org

Beware of Mercury!

LESS MERCURY

more economical, more healthy

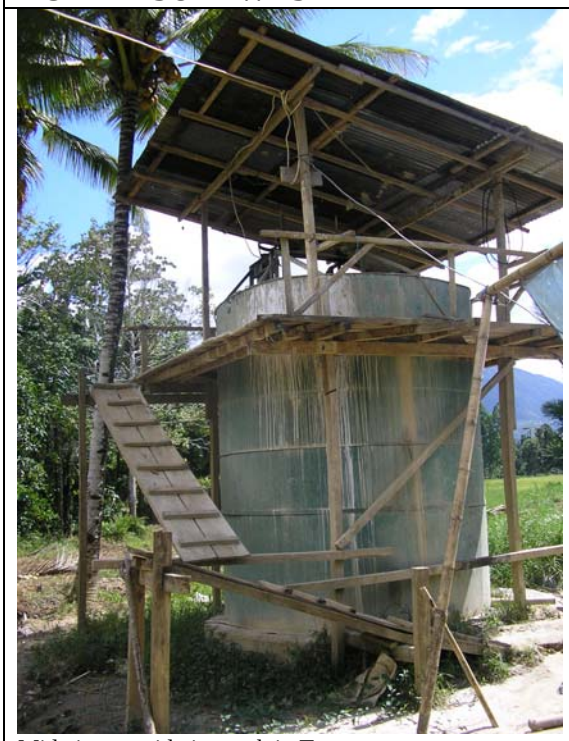
Figure 8 Awareness campaign photos from all sites

GALANGAN, CENTRAL KALIMANTAN	
 YTS staff and the complete TDU on duty at a mining camp in Galangan, Kalimantan	 GMP trainer is seen explaining the fume hood airflow to the head of Katingan District during at the launching day.
 A happy gold shop operator with a plate full of recycled mercury captured in the water condenser, a new technology introduced by GMPin Kereng Pangi.	 Mr. Fauzi explains his retort to trainees at the first TOT in Rungan Sari, Kalimantan

A local miner and Lestari's trainer testing sluice box in Tanoyan, Sulawesi.

Budi Susilorini, Randy Baker and Dr. Henry showed miners and the public how to reactivate mercury at Tanoyan community center.

NORTH SULAWESI



Mid-size cyanidation tank in Tanoyan

GMP team discussed the mercury use in cyanidation process with local miners and a staff of Mining agency in Talawaan, North Sulawesi

Dr. Yeni Fildayani (FNPF) collecting hair sample from miner in Aspai

Demonstration of kitchen bowl retort

SEKONYER RIVER, CENTRAL KALIMANTAN

An elementary student reading a booklet on the health hazard of mercury during awareness campaign conducted by trainers from FNPF..

A miner fixing his sluicebox on Sekonyer River

Table 1 – Estimated mercury emission from gold shops in the town of Kereng Pangi, Central Kalimantan

Gold Shop	Percent amalgam received **unburned**	Total Hg vaporized daily (gm/Hg)	ANNUAL Hg Vaporized (Kg)	Estimated Recovery w/ water condenser	**ANNUAL EMMISSION**
Huda	30%				
Delta	75%	38.9	14,180	7,090	**7,090**
Jonito	80%	488.3	178,211	7,200	**171,011**
Aulia Indah	75%	328.0	119,720	36,000	**83,720**
Dua Saudara	80%	26.2	9,578	0	**9,578**
Karya Famili	60%	204.8	74,752	8,000	**66,752**
Al Karomah	40%	41.4	15,111	3,600	**11,511**
Sahabat Baru	40%	33.1	12,089	0	**12,089**
Maskanah	40%	16.6	6,044	0	**6,044**
Kenangan Baru	50%	75.6	27,603	400	**27,203**
Sumber Kayu	50%	132.0	48,180	500	**47,680**
Noor Yahya	50%	90.8	33,124	4,000	**29,124**
Pancar Indah	85%	454.1	165,756	4,000	**161,756**
Sentral	50%	82.5	30,113	0	**30,113**
Karya Baru	70%	142.4	51,958	3,000	**48,958**
Swarga	80%	54.1	19,754	0	**19,754**
Shop Average	**60%**	142.7	52,083	4,799	47,284
TOTAL		2,283	833,328	76,790	**756,538**

Gold Shop	Percent amalgam received **burned**	Total Hg vaporized daily (gm/Hg)	ANNUAL Hg Vaporized (Kg)	Estimated Recovery w/ water condenser	**ANNUAL EMMISSION**
Huda	70%	66.2	24,145	0	**24,145**
Delta	25%	141.8	51,739	0	**51,739**
Jonito	20%	72.0	26,280	0	**26,280**
Aulia Indah	25%	21.6	7,884	0	**7,884**
Dua Saudara	20%	5.8	2,102	0	**2,102**
Karya Famili	40%	115.2	42,048	0	**42,048**
Al Karomah	60%	48.6	17,739	0	**17,739**
Sahabat Baru	60%	38.9	14,191	0	**14,191**
Maskanah	60%	19.4	7,096	0	**7,096**
Kenangan Baru	50%	61.9	22,584	0	**22,584**
Sumber Kayu	50%	108.0	39,420	0	**39,420**
Noor Yahya	50%	74.3	27,101	0	**27,101**
Pancar Indah	15%	70.9	25,869	0	**25,869**
Sentral	50%	67.5	24,638	0	**24,638**
Karya Baru	30%	52.7	19,217	0	**19,217**
Swarga	20%	11.9	4,336	0	**4,336**
Shop Average	**40%**	61.0	22,274	0	22,274
TOTAL		976	356,390	0	**356,390**

Note: Data was collected from 16 of 35 existing gold shops in Kereng Pangi

Table 2: List of TDU Components for Galangan, Central Kalimantan

1.	**Transportable Demo Unit (TDU)**
	Trailer- Mounted Aluminum Cargo Box with TDU Signage
2.	**TDU Components**
	Sluice Box Model
	Elutriation Column
	Retorts: Fauzi Retorts / Salad Bowl Retorts / RHYP Retorts
	Portable Stove (Kerosene)
	Portable Propane Torch
	Amalgamation Drum 10-20 Kg
	Amalgam
	Gold Pans
	Fumehood
	Activated Carbon Filters
	Scales: Gold Scale (20 Gram) / Sample Scale (200 Kg)
	Slurry & Water Pump
	Sieves (25mm, 2mm, 1mm, 0.5mm, 0.3mm, 0.15mm, 0.75mm)
	Grizzley Screen (1 x 1 x 2.5 Cm)
	Buckets
	Tubs
	Wheelbarrow
	Shovels
	Magnetic Sheet
	Various Carpets
	Mercury Reactivation Cell
	Protective Equipment (Gloves, dust masks, boots, safety glasses)
	Tent (6m x 6m)
	Small Tools (Hammer, Screwdrivers, etc)
3.	**TDU Operational Supply**
	Tables
	Mat
	Tarp
	Portable Power Generator
	Tent Lighting
	VCD Player
	Voltage Regulator
	Computer Projector and Screen
	Cabinet
	Cutlery, Glasses and Dishes
	Camping Stoves & Cooking Material
	Bedding Set
	200 L Water Tank

Table 3: Mercury Use in Licenced Trommel/Tong Operations - Bolangmongodou North Sulawesi									
							Total Hg Loss per Day (kg)[6]	Number of Days Operation/y[7]	
Total Trommels = 600			% Freq of Operations[2]	Frequency of Hg Addition[3]	# of Trommels with Hg / d [4]	Hg Loss / Trommel (g/d)[5]			Total Annual Hg Loss (kg)
	Frequency of Hg Usage in Trommels	# Trommels[1]							
	Full Time	400	0.35	1.00	140	50	7.0	260	1820
	1 - 2 Trommels Full Time (30%)	400	0.20	0.25	20	50	1.0	260	260
	All Trommels 2 x per week (20%)	400	0.15	0.30	18	50	0.9	260	234
	1 Trommel gold grade check (15%)	400	0.15	0.50	30	50	1.5	260	390
	No Mercury use (15%)	400	0.15	0.00	0	50	0.0	260	0
	Total		1.00		**208**		**10.4**		**2704**
The following assumptions are made:									
1	Of the total number of trommels (~600) in Tanoyan, about two thirds are in operation at any one time								
2	This is the presumed that the percent frequency of Hg use in trommels; for example, 35% use Hg all the time; 15% use no Hg; 15% use Hg in all trommels 2 x /week								
3	This is the precent of trommels that receive mercury according to the type of operation (i.e., all get Hg, some get Hg, none get Hg)								
4	This is the number of trommels in Tanoyan to which mercury is added every day								
5	Daily loss of Hg to the tailings, assuming 5 x 2 to 3 hour runs of 40 kg of ore (200 kg ore); maximum 100 gm may be lost in 400 g								
6	Estimated total daily loss of Hg from each type of trommel operation								
7	Estimated number of days of operation per year								
Footnote:									
	This does not include mercury lost to the mercury/gold amalgam and subsequent burning; mercury loss in subsequent amalgamation steps at the end of the cyanidation process (eg. Canapa); and mercury loss from **illegal** mining operations. If we assume a 1:1 Hg to Au ratio 'lost' during the amalgamation process, we can estimate the amount of atmospheric Hg lost from burning annually. That is, one third of gold produced annually is from Hg. A similar amount of Hg is lost from burning.								