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SWISSAID

MERCURY REDUCTION IN ARTISANAL AND SMALL-SCALE GOLD MINING IN TANZANIA

Research Report

A collaborative project between the Geneva Graduate Institute and SWISSAID-Genève

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EXECUTIVE SUMMARY

1. **Background:** Artisanal and small-scale gold mining (ASGM) in Tanzania is an essential economic enterprise; it employs more than one million people and contributes to 30% of Tanzania's total gold production. However, the use of mercury poses severe health and environmental risks, as it contaminates air, water, and soil and disproportionately harms impoverished mining communities. SWISSAID works to improve conditions in artisanal gold mines in Tanzania. In collaboration with FADev, they develop model mines that adhere to strict environmental and health standards, including reducing and eliminating the use of mercury. However, despite these efforts and Tanzania being a signatory to the Minamata Convention on Mercury, the implementation of mercury reduction measures remains under-examined at the local level.
2. **Objectives:** This study aims to assess the implementation of the Minamata Convention and other mercury reduction efforts in Tanzanian ASGM, with a specific focus on regions where SWISSAID operates. By drawing on insights from three model mines in the Geita and Shinyanga regions, the report seeks to generate policy recommendations that are locally feasible, socially equitable, and environmentally sustainable.
3. **Limitations:** Due to logistical and ethical concerns, this study did not include fieldwork with miners, relying instead on indirect stakeholder interviews and previously gathered data and reports. Language barriers limited digital access in mining areas, and the absence of oppositional political perspectives also constrained the breadth of findings. The authors encourage future research to include deeper engagement with miners and diverse political stakeholders.
4. **Key Policy Indicators:**
    a. **Bottom-up formalization** : Formalization has the potential to support mercury reduction in ASGM and increase financial stability. A bottom-up formalization approach that balances regulation with socio-economic realities, avoids criminalization, and ensures access to suitable alternatives is favorable.
    b. **Poverty-driven framework** : Mercury use in ASGM is deeply rooted in poverty and limited economic alternatives. Classic entrepreneurial models fall short of understanding these conditions.
    c. **Sustainable financing** : Sustainable financing is a cornerstone for the transition away from mercury use in ASGM. The miners' dependence on mercury financing mechanisms as well as existing barriers for formal (subsidized) loan programs pose major challenges for mercury mitigation.
    d. **Institutional collaboration** : Overlapping mandates and institutional gaps hinder coherent policy implementation in Tanzania's complex ASGM sector.
    e. **Managing mercury supply** : Mercury is often imported illegally in Tanzania, limiting legal access to mercury for miners. Illicit mercury sellers trap miners in cycles of dependence, detracting from their profit and impeding their ability to invest in protection and processing equipment.
    f. **Community education and training** : Community-led, culturally sensitive education and long-term vocational training have been effective at promoting safer mining practices and addressing misconceptions about mercury use.

g. **Understanding technical factors** : Retorts and Personal Protective Equipment are efficient measures for reducing mercury use and exposure. The implementation of mercury-free processing often faces challenges regarding speed and scalability, and needs advanced equipment and training. To eliminate mercury, technologies like gravitation separation and cyanidation are promising alternatives, but need further adaptation to be successfully implemented.

h. **Adaptation to local contexts** : The successful adoption of mercury-free technologies in ASGM depends not only on technical feasibility but also on community engagement and alignment with local geological, social, and economic conditions.

5. **Key Findings:**
   a. **Tanzanian National Action Plan (TNAP):** The TNAP promotes a bottom-up approach to ASGM policy, incorporating community input and prioritizing formalization. It acknowledges poverty as a driver of mercury use and emphasizes access to credit, though financing mechanisms are vague. The plan features strong institutional coordination and community education strategies. However, targets are not tailored to local conditions, and measures for managing mercury supply and supporting research lack clarity.
   b. **International Accountability:** The international landscape, including rising gold prices and various international actors, influence the implementation of the Minamata Convention in Tanzania. Challenges such as poor traceability in the gold supply chain and weak Swiss legal frameworks for illicit gold trade require stronger sanctions, more transparency, and coordinated international efforts to improve supply chain accountability and miner conditions.
6. **Recommendations:** We extend recommendations at the local, national and international level for an improved implementation of the Minamata Convention.

ACRONYMS

Abbreviation	Definition
ASGM	Artisanal and Small-Scale Gold Mining
ASM	Artisanal and Small-Scale Mining
COE	Center of Excellence
FADev	Foundation for ASM Development
GMP	Global Mercury Project
LSM	Large Scale Mining
LSGM	Large Scale Gold Mining
MC	Minamata Convention
NAP	National Action Plan
NTF	National Task Force
OP	Organizational Plans
PPE	Personal Protective Equipment
PML	Primary Mining License
PPL	Primary Production License
REMA	Regional Miners' Associations
SACCOS	Savings and Credit Cooperative Societies
TNAP	Tanzania National Action Plan
UNEP	United Nations Environment Program
USA	United States of America

Acronyms for Interviewees, by sector

Abbreviation	Definition
A	Academia
APS	Academia and Private Sector
GPS	Gold Private Sector
IN	International NGO
NGO	Non-Governmental Organization
SP	Swiss Politician
TAN	Tanzanian ASGM NGO
TG	Tanzanian Government
TMC	Tanzanian Mining Community
UNEP	Member of the Minamata Convention Secretariat (UNEP)

TABLES OF CONTENTS

ACKNOWLEDGEMENT i

EXECUTIVE SUMMARY ii

ACRONYMS iv

I. INTRODUCTION 1

II. THE MINAMATA CONVENTION ON MERCURY 3

III. MERCURY: USAGE AND HEALTH AND ENVIRONMENTAL CONCERNS 4

IV. ASGM IN TANZANIA 6

1. Gold Trade in Tanzania 6
2. Policies and Legal Frameworks 7
3. Local and National Organization 7
4. ASGM Formalization 8

V. STATE OF RESEARCH AND QUESTIONS 9

1. State of research and gaps 9
2. Research question and subquestions 9
3. Object of study and selection of sample 9

VI. METHODOLOGY AND DATA ACCESS 10

1. Deconstruction Method & Policy Indicators 10
2. Data Access 10
3. Limitations of the study 11

VII. ANALYSIS: POLICY INDICATORS 13

1. Bottom-up Formalization 13
2. Poverty-driven framework 16
3. Sustainable Financing 18
4. Institutional Collaboration 21
5. Managing Mercury Supply 21

6. Community Education and Training 22
7. Understanding Technical Factors 24
8. Adapting Alternative Practices to Local Context 29

VIII. CONCLUSIONS 30

1. Tanzanian National Action Plan 30
2. International Accountability 32

IX. RECOMMENDATIONS 34

1. FADev, SWISSAID and SWISSAID-Genève 34
2. Tanzanian Government / National Level Policy & Action 35
3. International Development Organizations 36
4. Swiss Regulations 36
5. Chemistry and Technology Research 36

REFERENCES 37

ANNEX 42

I. INTRODUCTION

Artisanal and small-scale gold mining (ASGM) in Tanzania is an essential economic enterprise; AGSM employs more than 1 million people directly and more than 7 million people indirectly (13% of the national population).[1] The industry produces 18.7 tons of declared gold per year[2] and consumes 13.2 - 24.4 tons of mercury.[3] Several factors explain ASGM's growth in Tanzania, including favorable geological conditions, the discovery of high-grade deposits in the Lake Victoria region, and economic policy reforms of the 1980s and 1990s that liberalized the mineral trade and prioritized mining as a key economic sector.[4]

Demographically, women account for around 20–30% of miners, and primarily work on handling ore processing tasks, earning only 25–40% of men's income.[5] Children represent 1% of miners and start work as young as 7–10 years old.[6]

While ASGM is a key source of livelihood for mining communities, it also poses various health and environmental risks. The use of mercury for gold extraction is widespread throughout the sector, as a cheap, accessible, and effective way to isolate gold from ore.[7] This process can lead to the contamination of water, soil, and surrounding ecosystems, as well as serious health effects on workers and local communities.

To address these hazards, the Minamata Convention on Mercury (MC) was adopted in 2013 and entered into force in 2017, as the first international treaty aimed at reducing and eliminating the use of mercury in various contexts. Article 7 and Annex C of the MC specifically target ASGM, the world's largest source of anthropogenic mercury emissions (1,600 tons annually), requiring countries with significant ASGM activity to develop a National Action Plan (NAP) to reduce mercury use.[8] Tanzania, as a signatory, has responded by launching national initiatives, including mineral markets and buying centers, to encourage formalization, transparency, and improved environmental outcomes.

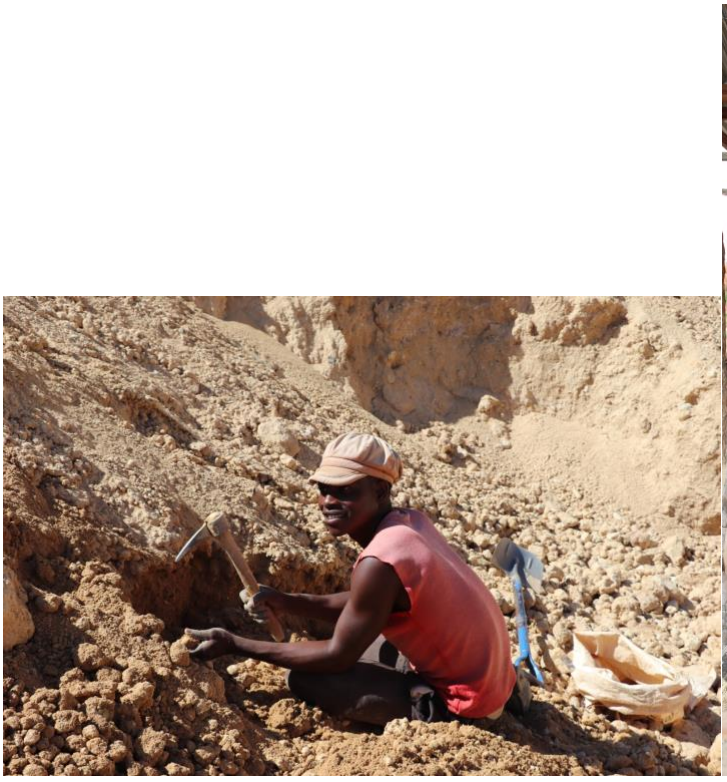
The Tanzanian Government and various NGOs have made efforts to reduce mercury use in ASGM and align with the goals of the Minamata Convention, but they continue to face significant implementation challenges. The industry remains informal in many aspects, characterized by fragmented actors, including primary mining license holders, pit owners, financiers, and brokers.[9] The remote location and informal operations of many mines make accessibility and systemic change difficult. Education surrounding mercury risks is low, financial insecurity is high, and new technologies unfamiliar– all which exacerbate the difficulties of implementing and funding alternative methods. Furthermore, since 2016–17, the price of gold has sharply increased, reaching over $3,000 per troy ounce in 2025. Many

1 (Tanzanian Vice President's Office 2020, iv)
2 (SWISSAID 2024, 16) The Tanzanian National Action Plan indicates differing numbers of 5.3-9.8 tons per year (page iv) and 13.2 and 24.4 tons per year (page 24).
3 (Tanzanian Vice President's Office 2020, iv)
4 (Mutagwaba et al. 2018, 23)
5 (Tanzanian Vice President's Office 2020, 12)
6 ibid.
7 (UNEP 2023; Esdaile & Chalker 2018)
8 (UNEP 2023)
9 (Mutagwaba et al. 2018, 27)

of the MC's interventions were conceptualized under different market conditions and now require recalibration to remain relevant and effective.

The primary aim of this report is to assess the status of mercury reduction efforts under the MC in Tanzania, with a focus on the mining areas where SWISSAID operates. Since 2023, SWISSAID, in collaboration with Tanzanian partner FADev, has worked to pilot three "model mines" in the north-western Geita and Shinyanga regions[10], aimed at implementing best mining and business practices. By using on-the-ground insights and drawing on stakeholder interviews and existing data, the report seeks to evaluate how the MC's goals are being implemented on the ground and to propose policy recommendations that are both environmentally sound and socioeconomically viable.

This research seeks to bridge the gap between international environmental commitments and local realities. It centers the perspectives of those most affected by mercury exposure and emphasizes the need for poverty-aware and practically implementable solutions. While the elimination of mercury is a long-term goal, significant progress could be made by better understanding the reality of the miners who will practically implement these commitments.



Figures 1 and 2: Images from SWISSAID Model Mines

10 See Section V.3: Object of Study and Selection of Sample for further information on these regions.

II. THE MINAMATA CONVENTION ON MERCURY

On October 19, 2013, 92 countries signed the Minamata Convention on Mercury (the MC) in Minamata, Japan. The objective of the MC is "to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds".[11] It entered into force on August 16, 2017. The MC recognizes and seeks to combat the adverse effects of mercury on human health and the environment, with particular attention to the effects in developing countries and Arctic ecosystems via biomagnification. Concurrently, it acknowledges the importance of economic support for developing countries to facilitate the process of mercury phase out.

The MC regulates mercury reduction in various domains, including mercury mining, import and export, and identification and disposal. Article 7 and Annex C are dedicated to the use of mercury in ASGM, which is the largest source of anthropogenic mercury pollution in the world, emitting 1,600 tons annually.[12]

It is mandated that if a country identifies a significant amount of domestic ASGM activity, the country must develop a National Action Plan (NAP).[13] NAPs should include the implementation of (a) technical measures, (b) policy frameworks, and (c) public health strategies. Specific requirements include (d) formalization and regulation of the ASGM sector, (e) measures to limit the national supply of mercury, and (f) promoting awareness.[14] The NAPs determine the specific policies and practices that will be undertaken to achieve these goals and specify the timeline for implementation.[15] Subsequent to the publication of the NAP, each country is required to produce progress reports every three years, presenting measures and metrics related to NAP targets.

Updates to the MC with regard to ASGM have included guidance on mercury tailings management and the creation of an Indigenous Peoples Platform, to facilitate dialogue between policymakers and affected Indigenous communities.[16]

11 (UNEP 2013/2023, 7)
12 (Evers et al. 2016, 893; Spiegel et al. 2014, 766-767)
13 (UNEP 2013/2023)
14 (Evers et al. 2016)
15 (Spiegel et al. 2014)
16 (UNEP 2023)

III. MERCURY: USAGE AND HEALTH AND ENVIRONMENTAL CONCERNS

Globally, a variety of gold extraction techniques are applied.[17] This study focuses on underground mining followed by whole ore or gold ore concentrate amalgamation, techniques applied by different ASGM communities worldwide. These techniques are most frequently used in ASGM in Tanzania, and both apply mercury.[18] [19] To extract gold from the mined ore, mercury, water and ore are mixed in tailings to form a gold-mercury amalgam (whole ore amalgamation). This alloy enables the collection of even the smallest gold particles. For gold ore concentration amalgamation, the ore is initially crushed and ground into fine powder. This ground ore is passed through a sluicing table to extract the gold concentrate. Only then is it amalgamated with mercury. With both techniques, the amalgam finally undergoes a heating process to separate the mercury from the collected gold.

The primary sources of mercury pollution in ASGM are amalgam roasting and the discharge of mercury-polluted tailings to land and water.[20] Mercury can occur in different forms throughout ore processing. Different states of mercury can have distinct negative effects on human health and the environment.

Figure 3: Amalgam burning at a SWISSAID Model Mine

Mercury gas is absorbed in the lungs and then distributed in the body, damaging not only the lungs, kidney, liver, and nervous system, but also crossing the blood-brain barrier and the blood-placenta barrier.[21] Other symptoms resulting from chronic exposure include "renal failure, tremors, movement disorders, and various psychoses and memory impairment", headaches, and vision and motor disorders. Acute exposure can result in "tremors, memory loss, respiratory distress and even death". The compromising of food chains by mercury accumulation is a central issue for miners and other local

17 (see e.g. Nkuba, Bervoets, and Geenen 2019)
18 (Tanzanian Vice President's Office 2020, 7)
19 For a detailed explanation of the gold production process, see (Tanzanian Vice President's Office 2020, 7; Esdaile and Chalker 2018, 6907–8)
20 (Esdaile and Chalker 2018, 6908; Tanzanian Vice President's Office 2020, 22; Diallo et al. 2003 and Taylor et al. 2004 after Geenen et al. 2021, 11)
21 (Esdaile and Chalker 2018, 6909)

communities.[22] Mercury uptake through food chains can damage the liver, central nervous system, and kidneys, and poses a risk to fetal development.[23] Additionally, mercury becomes water soluble through the reprocessing of mercury-contaminated tailings with cyanide. Consequently, it becomes more bio-available and contaminates food chains more easily. The MC recommends against combining cyanide with mercury because this can result in other, even more dangerous complexes.[24] The environmental consequences of mercury pollution are manifold, including water and soil contamination, with negative impacts not only on human health but on the wider ecosystem.[25]

22 (Esdaile and Chalker 2018, 6910)
23 (Esdaile and Chalker 2018, 6909–10)
24 (Esdaile and Chalker 2018, 6909; Tanzanian Vice President's Office 2020, 19; Geenen et al. 2021, 77)
25 Esdaile and Chalker mention specifically wildlife and plant health and biodiversity. (2018, 6910)

IV. ASGM IN TANZANIA

Figure 4: ASGM sites in Tanzania[26]

1. GOLD TRADE IN TANZANIA

Tanzania plays a significant role in Africa's ASGM and gold export landscape.[27] In 2022, over 18 tons of ASGM gold were officially produced in the country.[28] However, SWISSAID estimates that an additional 2–3 tons of ASGM gold goes undeclared annually.[29] Despite this gap, Tanzania records the highest estimated percentage of declared ASGM production among African countries.[30] Tanzania accounted for over 64 tons, or 8%, of Africa's total declared gold exports in 2022,[31] and has consistently exported more than 20 tons annually to Switzerland between 2012 and 2022.[32] Nonetheless, SWISSAID highlights irregularities in regional gold trade. For example, gold consignments have been declared to Ugandan customs as originating from Tanzania by

26 (© Tanzanian Vice President's Office 2020, 6)
27 For a comprehensive overview of global trade of African gold see Swissaid's report On the Trail of African Gold (2024).
28 (Swissaid, 2024, p. 16)
29 (Swissaid, 2024, p. 19)
30 (Swissaid, 2024, p. 21)
31 (Swissaid, 2024, p. 28)
32 (Swissaid, 2024, p. 50)

individuals with Congolese nationality—an indicator of potential smuggling. Similar cases involve gold declared as coming from Tanzania or South Africa by DRC-based operators.[33]

2. POLICIES AND LEGAL FRAMEWORKS

Tanzania ratified the Minamata Convention on October 5, 2020.[34] Since Tanzania has a significant amount of domestic ASGM activity, pursuant to Article 7 of the MC, it developed a NAP (the TNAP) to promote reduction and, where feasible, elimination of mercury use.[35][36]

Tanzania's policy landscape relevant to the ASGM includes the Mining Policy of 2009, which focuses on formalization, sustainability, and poverty reduction within mining communities. Complementary policies such as the National Environmental Policy (1997), the National Land Policy (1997), and the National Gender Policy (2002) address land use, environmental impacts, and inclusivity.[37]

At the legislative level, the Mining Act of 2010, amended in 2017, and the Environmental Management Act (2004) are central. Specific regulations, such as the Environmental Protection for Small-Scale Mining Regulations (2010), emphasize environmental and safety standards.

Land-related laws like the Village Land Act (1999) address conflicts over land access, a recurring issue in ASGM.[38] Customary land tenure in Tanzania is largely undocumented and reliant on customary practices, which creates obstacles by complicating land rights verification, discouraging investment, and fostering disputes.[39]

3. LOCAL AND NATIONAL ORGANIZATION

The TNAP describes the current organization of ASGM in Tanzania through the emergence of multiple associations at local, regional, and national levels. At the regional level, Regional Miners' Associations (REMAs), initiated by the government in 1987, act as representatives of small-scale miners by engaging in policy dialogue and advocacy on environmental and labor issues. REMAs are coordinated under the Federation of Miners Associations of Tanzania, which provides a platform for advocacy at the national level.[40] In addition to these associations, miners have formed site-based cooperatives and Savings and Credit Cooperative Societies (SACCOS). SACCOS play a strategic role in conflict mediation and income distribution, but often struggle with organizational and financial sustainability. Other key organizations include the Tanzania Women Miners Association and the Tanzania Mineral Dealers Association, which supports market access and regulatory engagement for mineral dealers.[41]

33 (Swissaid, 2024, p. 78)
34 (Tanzanian Vice President's Office 2020)
35 ibid.
36 See Section VIII.1: Tanzanian National Action Plan for further details on the TNAP.
37 (Mutagwaba et al. 2018, 35–38)
38 (Mutagwaba et al. 2018, 39–40)
39 (Pedersen et al. 2016)
40 (Tanzanian Vice President's Office 2020, 9)
41 (Tanzanian Vice President's Office 2020, 10)

4. ASGM FORMALIZATION

The Tanzanian government plays a central role in efforts to formalize the ASGM industry. The government has established mineral markets and trading centers that aim to centralize trade and curb informality.[42]

The mineral markets seek to ensure fair prices, improve market access, and discourage informal transactions. Additionally, the trading centers seek to enhance the visibility of revenues and improve financial benefit distribution and increase competition among brokers and dealers, thereby enabling better price negotiations for miners.[43]

However, the implementation of these various formalization strategies has revealed limitations, including challenges posed by the lack of transaction receipts and the exclusion of some AGSM workers who continue to trade informally to avoid fiscal obligations.[44] Additionally, an internal NGO report shows that the AGSM sector remains largely avoided by financial institutions due to its negative perception and the low repayment rates observed when loans were issued to AGSM groups. Therefore, the miners are still attached to the informal ways of selling their production, despite governmental efforts. They still sell to unregistered brokers, especially during low production periods. Often, production and trade are documented in terms of bags of ore of vague dimensions. These units are not weighed or sized properly, making estimations of the miners' incomes difficult.

In sum, the formalization of ASGM tackles many transparency issues by clarifying property rights, regulating fiscal contributions, and enforcing environmental as well as health and safety norms. In addition, transparency efforts have improved miners' awareness of gold spot prices, allowing for improvements in bargaining power. However, they have not substantially addressed broader livelihood challenges. Many miners remain disconnected from the benefits of formalization, prioritizing daily survival over long-term formalization benefits.[45]

42 (Pedersen et al. 2021, 4)
43 (Pedersen et al. 2021)
44 (Pedersen et al. 2021, 7)
45 (Pedersen et al. 2021)

V. STATE OF RESEARCH AND QUESTIONS

1. STATE OF RESEARCH AND GAPS

Various methods of mercury reduction have been studied closely. However, they have not been assessed in many specific places--for instance the mines in which SWISSAID operates. Our primary research found that this political, legal, and institutional context matters. This study aims to provide insight on how the MC is being implemented in Tanzania, drawing on insights from the mines in which SWISSAID and FADev operate, and evaluating how implementation could be improved.

2. RESEARCH QUESTION AND SUBQUESTIONS

The research questions guiding this study are:

a. What are the main challenges and opportunities for the implementation of the Minamata Convention in ASGM in Tanzania?
b. How can policies and interventions be designed to better reflect realities on the ground, with illustrative insights from the SWISSAID and FADev model mines?

3. OBJECT OF STUDY AND SELECTION OF SAMPLE

The object of study are artisanal small-scale gold mines that use mercury amalgamation methods to extract gold. Because it is not feasible to study all mines, or even countries, engaged with these mining methods, we use insights from a selection of three Tanzanian mines. These mines are in the Shinyanga and Geita Regions, known as the SWISSAID-Genève "Model Mines." As of 2019, the regional populations of Geita and Shinyanga are approximately 1.7 million and 2 million people, respectively.[46] In 2020, Shinyanga Region reported a GDP per capita of approximately 1.5 million Tanzanian Shillings (459 CHF), while Geita Region had a GDP per capita of about 2.1 million Tanzanian Shillings (642 CHF).[47] In Geita, ASGM produces approximately 2,800 kg of gold per year, using an estimated 4,480 kg of mercury annually, while in Shinyanga, the sector produces 910 kg of gold with a corresponding mercury use of 1,456 kg per year.[48]

These mines are exemplary for opportunities and challenges of mercury reduction and elimination. This study aims to establish practicable recommendations for successfully implementing mercury reduction policy, in line with the MC in Tanzania.

46 (ESRF 2019 (a), 25; ESRF 2019 (b), xii)
47 (Statistica 2020)
48 (Tanzanian Vice President's Office 2020, 8)

VI. METHODOLOGY AND DATA ACCESS

1. DECONSTRUCTION METHOD & POLICY INDICATORS

This research report was conducted in five phases, using deconstruction methodology. First, we conducted a literature review to understand the current state of research and relevant gaps. Second, after a detailed review of the ASGM sector in Tanzania, we used deconstruction methodology to identify eight policy indicators as key for the success of the implementation of the MC. Third, we collected original data via specialist discussions and stakeholder interviews. Fourth, we conducted a content analysis of the data collected. Lastly, we developed policy recommendations enumerated in this final report.

2. DATA ACCESS

a. **Literature and Reports**: The literature can be broadly divided into three categories. First, we reviewed academic literature. Secondly, we analyzed national and international policy frameworks and related reports and information. Thirdly, NGO reports further informed the research.

b. **Specialist discussions**: In-depth discussions with specialists were held to gain a better understanding of the field. This enabled a more accurate framing of the literature review and interview questions, and was used for contextualization of policy recommendations.

c. **Stakeholder interviews**: Given the constraints on field work,[49] stakeholder interviews were our most important source for data collection. A selection of interviewees with different profiles enabled the collection of information about a variety of topics, but also different perspectives on shared topics. The interviews applied a pragmatist approach, including guiding questions. We conducted 9 interviews from January to April of 2025.

i. Selection of interviewees

The following profiles informed the selection of interviewees, one per each category:

- Academic working on gold mining and human rights
- Academic and private gold sector actor
- Gold trader from the private sector
- Employee of an international NGO working on gold mining
- Swiss politician working on gold trade regulation and human rights
- Employee of a Tanzanian NGO working on ASGM in Tanzania
- Member of the Tanzanian Government
- Engineer and member of the Tanzanian Mining Community
- Member of the MC Secretariat (UNEP)

SWISSAID experts have brought up ethical and logistical concerns[50] that led to the exclusion of miners from the interviews. Matching persons to profiles was conducted with a snowballing system, starting with SWISSAID-Genève and FADev recommendations.

49 See Section VI.3.a: Lack of Field Engagement.
50 See Section VI.3.a: Lack of Field Engagement.

ii. *Guiding questions*

Guiding questions, informed by deconstruction methodology, formed the baseline for all interviews. We divided them by each of the relevant policy indicators:

- Bottom-up formalization
- Poverty-driven framework
- Sustainable financing
- Institutional collaboration
- Managing mercury supply
- Community education and training
- Understanding technical factors
- Adapting alternative practices to a local context

3. LIMITATIONS OF THE STUDY

a. **Lack of Field Engagement**: This study was conducted without physical fieldwork and direct engagement with miners. This decision was taken after consulting SWISSAID, who pointed out logistical hindrances and ethical concerns. SWISSAID conveyed that prior research in mining areas showed that the presence of – especially non-African – researchers in mining areas has been misinterpreted to indicate high-yielding gold deposits. This attracted more miners, fueling competition, discontent, and increased security risks. Furthermore, granting physical access to the mines within the study's timeframe was beyond FADev's means and not possible without them. Language barriers as well as difficulties with internet reliability and access to digital devices in mining areas made direct online contact to miners impossible. Therefore, this study relies on a broad interviewee pool of stakeholders and other experts. Nevertheless, the absence of firsthand experience limits the depth of insights into artisanal mining practices and the lived realities of mining communities in Tanzania. The results need to be further scrutinized with regard to miners' experiences and expertise.

   The study also misses voices of Tanzanian political opposition members. While one prominent politician refused contact due to security concerns for themselves, contact with another opposition member could be established. However, after multiple unanswered requests, they indicated that due to their dense schedule they would not be able to schedule an interview. The absence of oppositional political lenses may mean that critical perspectives on governance, human rights violations, and social needs are overlooked.

b. **Data Accessibility and Language Barriers**: The accessibility of information on artisanal mining in Tanzania presents a notable challenge. Government records on critical topics, such as mercury trade, are scarce or limited to prescriptive strategies, and the remoteness of mining sites further complicates data collection. Additionally, the study relies mostly on English in terms of the communication with partners and literature, limiting the inclusion of localized perspectives or data in other languages.

c. **Potential Externalities of the Research**: Lastly, policy recommendations derived from the findings must be considered with caution. Solutions, while aiming to address environmental

or safety concerns, may inadvertently create externalities, such as disruptions to local economies and livelihoods dependent on artisanal mining practices. Balancing these impacts remains a critical tension within the study.

VII. ANALYSIS: POLICY INDICATORS

According to our data, we established eight key indicators related to best and worst practices of mercury reduction and elimination policy in Tanzania. These factors were assessed with a long-term, sustainability forward framework. These policy indicators are based upon the successes and challenges of past experiences, to the literature and enhanced by our interview data.

1. BOTTOM-UP FORMALIZATION

a. **The Potential of Bottom-Up Formalization**: The MC mandates that any country developing a NAP should take, "steps to facilitate the formalization or regulation of the artisanal and small-scale gold mining sector."[51] Our interview data supports that a bottom-up approach to formalization is the most realistic, pragmatic, and beneficial process for the miners. In the field of development, bottom-up approaches refer to, "strategies and processes driven by local actors—such as communities, grassroots organizations, and civil society—emphasizing participation, empowerment, and locally contextualized knowledge as central to achieving sustainable and equitable development outcomes."[52] Interviewees A and APS noted, however, the standard approach after the MC has been for governments to put formalization as a primary requirement, rather than to work with the miners, understand their situation, and achieve formalization along the way.

Traditionally, ASGM is a highly informal, unregulated industry, with low barriers to entry, such as formal registration processes.[53] Interviewee SP noted, for example, "remote mines are more likely to use illegal techniques because they know it's difficult to control them." Hence, as supported by the literature, formalization has the potential to improve the working conditions of miners, increase tax revenues, promote opportunities for fair trade certification, improve environmental and safety oversight, and strengthen miners' land titles.[54] Elements of formalization can include legal measures (licensing; implementing labor, health, environment, and safety regulations), technical initiatives (data gathering; distribution of efficient equipment and processing techniques), institutional changes (creation and expansion of monitoring bodies), and financial infrastructure (taxation, credit, and lending).[55]

b. **Challenges of a Top-Down Approach**: Previous efforts towards ASGM formalization have faced significant challenges when implementing a top-down policy approach. When policymakers and donors are far removed from ground activities, the likelihood of sustainable implementation and enforcement significantly decreases. Many low-income countries do not have the resources for widespread legal enforcement and ASGM communities are unfamiliar with complex bureaucratic systems.[56] Interviewees SP, GPS and TAN noted that the Tanzanian government does not have the financial resources to enforce environmental and health regulations fully in ASGM, especially in remote mining areas,

51 (UNEP 2013, Annex C.1.c)
52 (Chambers 1997)
53 (Prescott et al. 2022, 242)
54 (Prescott et al. 2022; Spiegel et al. 2014)
55 (Kinyado and Huggins 2020, 758-759)
56 (Veiga and Fadina 2020, 1139)

making top-down approaches ineffective. Furthermore, Interviewee TG remarked that the primary challenge in enforcing mining regulations is access to remote areas. Interviewees TAN and TG confirmed that engaging with local communities, as has been done in the model mines, and collaborating with village leaders can help integrate small-scale miners into formal frameworks, ensuring better compliance while preserving livelihoods. Interviewees A and TAN praised that the mineral markets[57] in Tanzania have successfully increased the proximity between government and mining communities, countering the common impression that miners have that "they get nothing in terms of support from the state [...] in terms of health services, technology services, and also access to markets and fair prices."[58]

Additionally, such top-down efforts can backfire, creating more barriers to registration and driving more mines into illicit markets. For example, the Mineral Sector Development Technical Assistance Project in Tanzania directed support only towards licensed operators, despite the fact that a majority of ASGM is unlicensed.[59]

c. **Criminalization Inefficiencies**: The criminalization of mercury use in ASGM risks alienating mining communities, reinforcing distrust, and pushing activities further underground—especially when alternatives to mercury are not yet accessible or viable.

Criminalization approaches, such as policies that criminalize the whole ore amalgamation process altogether, often have the effect of driving ASGM enterprises into more unregulated illicit markets.[60] Moreover, Interviewee UNEP expressed concern that, as government crackdowns on illegal mining have understandably increased, but must be balanced with creating space for legal mining and upholding fundamental human rights of miners and surrounding communities. Miners, even those working illegally, are still human beings with rights, and policymakers should beware violations of the rights of indigenous peoples and local communities to their land and territories and from bodily harm.

Thus far, Tanzania has not included the criminalization of mercury use in their formalization efforts. Many of our interviewees emphasized that it is essential that alternatives to mercury are available before criminalization measures are implemented. Interviewee APS stressed that criminalization facilitates a derogatory view of ASGM and has acted as a barrier to facilitating policy conversations with this important sector. Moreover, criminalization only further isolates and excludes miners from the system and they are unlikely to stop using mercury, as has been corroborated in countries that have banned its use. For example, Interviewee IN noted that in Colombia, the criminalization policy worked well for large scale mines that had financial capacity and infrastructure to incorporate alternative practices, but for ASGM, mercury continued to be used "behind closed doors." Interviewee A corroborated that, similarly, despite an official ban on mercury use in Burkina Faso and Ghana, it remains the standard method for gold extraction in ASGM, with little enforcement or change in

57 See Section VII.1.g: Tanzanian Mineral Markets for further reading on mineral markets.
58 Interviewee A.
59 (Hilson et al. 2018, 125)
60 (Esdaile and Chalker 2018, 6910)

behavior. Law enforcement efforts sometimes target small operators, while larger illicit networks continue to dominate the sector.[61]

d. **Licensing and Environmental Oversight in Tanzania**: In Tanzania, while licensing can contribute to formalization and environmental protection, its effectiveness depends on consistent enforcement and inclusive structures that account for the realities of how ASGM operates on the ground.

   As several interviews indicated, in Tanzania, a significant step towards formalization has been licensing requirements. Interviewee TMC expressed that licensing allows for increased accountability for miners, particularly by clarifying the location, companies, and persons associated with mining operations. Licensing in Tanzania comes with directly beneficial environmental effects-- to achieve the license, an environmental impact assessment must be approved with the Ministry of Environment. Moreover, Interviewee TG expressed that licenses can be revoked if environmental regulations are not followed, such as the containment of waste. The Ministry of Mines emphasizes that all waste from the processing or extraction site should be contained when mercury is being used. The licensing requirement is not always effective, however, as the Ministry of Mines has reported that license holders often employ unlicensed operators of mines. In this situation, the Ministry of Mines has worked out a system that those without a license can work under a licensed owner through a registered contract with the mining commission to ensure formalization and regulatory oversight.

e. **Geological Data and Technical Support**: Limited access to accurate geological data remains a significant barrier to both the efficiency and financial viability of ASGM in Tanzania. Interviewee TMC expressed that many miners rely on the Geological Survey of Tanzania (GST), which relies on outdated colonial data and lacks sufficient expertise in exploration. Interviewee TAN stated that only 16% of Tanzania's mineable areas have been geologically mapped, making it difficult for small-scale miners to locate gold. Many miners dig arbitrarily without proper geological data, due to the high cost of geological surveys. To address this issue, the Ministry of Minerals has acquired drilling rigs to improve prospecting information for small-scale miners, but the impact of this initiative is yet to be seen. Without reliable information, miners face not only operational uncertainty but also financial difficulty, such that, even when mines are formalized, the government may need to assist in securing loans and financing.[62]

f. **Financial Inclusion and Legal Security**: Formalization has the potential to bring significant financial and legal benefits to ASGM miners, including improved access to credit, partnerships with large-scale mines, and clearer land rights. However, unresolved issues like high taxation and lack of reinvestment in mining communities risk undermining these benefits, emphasizing the need for a more equitable and supportive fiscal framework.

61 See Section VII.3.a: Mercury as a Social and Financial Mechanism for explanation on mercury's function as a social tool.
62 See Section VII.3.b: Formal Funding: Access and Use for further explanation on geological information and credit.

Interviewee GPS expressed that formalization can be a financial benefit to the miners, as formalized, legal mines are a more secure and attractive investment for lenders. The government also has favored funding for LSM for the same reason of security. Interviewee A suggested that if a collaborative legal approach between LSM and ASGM is solidified in the formalization process, financial benefit could come from agreements where larger companies provide safety gear, equipment, or even buy gold from them. Moreover, Interviewee A added that formalization can help with guaranteeing and clarifying land rights to ASGM operations. Currently, while LSM operations are more formalized and licensed, they have been advantaged in legal disputes regarding land rights.

Interviewee TMC noted that taxation has been an unsolved issue in Tanzania. While miners are already in a difficult economic situation, gold can be taxed up to 20%. The tax revenue intended for infrastructure improvements, such as roads leading to mining sites, have not been well maintained near the model mines. Additionally, considering ASGM creates local value and employment, Interviewee GPS advocated that ASGM should either be taxed minimally or not at all. ASGM indirectly contributes more in taxes through economic activity than it would through direct royalties.

g. **Tanzanian Mineral Markets**: Our data indicates that a crucial improvement for local ASGM trade was the installation of mineral markets and buying centers by the Tanzanian government. According to Interviewee TAN, the introduction of mineral markets not only reduced miners' dependence on illicit gold brokers, but even reduced illegal gold exports. Interviewee TAN also described how miners had difficulties finding reliable illicit brokers to sell their gold. Now, finding a buyer is reportedly not a concern for them anymore as there are buying centers in almost every district. The possibility to sell quickly provides opportunities to re-invest accordingly and Interviewee TAN reported that with the presence of an official market, miners increasingly concentrated on formalization and productivity issues. Even Interviewee A, who is not specialized in Tanzania, reported that the Tanzanian mineral market system was very present in research as a best practice example and emphasized the element of trust building with miners through the markets. They emphasized that besides formalization aspects, the offered gold price plays a crucial role for where miners sell their gold, and our data indicates that miners can generally sell gold at higher prices in the official markets. On the national level, the government's strategic implementation of mineral markets is an important pillar for Tanzania's high levels of formal gold trade in comparison to many other African countries.

2. POVERTY-DRIVEN FRAMEWORK

Past experience suggests that an understanding of ASGM as a poverty-driven industry should shape policy. A poverty-driven policy framework interprets mining practices as a product of restrictive economic circumstances, not an innovative business strategy. Previous interventions, such as the Global Mercury Project (GMP; 2002-2007), have encountered significant challenges when miners were approached as entrepreneurs, willing to scale their operations and advance

technologies for the sake of business growth.[63] Profit maximization does not necessarily require 'growth' in the classic sense, and it must be understood that many miners live under enormous economic pressure.[64]

This is also the case in Tanzania, where most miners live in poor economic circumstances and work in ASGM because there is no viable income alternative. Interviewee SP described gold to be seen as a "miracle and promise of a better life". ASGM "promising" a plausible opportunity to make enough, or even a lot of, money, was also mentioned by Interviewee TAN, who interpreted this to be a cause for the growth of the Tanzanian mining sector.

While bearing risks to health and environment discussed above, mercury use is the cheapest and fastest method to refine small quantities of gold in ASGM. In Tanzania, Interviewee TAN stated that mercury is used most by those with the lowest starting capital because it is cheap. Interviewee GPS described mercury use as a "symptom, not a cause" of poverty and informality issues in ASGM. They stated that mercury use not only lowers financial barriers in ASGM, but is also easy to handle without much, if any, training and reduces processing time compared to other methods.

As several interviews indicate, economic pressure leads to miners prioritizing everyday income over (longer term) health and environmental concerns. Interviewee A compared mercury exposure to smoking: "you don't drop dead now and don't care too much". They also mentioned that miners take larger risks when working in shafts or with big machines, which marginalizes the importance of risks through mercury exposure for them. These findings concur with respective literature and case studies.[65] The bottom line for most ASGM communities is that mercury usage is a rational, economic choice in their circumstances.[66] However, Interviewee TAN reported that after their educational and financial interventions, miners who have enough capital buy personal protection equipment to protect their health.

Several interviewees indicated that mercury can only be successfully eliminated by presenting a viable alternative.[67] While the outsourcing of gold processing was discussed as a difficult but viable option by Interviewee GPS and A, Interviewee SP emphasized the empowerment aspect in miners refining their gold themselves, as they can significantly increase their income by doing so. Interviewee TAN indicated that mercury use could be mitigated by the use of sluicing tables, but that most miners couldn't afford to buy them without external financial support. Interestingly, all non-local interviewees mentioned alternative processing methods like cyanidation, which require more sophisticated equipment and technology for safe handling. Those interviewees therefore suggested upscaling ASGM communities' capacities to the respective technologies. While acknowledging financial and other barriers, technologization was described as the only way to successfully eliminate mercury.

Our data undermines that addressing mercury use in ASGM must begin with a clear recognition of its roots in poverty and limited economic alternatives, rather than treating it as a space for

63 (Hilson et al. 2018)
64 (Kinyado and Huggins 2020, 759-760)
65 Puluhulawa et al. found in a survey in Gorontalo, Indonesia, that miners were comprehensively aware of the dangers, but continued to use mercury because it was the cheapest option (2019, 6). See also Veiga and Fadina's review of mercury reduction projects across 35 countries (2020, 1137).
66 (Clifford 2014)
67 Interviewee GPS, TAN, TG and A.

entrepreneurial innovation. Successful transition strategies will require not only financial support and appropriate technology but also a policy framework grounded in the lived realities of those working in ASGM.

Figure 5: Image of gold weighing from SWISSAID Model Mines

3. SUSTAINABLE FINANCING

A primary challenge in the transition to cleaner and safer mining practices is the access to sustainable, long-term funding. In Tanzania, interest rates remain high at banks, there is a lack of loan subsidization, excessive collateral requirements and inflexible repayment options.[68] For example, even when the Tanzania Mining Act (2010) mandated the use of retorts, legislating that, "holder of a primary mining licence shall not heat a mixture of gold and mercury (amalgam) to recover the gold without using a retort," retorts were not subsidized.[69] On average, retorts have a value of 130,792 Tanzanian Shillings (40 CHF), and this is a cost that many ASGM communities are unable to bear without support.[70] Additionally, Interviewee UNEP emphasised that ASGM financing needs can broadly differ from buying a pan to financing a small scale processing plant. Therefore, it is important to properly assess miners' financing needs and provide tailored solutions.

a. **Mercury as a social and financial mechanism:** Our data indicates that a central lending mechanism in Tanzania usually does not work with money but with mercury. Illicit brokers distribute mercury to the miners and in return expect them to sell their gold to them at a discounted price.[71] Interviewee A emphasized that mercury has a financial and social function: "[miners have] the sense of: it comes for free through the guys who prefinance gold extraction and [it] is then a social commitment device that this gold is also sold back to those people who gave." Interviewee TAN warned that through this mechanism, miners become

68 (Spiegel et al. 2014, 776) Note that these data need to be verified regarding their validity in 2025.
69 (Davies 2013, 114)
70 ibid.
71 Interviewees TAN, IN, A, APS and UNEP.

dependent on the brokers and are blocked in low revenue cycles. This prevents them from being able to make necessary investments to improve their situation.

However, not all our data pointed towards these cycles. In contrast to the explanations above, Interviewee TMC reported that in their area, mercury sellers are "just ordinary guys" with well-guarded contacts to (unidentified) mercury wholesalers. They explicitly mentioned that those sellers traded mercury for money, not gold.

According to Interviewee APS, another financial challenge for the elimination of mercury is the division of gold revenues along the processing chain. The miners extract the gold, crush it and amalgamate it with mercury and keep the gained gold. Subsequently they sell the leftover tailings to a larger leaching operation for a low price. The leaching operation keeps the gold revenue from the "waste" tailings. This division of work and revenue is facilitated by mercury. If mercury was eliminated (for example, by directly leaching gold concentrate), the distribution of revenue would be disrupted and would probably shift in favor of the larger leaching operation. Therefore, miners have a financial interest to continue using mercury.

b. **Formal Funding: Access and Use**: Literature indicates that subsidized loan programs are highly favorable, particularly in the poorest areas. It can, however, be an economically risky venture for the lender and debtor, with a risk of non-repayment[72] and high debt accumulation.[73] Literature suggests that while the sector remains informal, and mines un-licensed, this problem is exacerbated. Throughout Africa, banks will not lend to informal mines and micro-credit programs are highly limited in capacity.[74]

Regarding existing formal financial institutions, Interviewee UNEP pointed out three main obstacles: the lack of appetite for risk, documentation requirements and location. Banks are often not willing to finance high-risk activities like ASGM. Additionally, the required credit history can pose a serious obstacle to miners: besides formalization issues, many do not even possess an identity document.[75] Furthermore, most banks are located in the city, while miners live and operate in what Interviewee UNEP called "hinterlands". To go to the city, miners would have to give up one to several workdays. Interviewee UNEP explained that, "that's not generally within the miners' interest. He would rather mine, get the gold than go to a bank and not be sure that he or she can get the money." Those considerations have to be taken into account regarding financing options for ASGM mining with banks.

According to Interviewee APS, the development sector is not able or willing to understand and mitigate financial barriers:

"I'm a little bit pessimistic on the international development industry. [...] But there's very little true recognition of what does that mean, access to finance, how much money is required, and how do you distribute those funds into any economic activity? So you're getting to the point

72 Interviewee APS referred to repayment rates for loans as low as 15% throughout ASGM in Sub-Saharan Africa.
73 (Spiegel et al. 2014, 776)
74 (Veiga et al. 2014, 355)
75 This was a general observation and would need to be scrutinized with regard to Tanzania.

where you're starting to think about, well, how do you save money? What do you do with it, et cetera? […] It's just to say there's no framework into which the access to finance fits with the normal financial sector systems that we live and operate in.[76] *And that's just not really being acknowledged by the development community for mining."*

However, Interviewee TAN indicated that miners can request formal loans in the government-installed mineral markets, which mitigates their dependence on the banking sector and illicit brokers.

Additionally, FADev has experience with providing loans for miners. Interviewee TAN described a loan system FADev provided for miners, that was used for a broad range of activities like exploration, setting up new mines or buying sophisticated equipment for existing ones. If used for cyanidation equipment, upon successful installation, miners were not only able to repay the loan but also buy shaking tables to eliminate the mercury amalgamation. But most miners who received a loan used it to start, not improve, production. Many needed to lay the basics by pumping the water out of the mining shafts. In these newly established mines, the loans were generally invested in common equipment like generators, shaft maintenance supplies and sometimes PPE. There were some problems with repayment, either because of unforeseen circumstances like flooding or a collapsed shaft, and sometimes simply because the miners wanted to invest the money again instead of paying it back.[77] Others did not understand why they had to pay back the loan if it was meant to support them like the (free) training programs FADev offered as well. Interviewee TMC had received one of these loans. Additional to the issues mentioned above, they explained that it was used for the exploration of some mining sites, but with disappointing results. Consequently, because they had not found gold veins, they were not able to return the money. In their view, loan repayment guarantees can only be requested contingent upon positive exploration results.

If the funds were returned, they could be re-distributed to help more miners. The interviews indicated a difficulty in the sector to identify strategies to improve repayment rates. However, Interviewee TAN proposed a mechanism that would facilitate better access to get a new loan if miners repaid their previous one(s). But they also stated that this would require a mechanism to track miners' financial history, which seems impossible in the current informal state of most ASGM communities.

In conclusion, sustainable financing is a cornerstone for the transition away from mercury use in ASGM, yet it remains one of the sector's most persistent challenges. The Tanzanian case illustrates how structural barriers trap miners in cycles of dependency and limit their ability to invest in safer, more sustainable practices. Banks currently play a limited role in financing ASGM due to the sector's perceived risk, lack of formalization, and logistical barriers such as lack of documentation and remote mining locations. These factors make traditional lending

76 Additionally, interviewee APS outlined that lending in ASGM requires way lower sums than usual bank lending transactions, which poses an additional administrative complication for banks.
77 Regarding re-investment interviewee GPS described that their fair gold premium would not directly go to individual miners but to miners' associations. They then were responsible to reinvest into equipment. This could also be a promising approach for other financing systems.

unattractive or inaccessible for most miners. While subsidized loans and NGO-backed credit programs offer potential pathways toward mercury-free mining, they often fall short due to practical and structural obstacles. Though proposals like offering better loan terms to miners with a positive repayment record could improve outcomes, such solutions require a level of formalization and infrastructure that most ASGM communities currently lack.

4. INSTITUTIONAL COLLABORATION

The Secretariat of the MC has emphasized that legislation should be handled by environmental policy agencies.[78] It is noted in the literature, however, that in many African countries, it is a separate minerals commission that awards mining licenses.[79] It is essential for all relevant regulating bodies to coordinate proactively, both nationally and trans-nationally, as the trade and processing of mercury often transcends borders.

Our data suggest that in Tanzania, while collaboration among key agencies is generally functional, gaps remain, especially in aligning policies tailored to the unique structure and scale of ASGM. In Tanzania, Interviewee TG noted that the principal institutions dealing with the reduction of mercury are the Ministry of Natural Resources, Mining Commission, Ministry of Minerals, National Council for Environment, Ministry of Environment, and Ministry of Health. They added that around "75%" of the time, the institutions work well together, but other times, they fail to do so due to coordination issues. Interviewees TAN and TMC added that, since the Mining Commission is responsible for licensing, they are the most important player in the collective action.

Additionally, regulations should be attuned to the complex organizational structures and variance in size of ASGM operations.[80] Interviewee TAN provided that the Mining Commission and National Council for Environment, who are responsible for the environmental protection plans (EPPs) and environmental law, respectively, have produced conflicting policies. While these institutions have created successful policy for LSM, these conflicts are particularly salient in ASGM, which is overseen by the Mining Commission.

5. MANAGING MERCURY SUPPLY

a. **Domestic Supply**: ASGM accounts for 80% of Tanzania's mercury consumption, namely an estimated 13-24 tons per year.[81] As there is no primary mercury source in Tanzania, all mercury is imported.[82] Although there are no official government records on mercury trade, dealers and users of mercury must register.[83] The main import routes are presumably via Sirari, Namanga, Dar es Salaam City, and Tunduma.[84]

   Mercury trade in Tanzania is regulated by the Government Chemist Laboratory Authority. Interviewee TG stressed that mercury importers have to register for a permit and indicate how the mercury will be used. Permits for mining use are only granted upon proof of security

78 (Hilson et al. 2018, 127-128)
79 ibid.
80 (Veiga et al 2014)
81 (Tanzanian Vice President's Office 2020, 7)
82 (United Republic of Tanzania and Kiwango, 2024)
83 (Tanzanian Vice President's Office 2020, 10)
84 (Tanzanian Vice President's Office 2020, 10–11)

protocols preventing unsafe practices. However, even Interviewee TG, a Tanzanian government official, admitted that many miners use informal channels for their mercury supply. This corresponds to statements from Interviewees TAN and TMC. Interviewee TMC stressed that in their area, there is no legal way to buy mercury. They reported that it is only traded in illicit markets and sellers are identified by word of mouth. As outlined above, our data differ regarding the local mercury trade actors. Interviewee TAN indicated that in Tanzania, mercury serves as a financing mechanism which increases miners' dependence on illicit brokers. This was contrasted by Interviewee TMC's description of independent illicit sellers who traded mercury for money. To further complicate the picture, the TNAP additionally lists PML owners, goldsmiths and owners of processing centers as potential mercury sources for miners.[85] As Interviewee UNEP pointed out, for all these actors, mercury is a commodity through which they gain profit, and they therefore have an interest to sustain the use of mercury. These factors highlight how the lack of legal access combined with financial dependency entrenches miners in the use of mercury, complicating efforts to regulate or phase it out effectively.

b. **International Supply**: Based on MC NAPs, the only countries that produce primary mined mercury are China, Mexico and Indonesia. Consequently, mercury from these sources as well as existing inventories from other countries can feed mercury used in Tanzania. Literature indicates that the USA and Netherlands are the biggest exporters of mercury to Tanzania (approximately 30% each), followed by Kenya, Zimbabwe and Mozambique.[86]

   However, mercury is often traded informally. Corresponding to respective literature,[87] our data indicates that big amounts of mercury in Tanzania stems from illicit international trade networks. Interviewee TAN stressed that it is practically impossible to find out who is involved in mercury trade. They reported that usually national sellers are Tanzanian individuals collaborating with unidentified "bigger, foreign businesses". This corresponds to Interviewee A's findings that in many cases, illicit international networks operate in mercury trade via diversified international enterprises. They added that the flexibility gained through diversification is one of the reasons making it difficult to identify illicit mercury trade networks. Nevertheless, Interviewee A mentioned that the Swiss mercury export ban shows that regulation is possible. But mercury keeps being traded globally at low prices.

   The challenges discussed above underscore the need for coordinated international measures to improve transparency and accountability in mercury trade, without which Tanzania's domestic reforms will have limited impact.

6. COMMUNITY EDUCATION AND TRAINING

a. **Community-led Awareness Campaigns**: Past awareness efforts that were short term, overly technical, and lacked input from mining communities failed to yield impactful reductions in

85 (Tanzanian Vice President's Office 2020, 11)
86 (Davies 2014, 117)
87 (Davies 2014, 117)

mercury use.[88] Davies raises the concern that a vast majority of funds in mercury reduction projects go towards monitoring and enforcement, and not towards education.[89] The long-term, low-dosage of mercury exposure in ASGM can make the effect of the toxicity ambiguous and delayed for many years, compounding the difficulties of raising awareness in many cases.[90] Hence, the literature supports that a strategic approach to raising awareness is essential, in which mining communities are trusting of their educators and are fully informed.

On the other hand, UNIDO projects in Zimbabwe and Tanzania yielded more engagement when the slogan "less mercury, more gold and better health," was adopted, as miners were made aware of direct personal benefits.[91] In Ghana, miners that had full awareness of the risk of mercury toxicity were more likely to use retorts.[92] Without awareness, long-standing mining behaviors are unlikely to change. At the same time, the approach to educating miners must be culturally sensitive and community informed. Interviewee IN corroborated this approach, stating that it is not simply a matter of technical training, but an "educational, economic, [and] social plan" should be undertaken to achieve effective results.

Moreover, training related to mercury alternatives and retorts must be similarly responsive to community needs. In Tanzania, a comprehensive review of 'Centers of Excellence' (COEs) training facilities identified, "equipment rentals, geological information, accessibility to loans, and training on financial literacy" as essential elements to attract miners.[93] Any shift to retort usage must be cognizant of the continued presence of mercury, and implement retorted mercury management training programs and awareness campaigns.[94]

b. **The Pitfalls of Short-Term Training Programs**: As with risk awareness and education, long-term interventions for training are key. This was a salient finding of the outcome of the GMP, which employed short term training interventions. Due to the lack of continuity, miners' uptake of the new methods introduced was minimal. Interventions in Mozambique and Colombia yielded similar, non-sustaining results regarding training in the use of retorts.[95] Interviewee APS corroborated that short-term training programs are insufficient for real change; instead, they recommended long-term, vocational education tailored to the realities of artisanal miners. They emphasized that mining is a highly complex process requiring significant technical expertise, unlike the oversimplified way it's often treated by the development industry.

c. **FADev's Long-Term, Community-Based Training Model**: Our local interviewees supported that FADev's long-term, community-based training approach has been effective in raising

88 (Clifford 2014)
89 (Davies 2013, 116)
90 (Clifford 2014, 109)
91 (Spiegel et al. 2014, 774)
92 (Clifford 2014, 109)
93 (Kinyado and Huggins 2020, 765)
94 (Kosai et al. 2023, 6-7); See Section VII.7.a.i: Retorts.
95 (Veiga and Fadina 2020, 1138)

mercury risk awareness, particularly by empowering local trainers, using visual tools, and targeting both adults and children.

With regard to the model mines, Interviewee TMC and TAN noted that FADev's capacity building training has been particularly effective by employing a long-term approach and engaging with community members. Interviewee TAN emphasized the importance of education, particularly aimed at the influx of newcomers to mining that have recently moved over from the agricultural sector. Interviewee TMC praised that support is being given to women in small-scale mining by encouraging alternative forms of involvement beyond direct mining, such as providing social services and engaging in entrepreneurial activities. While education has made a difference in communities FADev has already reached, many are still unaware of the dangers of mercury and even store food in containers that once held chemicals.

Interviewee APS highlighted that it is crucial that training and educational efforts are led by technically credible individuals. Delivering top-down messaging, especially from outsiders lacking mining experience, is often ineffective. Along those lines, Interviewees TAN and TMC noted that FADev's training-of-trainers sessions empowered people from the community to distribute educational materials and t-shirts throughout their networks. They have observed that there is often a snowballing effect with PPE usage, as well, such that when some miners start using it after proper training, others will follow suit. Additionally, they found teaching children about the dangers of mercury, particularly those that live near mining areas, helps create long-term awareness. As these children grow up, they carry this knowledge with them, potentially spreading it further if they join the mining sector. Interviewee TMC emphasized the powerful impact of visual tools—like a video showing mercury's harmful effects—which resonate more deeply than verbal explanations. Lastly, they praised clear presentations on financial management, such as budgeting, record-keeping, and planning expenses and technical guidance, especially on the safe handling of mercury. With their method, significant improvements in mercury risk awareness and practices have been observed.

Despite challenges in reaching all miners and some initial resistance, persistent, locally led education efforts and relatable storytelling have led to positive mining behavior changes, including increased PPE use and safer practices. Interviewee TMC offered that the main limitation in these efforts is the ability to reach all miners. Interviewee TAN added that some miners, "don't take it too seriously," which may contribute to low participation rates. To counter these concerns, FADev shared real-life stories, photos, and videos of community members who had been harmed by mercury. Such repeated and persistent efforts that are corroborated by community members themselves, Interviewee TAN claimed, led many to eventually adopt safer methods.

7. UNDERSTANDING TECHNICAL FACTORS

An important lever for diminishing mercury emissions and risk exposure is, on the one hand, the reduction and recycling of mercury in ASGM processes. On the other hand, the elimination of mercury in ASGM requires alternative techniques. The use and impacts of other chemicals like

cyanide or borax must be further examined.[96] The solutions, however, must align with specific realities on the ground.[97]

a. Mercury Reduction in Use and Exposure

i. Retorts

Retorts can be used during the ore roasting process to collect and condense vaporized mercury. The use of retorts for the amalgam roasting process not only contributes to mercury recycling, but also reduces mercury gas emissions, therefore significantly mitigating health and environmental risks.[98] Various interviewees stressed the importance of retorts for mercury risk mitigation. In spite of their benefit, both the literature and interviews reveal a range of persistent challenges when it comes to the introduction of retorts. The following paragraphs will discuss those challenges and respective solution approaches.

ii. Distrust and Misconceptions

A primary concern identified in the literature is the miners' fear of gold loss when using retorts. This stems from the design of retorts, which mostly do not allow miners to observe the burning process. The literature emphasizes that proper training is required to address this misconception.[99] This theme was echoed by Interviewee TAN. FADev found that many miners believe that the use of retorts may lead to a loss of gold. To address this distrust, some have proposed the use of transparent glass retorts, which would allow miners to observe the process and thereby build confidence.[100] However, beyond this technological distrust lies a deeper cultural resistance. According to Interviewee TAN, many miners are used to working without retorts and are reluctant to adopt new technology.

iii. Technical disadvantages and opportunities

Pointing out an additional challenge, Interviewee APS stated that certain retort designs may leak up to 20% of mercury, undermining their effectiveness. Converging with literature,[101] they mentioned that retorts themselves become mercury-contaminated after use and are often not handled with the required caution, which increases the risk of secondary contamination in households and communities.

iv. Training and Accessibility

Economic and physical access to retorts and awareness of their use are also critical challenges. Our data and the literature converge in the need for respective training.[102] Interviewee TMC reported that in their area, an estimated 70% of miners did not know what a retort was. However, there were differing opinions among our interviewees on the usefulness of training alone. Interviewee TAN reported that their NGO achieved good results by educating miners on the use of retorts and establishing contacts to official sellers without providing retorts for free. On the other hand, Interviewee TMC assessed education without distribution of free retorts as unsuccessful and criticized the lack of

96 (Garcia et al., 2015 and Veiga et al. 2014b in Geenen, Nkuba, and Radley 2022, 796)
97 (See Veiga, Angeloci-Santos, and Meech 2014, 354; Esdaile and Chalker 2018, 6911; Veiga and Fadina 2020, 1136)
98 (Kosai, Nakajima, and Yamasue 2023, 4; Esdaile and Chalker 2018, 6913)
99 (Esdaile and Chalker 2018, 6913)
100 Interviewee TAN; (See also Veiga, Angeloci-Santos, and Meech 2014, 354; Esdaile and Chalker 2018, 6911)
101 (Kosai, Nakajima, and Yamasue 2023, 6)
102 (Spiegel et al. 2015, 773; Esdaile and Chalker 2018, 6913; Tanzanian Vice President's Office 2020, 19-20)

physical and economic access to the tool itself. Literature also indicates that the cost of retorts can prevent many miners from using them.[103] Best practices include the involvement of gold buyers in the distribution of retorts and the training of miners to fabricate retorts from kitchen supplies and plumbing equipment to reduce costs. While literature indicated that home-built glass salad bowl retorts are slow, but were successfully introduced in over 20 countries,[104] the concept of self-made retorts did not come up in any interview.

v. Mercury recycling

Finally, retorted mercury can be reused. Interviewee TMC described this as a financial incentive for the use of retorts, "because if you don't recycle you have to buy [mercury] again. So people are taking care of it." However, Interviewee APS mentioned that retorted mercury becomes increasingly contaminated with each reuse cycle. Eventually, miners often discard it—sometimes directly into rivers—because they lack the means or knowledge to purify mercury. However, mercury could be chemically reactivated for reuse. Although the process requires some know-how, Interviewee APS described it as quick and easy. Reportedly, the only downside is the risk of higher exposure levels during reactivation. Despite this promising disposition, mercury reactivation is only conducted very rarely and was seldom discussed in other interviews or literature.[105]

vi. Personal Protective Equipment

The introduction of protective equipment can further reduce mercury exposure. Interviewee TAN and TG emphasized that while PPE is a standard in LSGM, it remains generally unknown in ASGM. The Tanzanian government and FADev facilitate educational programs on PPE use, which both respective interviewees reported to achieve slow, but steady progress. The question of free distribution was brought up again by Interviewee A. They emphasized that ensuring protection should be seen not as a reward for formalization, but as a foundation for safer practices and gradual sector transformation.

vii. Other measures

Besides targeting the extraction and burning process, further societal and environmental measures could be implemented to reduce mercury exposure and pollution.

viii. Amalgamation Centers

Going beyond the measures described above, Interviewee GPS introduced the concept of amalgamation centers. With their business they established those centers outside the miners' villages to minimize exposure for the community. They emphasized that independence from buyers and safety measures including a security guard are crucial for success. While those amalgamation centers have been effective in certain Latin American mining communities, their success appears highly dependent on strict conditions which may not be easily replicable in other contexts.

103 (Veiga, Angeloci-Santos, and Meech 2014, 358–59; Spiegel et al. 2015, 773; Esdaile and Chalker 2018, 6913; Tanzanian Vice President's Office 2020, 19)
104 (Esdaile and Chalker 2018, 6913; Clifford 2014, 110; Veiga, Angeloci-Santos, and Meech 2014, 358-359)
105 As a rare reference, Kosai et al. report cases where retorted mercury was "simply discharged to the environment or kept in the house" and propose a mercury reactivation process. (Hinton et al. 2003 in Kosai, Nakajima, and Yamasue 2023, 6)

ix. Mercury-Contaminated Tailings

Our data indicate that a significant part of mercury pollution stems from mercury-contaminated tailings. According to Interviewees SP and GPS, they are often discarded into nature without prior cleaning. Interviewee IN and TMC reported that most mercury-contaminated tailings are further processed with cyanide, which is a worst practice according to the MC.[106] Interviewee IN described tailings as an additional source of capital for miners, who would stock or sell them for processing dependent on current gold prices. Under this light, Interviewee TMC voiced concerns regarding tailings storage if their mine's capacities increased. They explained that safe tailings storage would even grow more difficult and the risk of accidents would increase. Interviewee UNEP therefore stated that, "the best way to really deal with the tailings is not to contaminate it [sic!] with Mercury in the first place." Asked about solutions for the outlined issues, all interviewees stated that they did not see a realistic approach to safely handle mercury-contaminated tailings without significant revenue losses.[107]

b. Mercury Elimination through Alternative Extraction and Processing: Mercury-free extraction techniques can be categorized as physical, hydro-, and pyrometallurgy.[108] [109] These techniques present a promising yet complex alternative to the use of mercury. While their implementation often demands more advanced equipment and training, which can be difficult under the financial constraints of ASGM communities,[110] some approaches have shown potential to increase gold yields and reduce overall costs.[111] For these alternatives to be viable, they must also meet criteria such as environmental soundness, short timescales and the ability to process large volumes.[112] [113] Given these circumstances, the obstacles to successfully replacing mercury in ASGM remain substantial, and in the short term, no technology appears poised to offer a definitive breakthrough.

i. Physical Metallurgy: Gravitation Techniques

Physical metallurgy techniques include sluicing, Gemini (shaking) tables and other gravitation techniques. According to the literature, gravitation techniques have been successfully implemented in countries like French Guiana, Senegal, Colombia and Peru.[114]

The successful application of sluicing techniques in Tanzania has been mentioned by both Interviewee TMC and TAN. Interviewee TMC emphasized that while miners might still need financial support to cover the cost of sluicing tables, the cost is lower than for other, more sophisticated mercury-free techniques. However, our data show that gravity separation is often combined with mercury amalgamation. One plausible reason for this could be that sluicing can reduce the amount of mercury utilized for the same amount

106 (UNEP 2025, 62, Appendix C.1.iv)
107 Interviewees IN, TMC, GPS and UNEP.
108 (Keane et al. 2023, 841)
109 For a description of a specific mercury-free extraction process see e.g. (Maganga et al. 2023, 38)
110 (Davies 2014, 110; Spiegel et al. 2015, 773; Esdaile and Chalker 2018, 6913)
111 (Davies 2014, 108, 110)
112 (Esdaile and Chalker 2018, 6911) For a comprehensive overview of key factors for assessing the suitability of mercury-free gold processing technologies see Figure 8 in Annex.
113 For a comprehensive overview of key factors for assessing the suitability of mercury-free gold processing technologies see Figure 8 in Annex.
114 (Davies 2014, 115; Veiga, Angeloci-Santos, and Meech 2014, 356; Esdaile and Chalker 2018, 6913; Maganga et al. 2023, 34–35)

of gold revenue.[115] An advantage of this combined technique pointed out by Interviewee GPS is that a smaller amount of the extracted material is contaminated with mercury.

ii. Hydrometallurgy: Cyanide and other Leaching Techniques

Worldwide, cyanidation is the current standard for industrial gold mining. Cyanide leaching complexes and dissolves residual gold.[116] According to Interviewee APS, this poses a clear advantage compared to gravitation separation methods, as these can only catch free gold. Cyanide also has a higher recovery rate than most gravitation separation methods and the chemical itself is relatively cheap. It enables an efficient procedure and is less toxic than mercury.[117] Interviewees TAN and A stressed that its effect on environment and human genetics is far less dangerous than mercury. Nevertheless, mercury made bio-available through cyanide poses a great risk to environment and human health. Operators using cyanide on mercury-contaminated tailings are therefore classified as a "worst practice" under the MC.[118] However, avoiding this practice is difficult to ensure in most ASGM sites.[119]

To avoid safety concerns, cyanidation can only be conducted with rigorous safeguards and sophisticated equipment, requiring investment, training and organization of labor. For most ASGM operations this cannot be ensured.[120] Various interviewees therefore suggested only doing cyanidation in sophisticated processing plants.[121] As giving their ore away for cyanidation raises concerns about trust and revenue imbalance issues among miners, the option of collective cyanide processing centers was discussed by Interviewees IN and TG.

According to Interviewee A, a disadvantage of cyanidation in comparison to mercury is the prolonged processing time. Cyanidation can take up to two weeks, which results in many logistical and trust problems. The delay between extraction and gold sale poses a serious problem especially to the miners in most precarious financial situations. Furthermore, the processing site has to be guarded for safety reasons during the whole cyanidation, which brings additional safety and logistical issues as well as expenses. Another challenging aspect is the shifting wealth separation if a variety of (industrialized) players are included in the process. Also, it has to be considered that respective low-training jobs are lost if mercury amalgamation is abandoned due to more sophisticated processing techniques.

Despite these challenges, combining cyanidation with gravitation separation is a promising path towards the elimination of mercury.

115 (Davies 2014, 115; Tanzanian Vice President's Office 2020, 7), also mentioned by Interviewee APS.
116 (Veiga, Angeloci-Santos and Meech, 2014, p. 357; Esdaile and Chalker, 2018, p. 6909)
117 (Veiga, Angeloci-Santos and Meech, 2014, p. 357; Esdaile and Chalker, 2018, p. 6909; Veiga and Fadina, 2020, p. 1136; Stapper, 2022)
118 (UNEP 2025, 62, Appendix C.1.iv)
119 (UNEP 2025, 65)
120 (Spiegel et al. 2015, 774; Stapper 2022)
121 Interviewees IN, TG, TMC.

iii. Pyrometallurgy: Borax

Borax is often described as a mercury alternative, but this is only true for the burning process.[122] Interviewee APS stressed that borax cannot be used to entirely substitute mercury as it cannot be used to capture gold in an amalgam. They stated: "I wouldn't describe borax as an alternative to mercury ever." Both Interviewees APS and TMC mentioned that in theory borax could also be used without mercury, if miners were able to produce a sufficiently dense gold concentrate with gravity techniques. The potential of borax was assessed differently in our data. Literature suggests that borax is environmentally benign and easy to apply,[123] converging with Interviewee TAN who described borax as "promising" and explained that FADev was working on improved effectiveness for borax techniques. On the other hand, both Interviewees APS and TMC stated that if borax is not applied correctly, big amounts of gold can be lost in the process and Interviewee TMC described borax as "not promising at the moment".

8. ADAPTING ALTERNATIVE PRACTICES TO LOCAL CONTEXT

Effective adoption of alternatives to mercury requires meaningful engagement with mining communities and sensitivity to ore types, access challenges, and the cultural significance of mercury. Literature supports that equally important to the availability of economically feasible clean technologies is the conversation with and input of communities that will be using them.[124] Interviewee APS remarked, "mining is complex, so there's no simple…one size fits all for a mining operation." The specific ores being mined, the knowledge level of the miners, and the social dynamics of technological decision making all must be taken into account.[125] Interviewee UNEP emphasized that no technology will work effectively without being matched to the right ore. They strongly advised that efforts to promote mercury-free technologies should be sensitive to ore type.[126]

Interviewees APS and A reasoned that given that mercury-free methods are not only technically viable but also already in use by formal operations worldwide, the sector has already demonstrated that cleaner alternatives can achieve high gold recoveries without mercury. The challenge, then, lies not in the technology itself but in tailoring its adoption to the realities of local mining communities. Interviewee A specifically emphasized that mercury functions as a social commitment device in many communities. Interviewee TG, however, stated that the primary barrier in Tanzania remains access to mercury-free alternatives in remote areas.

122 (Davies 2014, 116; Veiga, Angeloci-Santos, and Meech 2014, 357; Esdaile and Chalker 2018, 6914)
123 (Davies 2014, 116; Veiga, Angeloci-Santos, and Meech 2014, 357; Esdaile and Chalker 2018, 6914)
124 (Veiga and Fadina 2020); (Spiegel et al. 2014, 773)
125 (Spiegel et al. 2014; Veiga et al. 2014)
126 See Figure 9 in Annex.

VIII. CONCLUSIONS

1. TANZANIAN NATIONAL ACTION PLAN

The Tanzanian National Action Plan (TNAP) contains various elements that are in line with best practices described in our policy indicators. Our interviewees supported that the TNAP was formulated and implemented in a bottom-up fashion, in conversation with the ASGM community. Interviewee TMC recalled meetings in Dar Es Salaam with members from ASGM communities. Interviewee UNEP remarked that the first TNAP evaluation and assessment report is still in progress, so it is difficult to determine the effectiveness of the plan, to date. At publication, the TNAP will be near expiration (end of 2025). The Tanzanian government has yet to clearly outline future plans for implementation of the MC.

Below, we evaluate the strengths and weaknesses of the TNAP as written, based on how well it aligns with our established policy indicators.

Bottom-up formalization **:** Similarly, the TNAP encourages a bottom-up style approach to formalization. Formalization of the sector is a priority, but not a requirement, of the sector.[127] Input from a diverse array of stakeholders was included in the formulation and evaluation of the plan. This included various focus groups, workshops, and field studies from August 2016 to June 2019 and the establishment of a Stakeholders Annual Forum on ASGM.[128] The elements of formalization included priorities highlighted in our study such as operationalizing mineral markets, strengthening capacity of licensing institutions and conducting "land use mapping and geo-prospecting."[129] The financial priority, however, to "Create enabling environment and arrangements to facilitate access to affordable credit and financial services by miners," is noted as highly vague.[130]

Poverty-driven framework **:** The TNAP framework acknowledges that mercury usage is an economic choice, often driven by poverty. A main task for the implementing officers is to "undertake diagnostic analysis of socio-economic inter-linkages of the ASGM sector."[131] It encourages a comprehensive understanding of how ASGM functions as a survival strategy and what structural changes are needed to make it a pathway out of poverty. Moreover, the emphasis on a need for credit access throughout the document reinforces the economic underpinnings.

Sustainable financing **:** The TNAP recognizes the need for ASGM community access to affordable credit and financial services, setting the goal of 30% improvement for ASGM operators.[132] This goal is elaborated as the need to, "develop and implement a financial and technical assistance plan to assist miners with the transition from worst practices to reduced- and zero-mercury mining practices through facilitation to access financial institutions and adoption of mercury free gold

127 (Tanzanian Vice President's Office 2020, 58)
128 (Tanzanian Vice President's Office 2020, 22)
129 (Tanzanian Vice President's Office 2020, 21)
130 (Tanzanian Vice President's Office 2020, 22)
131 (Tanzanian Vice President's Office 2020, 55)
132 (Tanzanian Vice President's Office 2020, 18)

processing technologies." [133] However, the specific mechanisms for achieving this goal are not clearly outlined in the plan.

Institutional Collaboration **:** A strongpoint of the TNAP is the highly specified coordination and collaboration mechanisms, both within pre-existing institutions and ad hoc task forces. As the primary coordination mechanism, it established the National Task Force (NTF), which was comprised of, "14 members drawn from relevant Government Ministries and Agencies, Academia and Non-Government Organization" and responsible for studying and writing the NAP.[134] Moreover, the roles and responsibilities of governmental, regional, district, village, private sector, academic, and civil society level institutions are clearly designated in Section 4.1.6: Strategies for Involving Stakeholders in the Implementation and Continuing Development of the Plan.[135]

Managing Mercury Supply **:** The TNAP contains efforts to improve statistical information about the use of mercury in ASGM nationwide through periodic baseline estimates.[136] The priority interventions regarding mercury supply remain vague, however, and the effectiveness of specific actions need to be proved.[137] Moreover, the plan is missing the key recognition that strict regulations on legal mercury could result in a shift towards illicit trade.[138]

Community education and training **:** A key goal of the TNAP is to, "Facilitate provision of information to ASGM and affected communities on mercury related issues,"[139] recognizing the need for increased awareness on the issue. This need is addressed through more specific strategies of developing a comprehensive public health campaign[140] and training plans for mercury capture techniques (i.e. retorts) and mercury alternatives (i.e. gravity separation and cyanidation).[141] The strategies appear to follow a community-centered education and training model by applying different educational program formats (i.e. radio, social media, workshops, school curricula, etc..) for different target groups. Context-specific outreach plans following these formats were developed for different communities in light of analysis conducted to measure the efficacy of different formats.[142] Lastly, in light of the misconceptions and stigmas that exist (i.e. about retort use), the TNAP dictates that, "any method to replace mercury should first address the needs and beliefs of the miners."[143]

Understanding Technical Factors **:** With regard to technical processes and implementation, the TNAP expresses a nuanced recognition of the need for a combination of mercury reduction and elimination and acknowledges that complete mercury elimination might not be possible.[144] Awareness raising and training regarding retorts and mercury-free extraction techniques are adequately addressed, along with the promotion of research on mercury free alternatives.[145]

133 (Tanzanian Vice President's Office 2020, 20)
134 (Tanzanian Vice President's Office 2020, 55)
135 (Tanzanian Vice President's Office 2020, 27-28)
136 (Tanzanian Vice President's Office 2020, 20)
137 (Tanzanian Vice President's Office 2020, 24-25)
138 ibid.
139 (Tanzanian Vice President's Office 2020, iv)
140 (Tanzanian Vice President's Office 2020, 27)
141 (Tanzanian Vice President's Office 2020, 20)
142 (Tanzanian Vice President's Office 2020, 32)
143 (Tanzanian Vice President's Office 2020, 19)
144 (Tanzanian Vice President's Office 2020, 17-19)
145 (Tanzanian Vice President's Office 2020, 20)

However, specific mechanisms regarding how to promote such research are not clarified. Additionally, despite being described as a major problem, tailings management is not addressed.[146]

Adapting alternatives to local context **:** The TNAP was designed following a comprehensive national overview study of ASGM in Tanzania conducted from 2017-2019. The study surveyed more than 1048 stakeholders[147] and collected information from various sites on essential local elements including ore grade, gold recovery, gold and mercury prices, and number of miners and pits.[148] The target of the NAP, however, to reduce mercury use in ASGM by "30% by 2025 through elimination of mercury intensive and unsafe practices of mercury use, the adoption of mercury control and capture technologies, and/or the adoption of mining techniques that do not require mercury use"[149] is not adjusted per local conditions.

2. INTERNATIONAL ACCOUNTABILITY

Various international actors can have a major influence on the ASGM sector in Tanzania. Domestic and international gold trade were prevalent themes throughout our literature review and interviews. While only domestic gold trade is directly related to the supply of mercury as discussed earlier, international gold trade can still play a major role in achieving the goals set in the MC.

a. **Influence of Global Gold Prices on Implementation Efforts**: First and foremost, Interviewee UNEP acknowledged that, as mercury pollution in the global south continues to rise, an obstacle in MC implementation has been rising gold prices.[150] Since 2016–17, the price of gold has sharply increased, reaching $3000 per troy ounce in 2025. Elevated gold values increase the profitability of ASGM, creating economic incentives that can outweigh environmental and health considerations. Many of the convention's interventions were conceptualized under different market conditions and now require recalibration to remain relevant and effective.
b. **Traceability Issues**: The issue of traceability remains an unresolved challenge in the global gold trade. While various actors acknowledge its importance for curbing illicit flows and promoting ethical sourcing, current systems fall short of ensuring transparency across the supply chain. In Switzerland, refineries only have to indicate the origin data provided by the selling exporter.[151] Interviewee SP criticized that this poses a transparency issue and makes Swiss gold trade vulnerable to illegal practices. They argued that gold sellers should be held responsible for the whole trade chain since the extraction. Additionally, Interviewee SP pointed out that sellers of second hand gold do not have to prove provenance. Although the price for second hand gold is slightly lower, it is still an attractive way to sell smuggled gold, especially in larger quantities. They referenced the high percentage of second hand gold in Swiss refineries.[152] However, Interviewee GPS explained that it is very expensive to track gold

146 (Tanzanian Vice President's Office 2020, 20)
147 (Tanzanian Vice President's Office 2020, 3)
148 (Tanzanian Vice President's Office 2020, 2)
149 (Tanzanian Vice President's Office 2020, 17)
150 See Figure 9 in Annex.
151 (Swissaid 2024, 55)
152 While comprehensive data is difficult to find, a study from 2015 indicates that roughly half of all gold in Swiss refineries is not newly mined (Ruysschaert et al., 2015, 13). Swissaid reports that Swiss LMBA refineries declared recyccled gold imports from South Africa, Egypt and Morocco. Especially the amount of recycled gold imported from South Africa raises questions as the numbers indicated for the local market for second hand gold are significantly lower (Swissaid 2024, 53).

along the entire trade chain. While the relative cost decreases for higher quantities which would enable tracking LSM gold, tracing ASGM gold remains too expensive to still be marketable.

Atomic Equivalent Production Model: *For their fair gold trade business, interviewee GPS found a solution replacing the tracing of trade chains. As gold is an atomic element, there is no atomic difference between different gold stocks (in contrast to goods like coffee or wine). This makes it practically interchangeable on the market. Therefore, the trade company purchases uncertified gold on the market and re-sells it to their customers. The customers pay an additional fair gold premium which goes to a fair partner mine who produced the equivalent of gold and sold it officially. With this system, traceability issues and cost can be circumvented while still supporting fair gold production. Interviewee GPS pointed out that their model is not based on aid, but on trade and hands decision power to the buyers. They also reported that the direct market link to Europe and the USA positively affected miners' reputation and recognition in their own country. While their business model is successful in Latin America, interviewee GPS described logistics in Africa generally as "impossible" and instanced massively increased expenditures as a reason why their business model would currently not be successful in Africa.*[153] *However, from a development standpoint where competitiveness is not the main objective, it could be further inquired how this model could be applied in Tanzania to mitigate issues with traceability.*

c. **Swiss Legal Framework**: Interviewee SP criticized the weak Swiss legal framework, noting that it leaves entry points for imports of gold produced under illegal conditions. They pointed out that as a main global actor in gold refining, Switzerland has a special responsibility to prevent illicit gold trade. They suggested that gold sellers should be obligated to trace the origin of their gold and run controls along the chain.[154] With a transparent report on gold provenance, the Swiss government and NGOs could verify the indicated data, which is currently not possible.

   Furthermore, Interviewee SP pointed out that for actors dealing with big quantities, current sanctions on illegal gold trade are a calculated risk they are willing to take, as maximum fines only account for a small percentage of their profits. To raise not only the ethical, but also the financial stakes, Interviewee SP proposed introducing stronger sanctions.

   To complement trade regulations, Interviewee SP suggested introducing a modest tax on gold transactions, which could be used to improve conditions for miners. However, they also acknowledged that illicit gold flows quickly move to countries with less regulation. Furthermore, internationally taxing gold transactions is a highly technical and complex endeavor. To address this issue, coordinated international action is needed to identify how access to benefit sharing along the supply chain can be improved.

153 Notably, Interviewee GPS did not specify their statement with regards to the Tanzanian context.
154 On the release date of this report, the Swiss national council accepted an amendment to the precious metals control act as part of the revision of the Swiss customs law. If adopted, the amendment stipulates better controls along the entire trade chain, introduces stronger sanctions and enhances transparency. (Presseportal 2025)

IX. RECOMMENDATIONS

In light of our findings, we crafted policy recommendations for local, national, and international actors. The recommendations are categorized according to policy indicators, as demonstrated by the corresponding icons.

Policy Indicator	Icon
Bottom up formalization	
Poverty driven framework	
Sustainable financing	
Institutional collaboration	
Managing mercury supply	
Community education and training	
Understanding technical factors	
Adapting alternatives to local context	

Figure 6: Legend of policy indicators and icons

1. FADEV, SWISSAID AND SWISSAID-GENÈVE

We recommend FADev, SWISSAID and SWISSAID-Genève to consider

a. assessing environmental conditions and local practices, particularly ore-type, prior to implementing alternative extraction methods.
b. continuing their educational efforts on retorts and PPE with peer-led models and consider supporting economic and physical access to retorts when necessary.
c. extending their loan program, but differentiate between specific financing needs resulting from the scale of a mining operation and the planned activities.
d. exploring the potential for amalgamation centers and communal cyanidation plants with respect to miners' needs, government support and funding opportunities.
e. examining the potential and prerequisites for mercury reactivation after recycling.
f. exchanging on the assessment of potential for borax with mining communities.
g. continuing to design long-term, community-led awareness campaigns, tailored to newcomers from agriculture, women, and youth.

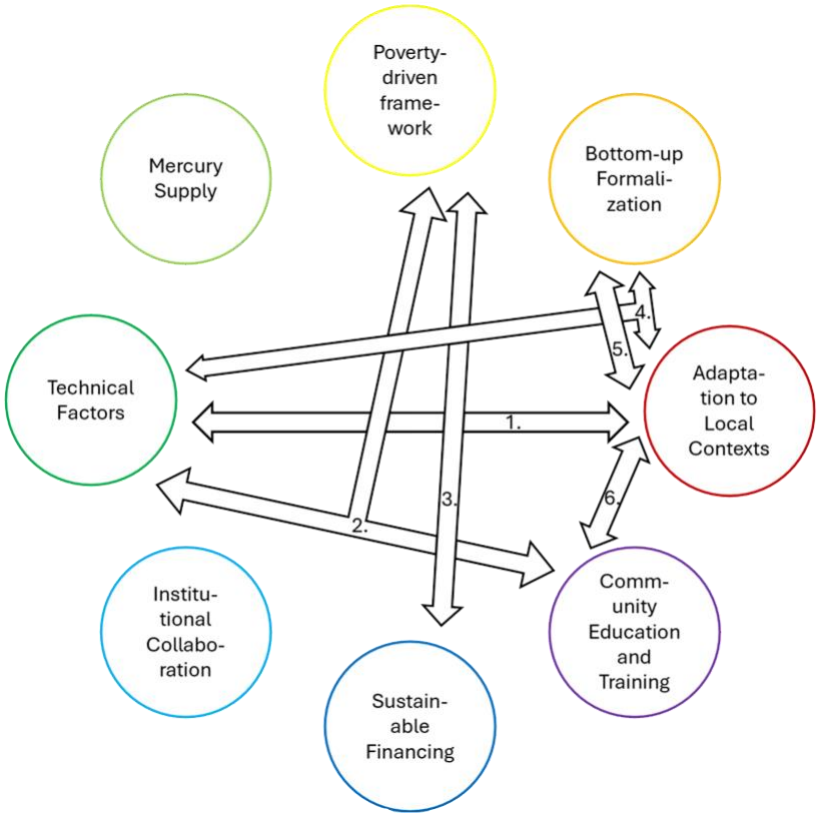


Figure 7: Visualization of interplay between different policy indicators in the local recommendations

2. TANZANIAN GOVERNMENT / NATIONAL LEVEL POLICY & ACTION

We recommend the Tanzanian Government to consider

a) continuing to support the establishment and perpetuation of mineral markets and COEs close to mining sites and extend loan programs offered in these markets.
b) accompanying formalization efforts with initiatives for better access to identification documents.
c) preventing formalization as a precondition for government support, especially regarding protective equipment and retorts.
d) improving access to legal mercury trade on a national level. This could include verification of use and safety protocols in mineral markets instead of custom controls.
e) assessing how the division of gold revenues along the value chain impacts the continued use of mercury.
f) amplifying miners' voices in efforts to formalize the sector, including legal measures (accessible and inclusive licensing measures), technical initiatives (supporting geological surveying and mapping), and financial infrastructure (expanding access to credit). Formalize

partnerships with village leaders, cooperatives, and local associations to mediate between the government and miners.

g) reviewing existing laws and regulations to clearly define institutional responsibilities in ASGM governance to establish legislative harmony, especially between the Mining Commission and National Council for Environment.

3. INTERNATIONAL DEVELOPMENT ORGANIZATIONS

We recommend international development organizations (including UNEP) to consider

a) assessing the potential of the Tanzanian mineral markets as a model for other countries.

b) continuing to coordinate international measures to improve transparency and accountability in mercury trade.

c) assessing how the rise in gold prices affects priorly planned implementation efforts of the MC.

d) portraying a nuanced understanding of ASGM miners and communities to avoid marginalization, especially regarding criminalization and mercury use.

e) continuing to promote context specific and locally informed adaptations of NAPs, with gradual, adaptive strategies to reduce the harms of mercury

f) reinforcing a holistic development lens that integrates labor rights, community agency, gender, economic alternatives, and health care.

g) assessing how access to benefit sharing along the supply chain can be improved

4. SWISS REGULATIONS

We recommend policy makers in Switzerland to consider

a) introducing a responsibility of gold sellers for the entire trade chain and sanctions that mirror the potential profit made with illicit gold trade.

b) inquiring about declaration options for big amounts of recycled or second hand gold to hamper illicit gold trade.

5. CHEMISTRY AND TECHNOLOGY RESEARCH

We recommend specialists in the field to further research

a) the design of technical or chemical solutions to treat and safely dispose of mercury-contaminated tailings.

b) if and how the processing time of cyanidation could be shortened.

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ANNEX

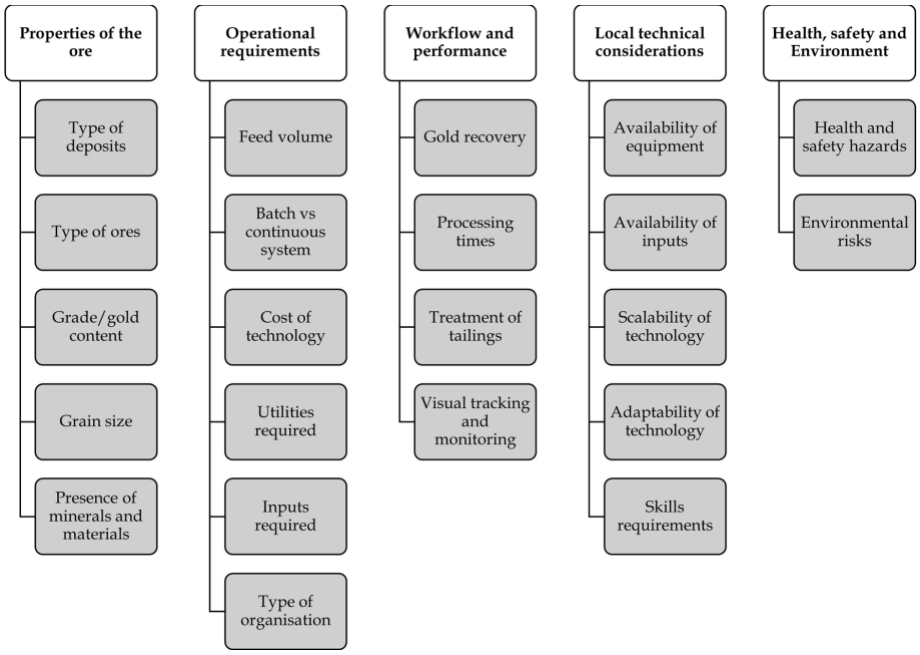

Figure 8: Key factors for assessing suitability of mercury-free gold processing technologies[155]

Figure 9: 20 Year Gold Price in USD/oz[156]

155 (© Keane et al. 2023, 840)
156 (© Gold Price 2025)