



## TSA STUDY ON THE ARTISANAL AND SMALL-SCALE GOLD MINING SECTOR IN ECUADOR

The Targeted Scenario Analysis (TSA) methodology (Alpízar and Bovarnick, 2013), developed by UNDP, helps public and private decision-makers design and implement sustainable sectoral development policies that incorporate ecosystem services' value into sustainable economic development. The TSA assesses the impact of two management scenarios identified in consultation with stakeholders in Ecuador's artisanal and small-scale gold mining (ASGM) sector. The TSA estimates the social and economic gains or losses resulting from continuing current practices (business as usual scenario-BAU) that cause a high environmental impact with a more sustainable path that promotes socially and environmentally responsible practices. This alternative path is termed responsible mineral processing (RPP for its Spanish acronym). The TSA comprises five participatory steps:

- Step 1: Define the client (decision-maker) and policy scope.
- Step 2: Define the BAU and RPP scenarios.
- Step 3: Select the criteria and indicators to compare the BAU and RPP scenarios.
- Step 4: Compare scenarios, estimate values and links with policies, and present results.
- Step 5: Make informed policy/management recommendations.

The TSA proposes to transfer the gold recuperation process from artisanal and small-scale miners to improved gold processing plants. The Ministry of Energy and Mining of Ecuador is the core client of the TSA study.

## KEY FACTS

- About 100,000 people depend on Artisanal and Small-Scale Gold Mining (ASGM).
- ASGM produces 85% of Ecuadorian gold with an estimated annual value of USD 300,000,000.
- The proposed RMP scenario promotes a change in the mineral processing model, where processing plants are instrumental in increasing profits over ten years:
  - Between USD 25,000 and USD 40,000 increase per year for small and medium-scale artisanal miners.
  - USD 134,000 increase per year on average for mineral processing plants.
  - Up to USD 65,000 increase per year per plant in royalties for the State.
- The avoided costs due to Hg contamination during the gold recuperation process could be up to USD 80,000,000 per year.

The sector is characterized by limited economic opportunities and access to financing, which produces technological inefficiencies. Mercury is still being used, despite its prohibition in 2015. This situation generates irreversible damage on health and the ecosystems and represents an estimated cost of USD 80,000,000 per year.

In this context, the Ministry of Mining, with PAGE support, identified an opportunity to apply a TSA study to assess and improve artisanal and small-scale mining practices by implementing the RMP approach to increase the profitability of the gold supply chain. This alternative approach also provides options for improving government regulations.

The study was commissioned to Conservation Strategy Fund (CSF).



## A Comprehensive Response: Responsible Mineral Processing (RMP)

Artisanal and small-scale miners extract raw mineral from the ground and rent rudimentary processing plants called "chanchas" and Chilean grinders in which mercury-based amalgamation is used to extract gold. The gold recuperation rate, using mercury, ranges from 30% to 40%.

The TSA assessed the impact of transferring the ore processing and refinement process from artisanal and small-scale miners to adequately-equipped processing plants. To this end, modern processing plants could buy the raw mineral directly from miners.

According to the TSA study, the proposed transfer could increase productivity and profitability for the miners and the processing plants and increase revenue to the Government. The increases will result from a higher, technology-based, recuperation rate, estimated at 70%-80%.

The TSA study included financial, economic, environmental and equity criteria for determining the benefits that each of the stakeholders would gain under the proposed RMP scenario:

1. Net annual profits (in USD/year).

2. Net annual profits per ton of material (in USD/MT of processed mineral).

3. Royalties paid to the State (in USD/year).

4. Mercury discharge in the environment (in tons/year).

5. The economic impact of mercury contamination (in USD/year) and impacts on the exposed population.

## Results of the RMP

The TSA results indicate that regarding production performance, financial profitability, financial returns, reduction in mercury use, and the associated costs, the RMP is the most convenient path to achieve the National Mining Policy's objectives.

Moving the separation process to the mineral processing plants generates notable savings for the Small-Scale Extraction Operations (OEPE for its Spanish acronym) proportional to the mineral volume. By ending the separation in "chanchas", their net earnings will double every year. A similar pattern results for Medium-Scale Extraction Operations (OEME for its Spanish acronym), although on a smaller scale.

Under the RMP, the mineral processing plants will experience losses compared to the BAU in the first years due to the initial upgrading costs to improve the production process. However, the processing plants will start earning substantial profits from the fourth year and doubling it by the end of the ten years.

When comparing to current net earnings, on average, at the end of the ten years, the RMP model will give OEPE miners USD 40,000 more per year, USD 25,000 more per year for OEME miners, USD 134,000 more per year for the mineral processing plants, and USD 65,000 per processing plant per year as royalties for the State.





The RMP proposes that the Central Bank of Ecuador increases its annual purchasing of gold. Therefore, an important public benefit under RMP involves increasing foreign currency reserves, estimated at USD 4,000,000 per year for each processing plant (USD 40 Million over ten years). Besides, because the RMP reduces mercury use by 80% in ASGM, the cost of avoiding contamination could reach USD 80,000,000 per year.

However, the transition from BAU to RMP will increase the production costs for the OEPE and the OEME, from USD 13 to USD 16 per gram and from USD 18 to USD 19 per gram, respectively. Other estimated cost increases include:

- The cost of introducing new technology for each processing plant .
- Establishing an operational fund to support the introduction of best environmental practices (USD 20,000 per month/per plant). The fund will also cover the costs of laboratory analysis necessary to ensure compliance with the minimum gold grade in raw mineral. This analysis is critical to maintaining the purchasing price of gold at USD 2.08/gram.

Although BAU practices generate benefits for the sector and the State, estimated at USD 300,000,000 per year, continuing under BAU will increase the artisanal miners' socioeconomic vulnerability and promote short-term, unsustainable economic growth with severe environmental consequences. Under BAU, given the large proportion of workers in the sector, who still operate informally, the State's ability to evaluate and control the ecosystem's degradation is minimal.

Moving the extraction of gold from raw material to processing plants, which are less numerous and more geographically concentrated than the artisanal miners, will enable the State to improve monitoring and controlling. RMP encourages responsible development through best practices and economic incentives. RMP will significantly reduce pollution and ecosystems degradation, reduce biodiversity loss, improve human health, preserve ecosystem services, and reduce the impact of other productive activities such as tourism. Table 1 illustrates the results of the TSA.

## Recommendations

- Engage the processing plants in the shift to RMP through a RMP program. To this end, design and implement a RMP program including detailed actions, costs and responsibilities; and introduce financial incentives to support processing plants to transition from BAU to RMP. Incentives such as tax breaks, preferential credit and co-financing (from public and international cooperation sources) could reduce the initial financial burden and financial losses caused by the transitioning.
- Development training materials and a training program for miners and processing plants; and communication material to disseminate and promote the incentives.
- Develop tools and provide technical support to improve mining operations, i.e., prepare guidelines to implement best environmental and ecosystem management practices (BEEMP), including recirculation processes, minimum discharges, and prior processing treatment. The BEEMP will address the challenges of using cyanide, disposal of tailings, and handling toxic and industrial waste.



- Establish a diversified gold purchasing program. This program will help provide security for the value chain, apply traceability measures, and comply with sound production standards.
- Enhance the current legal and regulatory framework by introducing secondary norms to make it possible to reinvest royalties, taxes, and fees from mining activities.
- Establish a coordination mechanism, led by the Ministry of Mining, to oversee the formulation of the RMP transition plan and its implementation. The coordination mechanism could also manage information and produce policy reform recommendations to support the transition plan.
- Introduce adaptive management to ensure a successful implementation of the RMP program. Adaptive management is critical to organizing, managing regulations, monitoring, measuring, reporting progress, and incorporating M&E feedback into planning.

The estimated gains resulting from the RMP intervention justify the State's investment in improving ASGM. The shift to RMP will diminish environmental impacts and significantly increase the most vulnerable participants' profits in the value chain. The development of a pilot program for a gradual and orderly transition to a more responsible model (RMP) will accelerate the National Public Mining Policy's objectives. RMP will also contribute to comply with binational engagements and the Minamata Convention. RMP could increase mining contribution to the national GDP, ensure sustainable economic benefits, and access quality ecosystem services.

Based on the implementation of the RMP in the pilot sites, it will be possible to plan and roll out a nationwide RMP program. A communication strategy could support his effort. Communicating initial RMP results and benefits to the public using multiple communication channels will ensure adequate understanding and strengthen political acceptance.



**Tabla 1. Indicadores, variables y resultados RPP**

INDICATOR	VARIABLE	OEPE Miners		OEME Miners		Mineral Processing Plants	
		BAU	PBR	BAU	PBR	BAU	PBR
	Scenario→						
Profitability	Net earnings Year 1	\$ 26.000	\$ 53.000	\$ 146.000	\$ 159.000	\$ 865.000	- \$ 2 M
	Net earnings Year 10	\$ 34.000	\$ 76 mil	\$ 166.000	\$ 190.000	\$ 1,2 M	\$ 2,1 M
	Earnings per MT/ Year 1	\$ 41	\$ 85	\$ 94	\$ 102	\$ 66	- \$ 163
	Earnings per MT/ Year 10	\$ 54	\$ 121	\$ 106	\$ 121	\$ 98	\$ 186
Social and environmental cost due to the use of mercury (Hg)	Annual aggregated Hg discharges - Year 10	1.325 kg	336 kg	Recuperation takes place in the mineral processing plants)		6.792 kg	5.626 kg
	Economic impact of Hg Year 10	\$ 66 M	\$ 17 M			\$ 339 M	\$ 280 M





## Impacts from the transition from BAU to RPP and their scale

Small-scale artisanal miners	Medium-scale artisanal miners	Mineral processing plants	State	Society	State
(Private)	(Private)	(Private)	(Public)	(Public)	(Public)
Average increase in profitability throughout the 10-year period	Average increase in profitability throughout the 10-year period	Average increase in profitability throughout the 10-year period	Average increase in royalties throughout the 10-year period	Average decrease in mercury discharges throughout the 10-year period	A plant's average sales for international reserves throughout the 10-year period
35.926,70 USD/year	19.925,59 USD/year	134.921,15 USD/year	9.402,13 USD/year	1.805 kg/year	4.704.636,22 USD/year

Source: CSF, 2020

### Proposed participatory action plan

PHASE I: 1 – 2 YEARS	PHASE II: 2 - 5 YEARS	PHASE III: 5 - 10 YEARS
<p><b>INITIAL ACTIONS:</b></p> <ul style="list-style-type: none"> <li>- Establish a technical support panel</li> <li>- Review the environmental ASGM</li> <li>- Share information</li> </ul> <p><b>I. DEVELOP AND LAUNCH A PILOT PLAN</b></p> <ul style="list-style-type: none"> <li>- Select processing plants</li> <li>- Provide training on technical cooperation mechanisms and technology transfer</li> <li>- Seek financing (public - private partnerships)</li> </ul>	<p><b>II. PILOT PLAN - IMPLEMENTATION:</b></p> <ul style="list-style-type: none"> <li>- Implement RPP model</li> <li>- Evaluate RPP model</li> <li>- Measure and disseminate results</li> </ul> <p><b>III. RPP MODEL REFINEMENT:</b></p> <ul style="list-style-type: none"> <li>- Update RPP secondary regulations.</li> <li>- Develop an incentives programme.</li> <li>- Establish agreements with laboratories and universities</li> </ul>	<p><b>IV. RPP FULL IMPLEMENTATION</b></p> <ul style="list-style-type: none"> <li>- Implement updated secondary regulations.</li> <li>- Update and formalize BCE purchasing plan</li> <li>- Introduce credit lines for certified buyers</li> <li>- Design and introduce a strategy to scale RPP</li> <li>- Strengthen monitoring, evaluation and feedback to adjust RPP.</li> </ul>



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