Final report

Targeted Scenario Analysis (TSA) for achieving a more environmentally friendly Artisanal and Small-scale Gold Mining Sector in Suriname

September 2023

Executive Summary

Policy challenge

Suriname is home to vast gold deposits, that form a vital resource for the country's economy and development. The gold sector is diverse, encompassing large multinational corporations and numerous small to medium-scale mining enterprises. These small to medium-scale enterprises, hereafter referred to as the Artisanal and Small-scale Gold Mining (ASGM) sector, operate in both a formal and informal context and often use mining practices that are harmful to the environment and society in Suriname. The main concerns are mercury pollution from gold extraction processes and the associated deforestation. The imperative now is to transition towards a more environmentally friendly gold mining sector that mitigates these environmental and socioeconomic externalities.

Targeted Scenario Analysis (TSA)

TSA is a methodology developed by the UNDP for assessing the economic benefits of sustainable policy and investment choices, taking into account ecosystem service values (Alpizar & Bovarnick, 2013). The outcome of the TSA allows decision-makers to consider the advantages and disadvantages of continuing with current practices (the Business-As-Usual (BAU) scenario) or following an alternative path of a Sustainable Ecosystem Management (SEM) scenario. The outcomes of the TSA are intended to guide policy makers involved in the EMSAGS project to estimate the impacts of management policies on economic benefits in the sector, ecosystem services and natural resources. This provides insight in how the potential benefits and/or losses resulting from shifting from BAU to sustainable production under SEM. Targeted Scenario Analyses have been conducted in a variety of contexts, including a study undertaken on the ASGM sector in Ecuador (UNDP, 2021) and Colombia (unpublished).

A TSA was applied in Suriname, following its five interactive steps: Step 1 addresses the TSA's clients, objectives, scope, and policy questions. Step 2 defines the Business As Usual (BAU) baseline and SEM (Sustainable Ecosystem Management) interventions. Step 3 includes the selection of criteria and indicators for the economic analysis, and Step 4 details the analysis of the BAU and SEM scenarios, including the conclusions of the analysis. Finally, Step 5 proposes the policy recommendations distilled from the study.

Principal client and stakeholders

The main stakeholders in this Targeted Scenario Analysis (TSA) are governmental entities and expert management teams involved in the Artisanal and Small-Scale Gold (ASGM) sector. The principal client of the TSA is the Ministry of Natural Resources (MNR), in particular the Directorate of Mining. Other essential stakeholders include the Ministry of Spatial Development (ROM), due to its key roles in mining policy, environmental monitoring, and legislation enforcement, and the Ministry of Regional Development and Sports.

Outside of the public sector, there are a diverse group of other stakeholders that are or will be affected by changes in the ASGM sector. Indigenous and Tribal communities in the interior of Suriname are directly affected by mining activities, through detrimental environmental and health effects as well as through social disruption. ASGM are also important stakeholders, as gold mining offers them a source of income that is hard to attain through other avenues. Furthermore, numerous private sector entities are involved either directly or indirectly in the ASGM sector. For the sector to become more environmentally friendly it is vital that all stakeholders are involved in shaping the future of the sector.

Business-As-Usual scenario outline

The current state of the ASGM sector in Suriname is marked by numerous unsustainable practices. Most prominently, the majority of operations still rely on the use of mercury. The

environmental concern extends with the deforestation of rainforests to facilitate mining, and a glaring omission in restoring these lands after the mining activities are done. This disregard for the environment is paralleled by the way concession rights frequently dismiss the traditional rights of local communities. Such oversights pave the way for unauthorized mining. Furthermore, the market for sustainably sourced gold from ASGM operations faces stiff challenges due to illicit gold sales and imports of mercury.

The communities situated in ASGM regions are facing significant challenges. Their wellbeing is under constant threat from mercury pollution. Adding to this is the surge in illegal immigration and the disturbing presence of human trafficking. These grave issues, however, seem to be overlooked by the government. The ASGM sector suffers from a palpable absence of oversight and stringent enforcement from national authorities.

Sustainable Ecosystem Management scenario outline

Efforts have been made to address the negative impacts of ASGM. While certain solutions have been implemented to a degree, the adverse effects of ASGM largely remain. Through comprehensive stakeholder consultations, a set of significant interventions for Sustainable Ecosystem Management (SEM) was identified. These interventions target the ASGM value chain and aim for sustainability by enhancing oversight and incentivizing better mining practices.

For mining operations under SEM, the shift is towards using equipment that allows for gravimetric concentration of gold particles, allowing for lower mercury use in gold extraction through Concentrate Amalgamation over Whole Ore Amalgamation. In addition, closed retorts are promoted for amalgam heating. Equipment like centrifuges and shaker tables will be introduced for concentrating gold particles. In Suriname's diverse ASGM landscape, the SEM scenario involves equipping micro, small, and medium-scale operations with specific tools that enhance sustainability.

In collection and refinement stage stricter standards for gold acquisition and refinement should be introduced. These include setting minimum environmental and social benchmarks (like child labor and illicit trade) for purchase and export permits, and ensuring independent organizations certify gold (e.g., Fairmined).

Across the value chain, SEM envisions a miner registration system for gold traceability, application requirements detailing mining techniques and rehabilitation, enforcement of existing laws, clear concession and land rights respecting Indigenous and Tribal Peoples, and the creation of national funds for nature rehabilitation and interior development, funded by sector-specific levies.

Indicators for the TSA analysis

In order to assess the effects of switching to a SEM scenario in the ASGM sector the following indicators were assessed:

- **Financial indicators** related to the profitability of mining operations. This aims to determine if there's a business case for a more sustainable mining approach where mining operations implement technology to concentrate gold particles.
- **Economic indicators**, such as gold production, traceability, and royalties from exports, to assess the potential impacts on the Surinamese economy and the gold market.
- **Environmental indicators** focusing on mercury leakage and forest degradation. These will assess the impact of mining operations on environmental factors like forest carbon stocks, ecosystem services, and mercury pollution in water, soil, and air.
- **Health indicators** mainly concerned with the effects of mercury exposure, especially its bioactive form, methyl mercury, on the local population.

- **Social indicators** addressing community effects of mining practices, including issues like illegality, mercury exposure to miners, and the impact on social cohesion in Indigenous and Tribal Peoples communities.

The study's geographical focus is the Marowijne Greenstone Belt Area in Suriname, predominantly in the Brokopondo, Marowijne, and Sipaliwini districts. The analysis considers the following timeframes:

- **Short term**: 2023-2026, aligned with the Multi-Annual Development Plan 2022-2026.
- **Medium term**: 2026-2032, targeting a 30% mercury reduction by 2032 as per the National Action Plan.
- **Long term**: 2032-2042, exploring necessary steps to develop a sustainable ASGM sector beyond the current plans.

Main results

Financial Outlook

Net Present Value (NPV) of Mining Operations Transition: The SEM scenario demonstrates a more favorable financial outlook compared to the Business-as-Usual (BAU) scenario. Specifically, mine operators adopting the SEM scenario are anticipated to realize higher cumulative net revenues within one to three years of equipment adoption, based on operation scale. Over a decade, there are projected cumulative net revenue increments of 124 thousand USD for micro-scale, 183 thousand USD for small-scale, and over 750 thousand USD for medium-scale operations. Notably, the NPV of investments under the SEM scenario surpasses the BAU scenario even with a 30% discount rate, underscoring the financial benefits of transitioning to sustainable mining (see Figure 1 below).

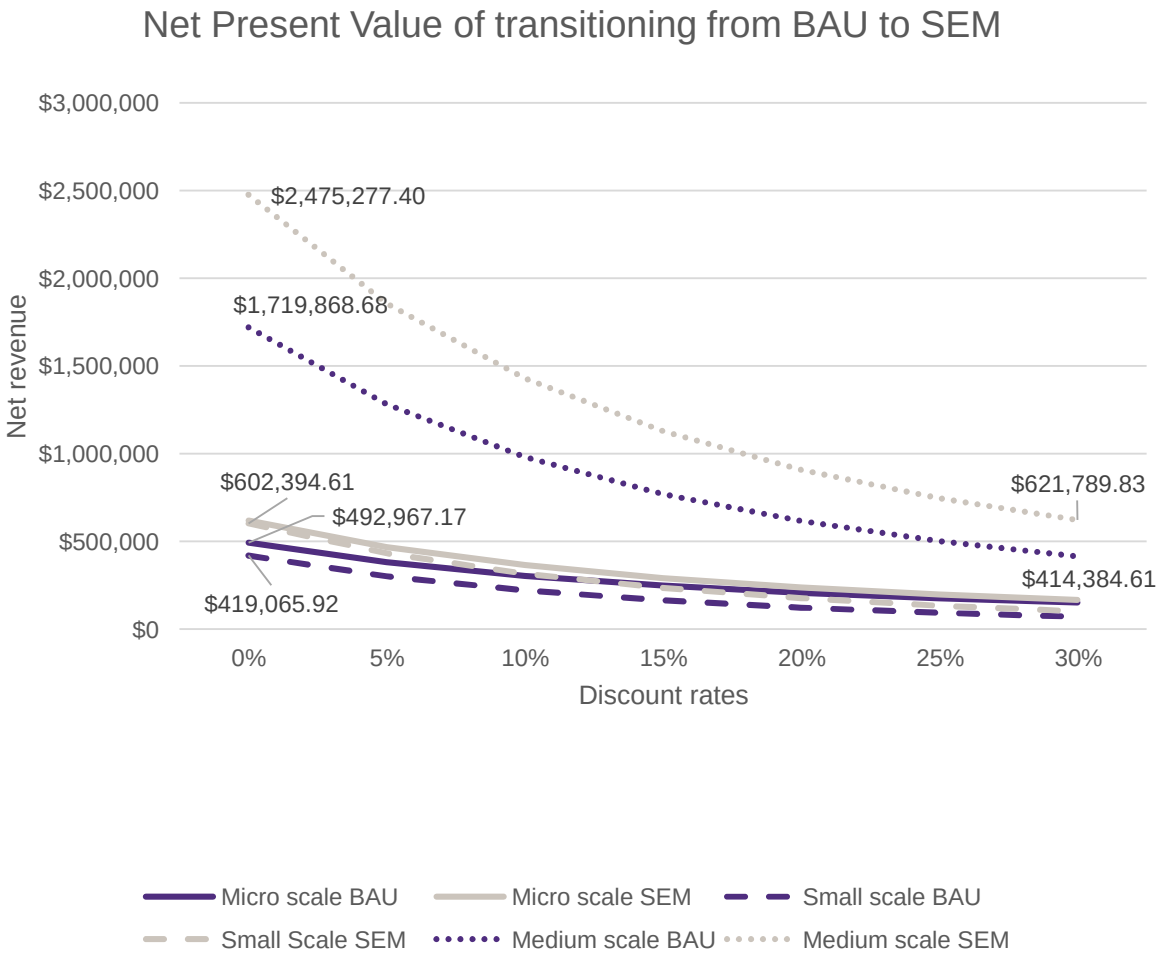

Figure 1: Net Present Value of net revenue over a period of 10 years for the BAU and SEM scenario under a range of discount rates. For three different scales of mining operations, indicating that there are clear financial benefits for transitioning to a SEM scenario.

Suriname stands to increase its annual export value by over 10 million USD by leveraging global demand for traceable gold. By reserving 10% of annual royalties for interior development in the SEM framework, approximately 6 million USD can be generated annually, summing up to an estimated 108 million USD over the long-term period. The proposed raise in government royalties from 4.5% to 7.5% in the SEM scenario could result in an accumulated royalty revenue hike of around 421 million USD, emphasizing the potential for bolstering green practices and traceability. The SEM transition necessitates significant initial investments. For example, the integration of gravimetric equipment alone is estimated at around 70 million USD,

not accounting for unregistered ventures and the associated training of miners to work with new technology.

For further reading, see sections 5.1 and 5.2 of the main report.

Environmental Impact

Mercury Emissions: A remarkable reduction in mercury emissions is evident when comparing the BAU scenario (1127 tons) to the SEM scenario (798 tons). The SEM approach paves the way for an overall decrease of over 300 tons in mercury emissions up to 2042 due to enhanced mining practices (see Figure 2).

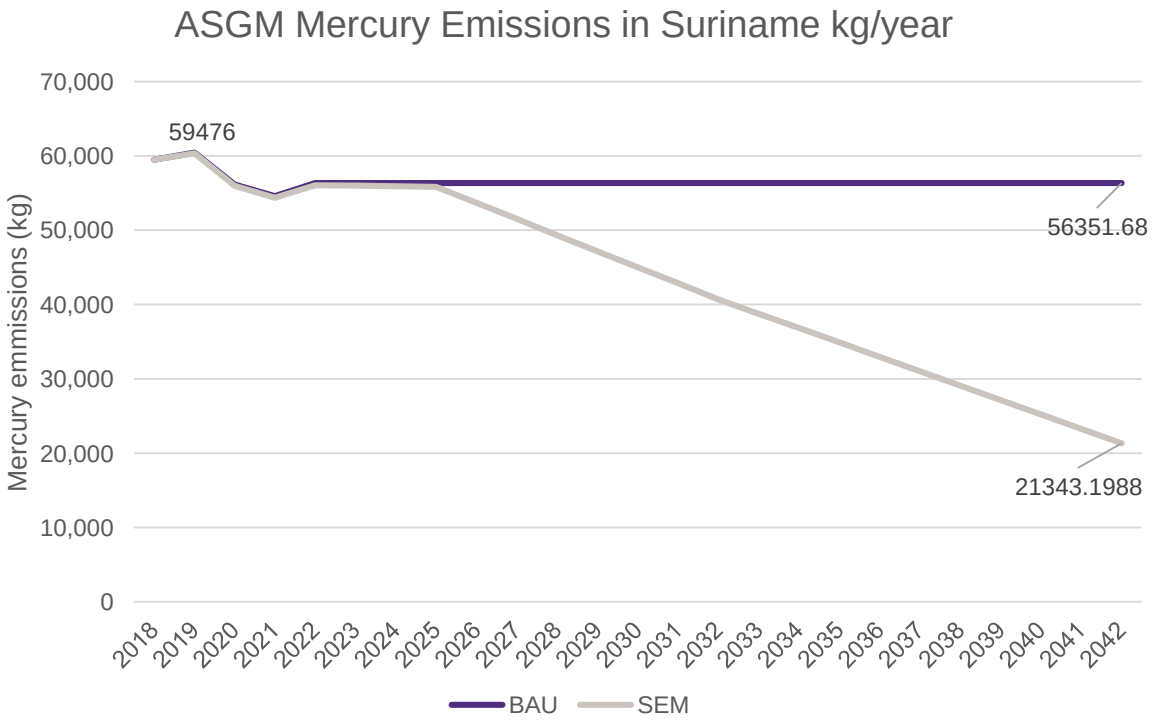

Figure 2: Mercury emissions under BAU and SEM based on projections of gold production in combination with current prevalence of modes of working with mercury (BAU) with a transition scenario to a higher prevalence of less mercury intensive modes of working (SEM)

If the SEM scenario is implemented, Suriname can drastically cut down on annual deforestation, preserving an area equivalent to over 425.2 square kilometers in the next XXX years. This protection could avert estimated losses in ecosystem service values of between 7 to 26 million USD, which translates to significant economic benefits for interior communities.

For further reading, see section 5.3 of the main report.

Health, Social, and Governance Implications

A transition to Concentrate Amalgamation from Whole Ore Amalgamation would lead to a tangible reduction in health risks for miners, mitigating symptoms associated with mercury exposure such as chest pain and fatigue. Fortifying governmental oversight in Suriname's ASGM sector promises increased gender participation and a potential economic boost by prioritizing gender equality policies. Strengthened governance could significantly decrease the prevalence of unauthorized and illegal workers, curtailing illicit migration and related illicit activities. Formalization of the ASGM sector in Suriname holds the potential to amplify social cohesion, especially among Indigenous and Tribal Peoples communities, via legal clarity, fair benefit distribution, community initiatives, and social program funding.

For further reading, see sections 5.4 and 5.5 of the main report.

Policy recommendations

Based on the results of the analysis, a number of recommendations are made for consideration by decision-makers in Suriname. These recommendations are geared towards enhancing governance, promoting sustainable mining practices, and ensuring community welfare, all while aligning with the broader objectives of environmental conservation and economic progression.

Management Policy Recommendations:

Ensuring effective governance and sustainable practices in the ASGM sector requires a robust management policy framework. The following recommendations lay down a strategic blueprint for holistic governance, improved inter-institutional collaboration, and heightened accountability, all aimed at fostering an environmentally responsible ASGM sector.

Overall Governance:

- Advocate for stronger inter-ministerial collaboration to oversee the Artisanal Small Gold Mining (ASGM) sector. Establish a coordinating body comprising members from related institutions for effective governance.
- Expedite the process of presenting the new draft mining law to the National Assembly to clarify roles and processes, preventing inefficient governance.
- Collaborate with Indigenous and Tribal Peoples for proper demarcation of lands in relation to mining concessions.

Environmental Remediation, Rehabilitation, and Deforestation Prevention:

- Amend the ASGM concession framework in the new Mining Law to hold miners accountable for environmental damages.
- Advocate for the restoration of abandoned areas with their original topsoil to speed up forest recovery.
- Foster collaboration between Geology and Mining Department (GMD) and the Surinamese Foundation for Forest Management (SBB) to integrate mining and forestry permits for optimal forest protection.

Investment Policy Recommendations:

Transitioning the ASGM sector to a more sustainable and environmentally friendly trajectory necessitates strategic investments. The recommendations in this section elucidate pathways for targeted investments that not only advance the sector's economic potential but also enhance its social and environmental footprint.

Sector Management:

- Institute a comprehensive registration system for all artisanal miners, leveraging the private sector's expertise in traceability. This should be anchored in the new Mining Law
- Encourage the organization of small-scale miners into associations, providing financial incentives for sustainable practices. This should be anchored in the new Mining Law.
- Equip institutions, including the Public Prosecutor, Police Corps of Suriname and the Geological Mining Agency that are involved in monitoring and enforcement of legislation with the necessary resources to oversee the sector more effectively. This should be anchored in the new Mining Law.
- Advocate for the introduction of environmentally-friendly gold mining techniques and certification of "Green Gold." This should be facilitated by the Ministry of Natural Resources.

- Collaboration between the Geological Mining Agency with the University of Suriname's NARENA to determine zones designated specifically for artisanal mining.

Mercury Reduction:

- Assess the funding needs and secure funding for the implementation of the National Action Plan for the Minamata Convention, emphasizing a phased approach to mercury reduction.
- Establish Mining Training and Extension Centers (MTECs) under the EMSAGs project as hubs for miners to access training, technology, and support.
- Increase enforcement on mercury import and transportation laws as part of the new Mining Law.

Community Development:

- Collaborate with stakeholders to create a National Benefit Sharing Mechanism, ensuring equitable division of ASGM sector benefits. The mechanism could be used to allocate a portion of government revenues from the ASGM sector towards community development in mining areas and land rehabilitation. To ensure effective implementation, the mechanism should be anchored in the new Mining Law.
- Incorporate a grievance redress mechanism in the new Mining Law to resolve conflicts between communities and ASGM miners.

This summary encapsulates the recommendations derived from the Targeted Scenario Analysis of the ASGM sector. The focus is on ensuring better governance, environmental conservation, and community development, rooted in extensive research and stakeholder consultations.

Index and acronyms

Acronym	Full name
ASGM	Artisanal and Small-scale Gold Mining (ASGM)
BAU	Business-As-Usual
CA	Concentrate Amalgamation
CAR	Concentrate Amalgamation with retort
EMSAGS	Improving Environmental Management in the Mining Sector of Suriname with Emphasis on Artisanal and Small- Scale Goldmining project
FPIC	Free Prior and Informed Consent
GEF	Global Environment Facility
GMD	Geological Mining Agency - Geologische Mijnbouw Dienst
MNR	Ministry of Natural Resources
MTEC	Mining Training and Extension Centers
NAP-S	National Action Plan Suriname for the reduction of mercury use in the ASGM sector, in line with the Minamata Convention
NIMOS	Nationaal Instituut voor Milieu en Ontwikkeling in Suriname
OGS	Ordening Goud Sector
PMU	Project Management Unit of the EMSAGS project
ROM	Ministry of Spatial Planning and the Environment
SBB	Foundation for Forest Management and Production Control - Stichting Bosbeheer en Bostoezicht
SEM	Sustainable Ecosystem Management
TSA	Targeted Scenario Analysis
UNDP	United Nations Development Program
USD	United States Dollars
WOA	Whole Ore Amalgamation
WOAR	Whole Ore Amalgamation with retort

Acknowledgements

It is essential to acknowledge the diverse group of stakeholders who were consulted over the course of the study. Their viewpoints, feedback, experiences, and expertise greatly enriched our understanding and perspective, ensuring that the results were well-rounded and grounded in practical realities. Our collective efforts have been dedicated to minimizing the adverse impacts on the environment while maximizing sustainable economic benefits in the ASGM sector, and this journey would not have been possible without the support, expertise, and commitment of every entity and stakeholder involved.

We'd like to extend our special thanks to the Ministry of Natural Resources (MNR), NIMOS, and the Ministry of Regional Development and Sports for guiding the direction of this study. The dedication and expertise of the UNDP team and the EMSAGS Project's Management Unit (PMU) in facilitating the inception workshop and results workshop were invaluable.

Contents

1 Introduction

Suriname is rich in natural resources, particularly in mineral resources. Currently, gold mining forms one of the most important economic activities in Suriname. Gold has been extracted in Suriname since before European colonization of the Americas, with the first large scale extraction occurring in the second half of the 19th century (for a more detailed overview of the history of gold mining in Suriname, please refer to Heemskerk (2010)). The country hosts the so-called Greenstone Belt (Figure 3), an area that is unique in its geomorphologic characteristics, amongst which the presence of gold deposits (Kioe-A-Sen et al., 2016). As a result of these large gold deposits in the country, there is a booming gold industry. The gold sector consists of a few large-scale industrial multinational companies, as well as numerous small and medium-scale mining enterprises. Mining activities have significant negative effects on natural ecosystems in mining areas, in large part due to mercury pollution associated with gold extraction techniques and the impact of the exploration sites on deforestation. In order to address these negative effects, efforts are being undertaken to transition to a more sustainable gold mining sector in Suriname, in which environmental and socioeconomic externalities are addressed.

The 'Targeted Scenario Analysis (TSA) of Suriname 's Small-scale Gold Mining Sector' is part of the larger 'Improving Environmental Management in the Mining Sector of Suriname with Emphasis on Artisanal and Small- Scale Goldmining' (EMSAGS) project[1]. The EMSAGS project aims to improve management of Artisanal and Small-scale Gold Mining (ASGM) in Suriname. The underlying purpose is to reduce negative effects of mining activities on nature, the environment and local communities. The project aims to achieve this goal of improved management by creating an enabling environment for sustainable mining on the institutional level. Concrete activities to be supported include the dissemination of more responsible mining techniques and by providing a knowledge base on responsible mining. At the basis of this transition is the pledge made by Suriname under the Minamata convention to reduce the use of mercury in ASGM with 30% by 2032 (Government of Suriname, 2021).

The primary implementation partners for the EMSAGS project are the Ministry of Natural Resources (MNR) of Suriname and the National Institute for Environment and Development in Suriname (NIMOS). The main beneficiary of the project is the Ministry of Spatial Planning and the Environment (ROM) The funding for the EMSAGS project is from the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP) is the contracting organization for the TSA project.

Targeted Scenario Analysis is a methodology developed by the UNDP for assessing the economic benefits of sustainable policy and investment choices, taking into account ecosystem service values (Alpizar & Bovarnick, 2013). The outcome of the TSA allows decision-makers to consider the advantages and disadvantages of continuing with current practices (the Business-As-Usual (BAU) scenario) or following an alternative path of a Sustainable Ecosystem Management (SEM) scenario. The outcomes of the TSA are intended to guide policy makers involved in the EMSAGS project to estimate the impacts of management policies on economic benefits in the sector, ecosystem services and natural resources. This provides insight in how the potential benefits and/or losses resulting from shifting from BAU to sustainable production under SEM. Targeted Scenario Analyses have been conducted in a variety of contexts, including a study undertaken on the ASGM sector in Ecuador (UNDP, 2021) and Colombia (unpublished).

A TSA was applied in Suriname, following its five interactive steps: Step 1 addresses the TSA's clients, objectives, scope, and policy questions. Step 2 defines the Business As Usual (BAU) baseline and SEM (Sustainable Ecosystem Management) interventions. Step 3 includes the selection of criteria and indicators for the economic analysis, and Step 4 details the analysis

[1] *EMSAGS Project Website, available at: The project | EMSAGS*

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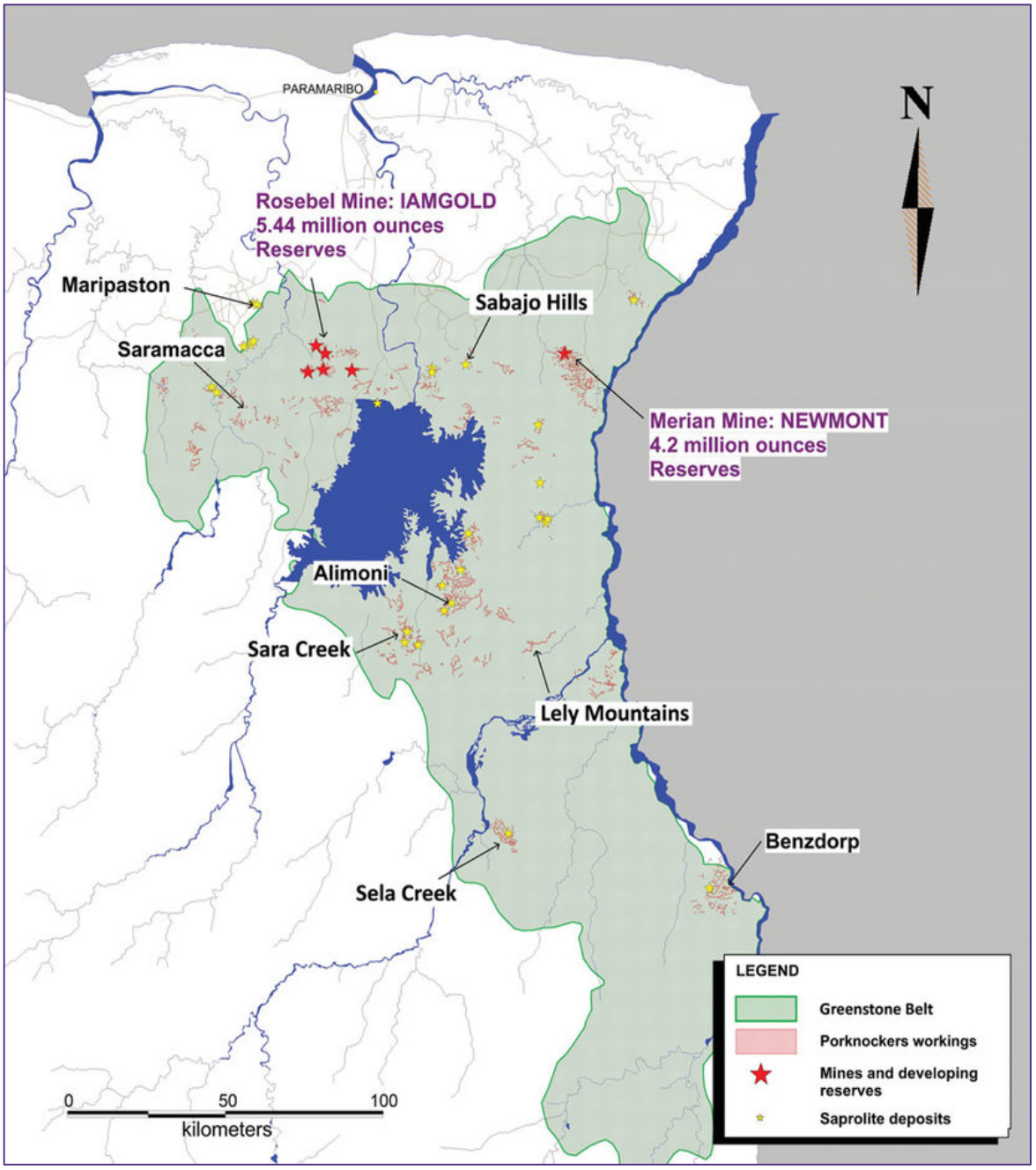

Figure 3: The Marowijne Greenstone Belt Area in Suriname. Taken from Kioe-A-Sen et al. (2016).

2 Objective and scope of the TSA

2.1 Targeted Scenario Analysis Clients and Objectives

The primary client of the TSA is the Ministry of Natural Resources (MNR). On the request and agreement of the MNR, NIMOS is enlisted as the project implementation partner. Besides the MNR, due to their pivotal roles in implementing mining policy, environmental monitoring, and environmental legislation enforcement, the NIMOS, and the ROM are also core governmental clients of the TSA study—the EMSAGS Project's Management Unit (PMU) represents NIMOS.

The PMU is an integrated team of expert project management and stakeholder engagement consultants. Their mandate is to coordinate the project's day-to-day execution. The PMU presents the intermediary and end-of-project deliverables to UNDP and the governmental clients and stakeholders of the EMSAGS.

The initial TSA discussions with the MNR, NIMOS, and the Ministry of Regional Development and Sports served to define several of the critical objectives of the TSA. These objectives include:

- Assess the EMSAGS project's interventions and targets, considering the potential social and economic impacts on the sector beyond environmental effects.
- Contribute to the ASGM sector's positive development by finding policy paths to minimize negative impacts and maximize sustainable economic benefits.
- Generate concrete and practical recommendations for shifting the sector’s policy towards a more environmentally friendly ASGM as a top priority.

The TSA's economic analysis will provide evidence to respond to the following policy-related questions and achieve the above-indicated objectives.

2.2 Policy questions

The TSA will respond to the following overarching question:

What are the compelling economic and social reasons to improve ASGM management and investment policies to achieve more sustainable productivity and profitability and ensure the long-term provision of ecosystem services that support the sector's productivity?

In addition, the TSA will provide responses to a subset of policy questions resulting from a comprehensive ASGM-related policy analysis (included in Annex D), and consultations with key clients and stakeholders. The policy analysis included the following critical laws and regulations:

1. Constitution (Grondwet)
2. Multi-Annual Development Plan
3. National Action Plan of Suriname for the Minamata Convention (NAP-S)
4. Plan Act (Planwet)
5. The Mining Law
6. Regulation of the ASGM sector
7. Value Added Tax (taxes from the ASGM sector)
8. Environmental Framework Act
9. Mining decree (Mijn decreet)
10. The Decision Negative List (Besluit Negatieve Lijst)
11. The Foreign Exchange Commission Subsides
12. Extractive Industries Transparency Initiative (EITI)

This subset of policy questions was validated at the inception workshop held in Paramaribo in February 2023. The policy questions primarily revolved around financial (net revenue),

economic (net benefits) employment, equity and fairness, environmental, and health criteria. The TSA selected several indicators under each criterium to assess the losses or gains under the business-as-usual (BAU) and Sustainable Ecosystem Management (SEM) scenarios.

The TSA also estimates the investment costs involved in transitioning from a BAU to a SEM scenario, potential net benefits to the ASGM sector, mine operators, and social benefits to communities in ASGM areas from the changes in the BAU to SEM. The initial TSA discussions also shed light on the interventions necessary for a shift to a SEM scenario.

The following policy questions are considered in the TSA analysis:

- What is the potential increase in net revenue to mine operators resulting from shifting from BAU to SEM policy, reforming the Mining Law and the NAP-S and achieving the projected outcomes of the EMSAGs project (See Annex D)?
- What are the potential net benefits to ASGM sector resulting from shifting from BAU to SEM policy (i.e., increasing investment in the National Action Plan for the Minamata Convention to phase out mercury use in ASGM and achieving the outcomes described in the Multi-Annual Development Plan 2022-2026 (See Annex D)?
- What are the potential social benefits to communities in ASGM areas resulting from continuing with BAU versus transitioning to SEM following the expected outcomes in the National Action Plan for the Minamata Convention to phase out mercury use in ASGM and achieving the outcomes described in the Multi-Annual Development Plan 2022-2026 (See Annex D)?
- What are the losses and gains related to economic, financial, employment, equity, environmental and health effects in the BAU and SEM scenarios and how are these effects distributed among stakeholder groups? What is the estimated investment required to implement more environmentally friendly mining technologies to support the transition from a BAU to a SEM scenario?

2.3 Stakeholder Consultations

To ascertain the study's final scope, thorough stakeholder consultations were conducted, and an inception workshop was held in February 2023. The project team visited Suriname, meeting stakeholders both virtually and in person. Annex A outlines the schedule for these consultations. The workshop took place on February 16th in Paramaribo. The attendees are listed in Annex B and the agenda in Annex C. The inception workshop served as a platform where the initial scope of the TSA study was presented and validated. The stakeholders provided valuable feedback, which was subsequently used to update the scope of the study. In August 2023 a validation workshop was conducted to discuss the results of the analysis and policy recommendations.

2.4 Spatial and Temporal Scope

The study focussed on the Artisanal and Small-Scale Gold sector in Suriname, with a geographic focus on the Marowijne Greenstone Belt Area. This area harbors the largest known gold reserves within the country, and it is where the majority of ASGM activities occur. It is located primarily in the Brokopondo, Marowijne and Sipaliwini districts. Figure 1 at the beginning of the inception report delineates the study area.

Temporally, the study focussed on a short-, medium- and long-term horizon.

- **Short term**: Particular focus on the implementation period of the Multi-Annual Development Plan 2022-2026 that the Surinamese government is working with. The short term is defined as the time between 2023 and 2026.
- **Medium term**: Focus on the 30% mercury reduction in 2032 envisioned in the National Action Plan for addressing mercury pollution under the Minamata Convention. Here the study will identify the economic effects of the transition to

more sustainable mining practices. The medium term is defined as the time between 2026 and 2032.

- **Long term**: Looking beyond the current National Action Plan for Suriname to 2042, will help identify what is necessary to develop a sustainable ASGM sector in the longer term. The long term is defined as the time between 2032 and 2042.

2.5 Operational Scope of ASGM

The Surinamese Mining Decree of 1986 only defines small-scale mining as being the "prospecting, exploring and exploitation of mineral deposits whose nature, mode of occurrence and size make extraction economically possible using simple means and techniques" (S.B. 1986 no. 28). No specific definition is provided for artisanal mining and the decree also does not specifically refer to gold mining. The 'National Action Plan-Suriname for reduction of mercury use in the ASGM sector, in line with the Minamata Convention' (NAP-S)(Currently unpublished, referring to draft version of report) (Government of Suriname, 2021) utilizes the following definition of ASGM: "Mining with rudimentary methods of exploration and exploitation, performed in the informal or semi-formal sphere, and executed by a work force that does not have a formal mining education. For this report the latter definition will be used, as it best captures the main characteristics of the sector.

The NAP-S also provides insight into the main types of operations in ASGM. These operations can vary in terms of number of miners, equipment used and technology used. Based on the NAP-S we have identified three scales of mining operations within ASGM that will form the basis of the scenario analysis, which will be referred to as micro, small-scale and medium-scale operations. An overview of the characteristics of the three scales can be found in Table 1. These scales were also corroborated through stakeholder consultation.

Table 1: Overview of operation sizes within the ASGM sector with associated characteristic, based on operations descriptions in the NAP-S

Name	Team size	Equipment	Capital investments
Micro-scale	1-2	Metal detector on tailings or low capital investment ground sluicing	Below USD 10,000
Small-scale	3-10	Sluicing without heavy equipment	Below USD 50,000
Medium-scale	>5	Sluicing with excavator and hydraulic mining with screen	Over USD 50,000

In addition to a subdivision by scale, based on the NAP-S distinctions can also be made regarding the mercury use in these operations, with mercury being used to concentrate smaller gold particles. This subdivision is based on the UNEP Level 2 Mercury Inventory Toolkit that was developed to help countries measure mercury emissions (UNEP, 2023). It makes a distinction between whole ore amalgamation (WOA) where mercury is mixed with all of the soil or rock that is mined and concentrate amalgamation (CA) where mercury is applied on soil or rock that has already been concentrated through gravity concentration. The latter mode of working involves significantly lower use of mercury than WOA. In addition, both modes of working can also involve the use of retorts in the process of separating the mercury from the gold through heating of the amalgam. Retorts can capture evaporated mercury to prevent it from being released into the air and thus the environment. Retorts can be used in both whole ore amalgamation (WOAR) as well as in concentrate amalgamation (CAR). The NAP-S provides baseline estimates for the proportion of operations that use these different modes of

working, indicating that over half of the operations use WOA (Table 2). It is important to note that the NAP-S does not provide insight into the proportion of mining operations in the ASGM sector that use mercury-free modes of mining, nor on the use of Jin Chan, a leaching reagent containing cyanide that is used to extract gold from mining tailings. As Jin Chan has been banned by law, it was not considered in the scenario analysis.

Table 2: Low and high estimates for the proportion of operations using different modes of working with mercury. This table shows only the proportions of different modes of working for mercury related gold but does not include any mining modes that do not use mercury. Taken from the NAP-S.

Mode of mining	Proportion (low estimate)	Proportion (highestimate)	Input factor (kg Hg/kg Au)
Whole ore amalgamation	53%	70%	5
Whole ore amalgamation with retort	3%	5%	4.25
Concentrate amalgamation	25%	20%	1.3
Concentrate amalgamation without retort	19%	5%	0.55

2.6 Limitations of the Study

Despite rigorous research and consultation, the TSA study faced limitations due to the remote and underdeveloped regions where most ASGM activities are carried out. For some of the indicators assessed in the scenario analysis there was a lack of standardized and consistent data. In such instances, we combined data from various sources or found proxies, resulting in certain assumptions being required in the scenario analysis. Wherever there are such assumptions, these are clearly outlined in the results section of this report.

3 Definition of the BAU baseline and SEM intervention

3.1 Value Chain Overview

In order to understand the stakeholder groups involved in ASGM and their interconnections it is important to have an overview of the value chain. This overview can also provide clarity on the types of stakeholders and part of the value chain to aim policy interventions at. It is based on the context description from previous sections as well as on a study on the gold marketing chain by Heemskerk (2010). In addition, extensive stakeholder consultations were undertaken in February 2023 to gain insight into the value chain. A schematic overview of the value chain can be found in Figure 4.

Figure 4: Overview of the gold sector value chain in Suriname. Based on own assessment and on Heemskerk (2010).

3.2 Market for ASGM gold from Suriname

Collection and refinement of gold from the ASGM sector in Suriname is undertaken by a select number of firms, with 8 formal buyers in Suriname, of which 5 also have a license to export gold. Gold for export is controlled, registered, and sealed at the Central bank of Suriname, after which it is prepared for export. Most gold produced by the ASGM sector is exported legally, to Dubai, with smaller quantities being exported to Switzerland and Belgium (Heemskerk, 2010). Total export figures for ASGM gold were nearly 17 tons in 2009, rising up to 22 tons in 2013 (IGF, 2017) and sat at just over 15 tons in 2019 (Government of Suriname, 2021). It is unclear what percentage of these exports constitute gold produced in Suriname, as due to higher export royalty levels in the neighboring countries there are indications that gold is being smuggled over the border between these countries and Suriname to profit from the lower export royalties in Suriname (IGF, 2017).

3.3 Challenges in mining sector (Economic, social, environmental)

The nature of operations and processes in the ASGM sector and the value creation from these activities result in several impacts. Some of these impacts occur immediately, while others become apparent over time (e.g., due to prolonged exposure). After decades of ASGM in the 20th century at a scale unprecedented, these effects have been studied numerous of times,

and their linkages with ASGM have been well understood. In addition, various authorities predict that gold prices will continue to rise (significantly) in the future (Stichting Planbureau Suriname, 2019, World Gold Council, 2022). This situation makes gold exploitation more lucrative, but herein lurks a great danger that this price uptake will accelerate unplanned small-scale gold mining which in turn in will increase the negative impact. The listing below provides an overview of negative impacts that have been reported over the past decades:

3.3.1 Ecosystems and Biodiversity

Though the country has high forest cover, the amount of deforestation has increased in the past 15 years. An increase in ASGM activities can be partly attributed to this. To make matters worse, deforestation occurs in a rather erratic, non-planned manner. The annual area deforested due to small-scale mining is estimated at 48–96 km^2. Deforestation and forest degradation cause a decline in biodiversity. Biodiversity loss in turn affects ecosystem quality and stability leading to a decline in a range of ecosystem services.

According to Arets et al., 2006, the first step in the ASGM process is the removal of topsoil. Operators do not replace the topsoil after mining activities cease. Therefore, current ASGM practices lead to degrading landscapes that require a relatively long time to recover since the topsoil holds seed banks that make regeneration possible. Also, mining activities disrupt the natural water management system by damming creeks, causing floods and a lack of water in other areas.

Figure 5: Deforestation due to ASGM in the Brownsberg Nature Reserve in 2017

Lastly, aquatic ecosystems are strongly affected by mining activities. Inorganic mercury used to extract gold spills into the watercourses during washing or deposits after evaporation. Inorganic mercury transforms into the highly toxic methylmercury when it leaches into rivers. It is then absorbed by ground-feeding organisms and moves up the food chain through carnivorous fish. Furthermore, mining activities can destroy and affect fish breeding and spawning areas. The increased sediment level in rivers and creeks as a result of top soil removal increases the turbidity of the water with (health) effects on the aquatic life system (for

instance, predatory fish that depend on visibility for hunting are no longer able to live in these water courses) and other animals that depend on that water (Molenaar, 2008).

3.3.2 Health

ASGM activities in Suriname can lead to a number of negative public health impacts, both in the miners themselves as well as in the wider community. The majority of the negative health impacts arise from the use of mercury. Small-scale gold miners are in contact with mercury in different stages of the mining process, notably amalgamation, separation of the amalgam, removal of excess mercury and burning the amalgam. Exposure to mercury may cause a wide range of symptoms including chemical bronchiolitis and pneumonitis (from inhalation), and damage to the nervous, digestive and immune systems, as well as the lungs and kidneys (Molenaar, 2008). Since the late 1990s, numerous mercury awareness campaigns have been organized for gold miners in Suriname, but so far with limited results. Due to mercury in water, the health and well-being of people in the hinterland using unfiltered water from rivers and creeks is put in danger. In addition, mercury in the waterways is absorbed by ground-feeding organisms and moves up the food chain through carnivorous fish and thus affects people depending on this food source. One final health effect results from increased sediment levels in rivers and creeks, rendering water previously used for drinking and cooking unsuitable for human consumption.

3.3.3 Conflict

With marginal government oversight, and high value that can be obtained from ASGM activities, it is expected that various types of conflict will arise. These conflicts arise between various stakeholder groups that are involved in or affected by ASGM. Conflicts can arise between miners and the (informal) concession holders, between different groups of miners (e.g., maroons versus garimpeiros), or even within communities. The list below provides some examples of conflicts that have occurred over the last decade (Duijves & Heemskerk, 2014).

- Between industrial operations and ASGM: people from the ASGM sector move into territories where industrial operations take place.
- Between concessions holders and ASGM: concessions are handed out in areas where ASGM was already taking place. Usually, people involved in ASGM are removed by force.
- Among local authorities / tribal leaders: there are sometimes disagreements between village chiefs and traditional leaders with respect to allowing miners to work in their area.
- In some cases, miners are allowed to work, but the traditional leaders do not distribute the received income from these operations equitably among the villagers.
- Conflicts among people in the ASGM sector exist over mining rights, access to land, payment, etc.
- Conflicts between migrant workers / garimpeiros and maroons (in particular local authorities); in some areas tribal leaders have decided that all migrant miners need to leave to allow local men to earn a living.
- Between ASGM and management of nature reserves.
- Between ASGM and the management of the Afobaka lake reservoir, when ASGM activities take place near dams.
- Between ASGM and national government (e.g., where the government intervenes in the conflicts mentioned above).
- Criminal offences are typically associated with gold transportation, prostitution and other mining related or dependent activities.

3.3.4 Social Conditions

As a result of the challenges listed in previous sections and the conflicts between stakeholders in ASGM a number of social issues arise. There is deterioration of the normally strong social fabric in tribal communities because of the internal conflicts described in the previous section. Furthermore, gold miners are typically poor, poorly educated, and not competitive in local and national job markets; ASGM offers them the opportunity to create and income of significant value. However, through working in this sector they are exposed to negative health impacts, primarily resulting from the use of mercury. These health effects at present are not being addressed as a result of there being several challenges in motivating gold miners to reduce mercury use, such as the lack of mining concession titles for small-scale miners, limited awareness, mobility of gold miners, minimal monitoring and control, and the expenses of equipment for mercury-free mining. Lastly, apart from issues for miners and local communities there are also serious concerns regarding the illegal trafficking of people mainly from Brazil, including women involved in prostitution.

3.3.5 Governance

Enforcement of mining regulation is difficult, due to the remoteness of the area, political will, unclear responsibilities and the complexity of the sector. The remoteness of the southern half of the country where the majority of ASGM takes place (e.g., some areas can only be accessed by airplane), makes any attempt by the Government to undertake enforcement activities in the area is cost prohibitive. Government activity is therefore marginal and thus far from effective. This is exacerbated by the fact that there is little dialogue between indigenous people and tribal communities on one hand and concession holders and miners on the other hand; there is hardly any meaningful participation in any sort of consultation processes, in particular the concept of free prior and informed consent (FPIC). This results in the handing out concession rights in areas that are traditional community lands of Indigenous and Tribal People, who depend on them for their livelihoods. Surinamese law does not recognize or protect Indigenous land rights, and FPIC is not utilized.

The import of mercury requires a government permit. However, no permit has been granted in the past decades, implying that virtually all of the mercury used in ASGM is smuggled into the country. The criminal code (Wetboek van Strafrecht) dictates that it is punishable to “sell, offer for sale, deliver or hand out goods, knowing that these goods are harmful to life or health, while omitting to mention their harmful character...” The criminal code also stipulates that it is unlawful to be responsible for “the sale, delivery or handing out of goods that are harmful for life or health, without the buyer or recipient being aware of the harmful character …”. This implies that entities or persons that transport or carry mercury fall within this definition and are thus acting in a criminal manner.

Within the government, responsibilities and knowledge about mercury are fragmented among ministries and departments, which obstruct effective policy making and implementation with regard to mercury. Current national legislation regarding import, use, export and handling of mercury is inadequate. Though mercury enters the country in rather large volumes, the Coast Guard has never encountered mercury during control of vessels at sea, the customs department has never intercepted any mercury in freight containers or luggage at the country’s main entry points (harbors, border posts, international airport), and there are just a few cases where the police has intercepted mercury over the past decades. It seems likely that the level of control as well as corruption might play a part in this. To this end, it can be stated that Suriname’s ratification of the Minamata Convention has had no immediate consequences for the Suriname mercury market and mercury use as of yet (Social Solutions, 2010, Government of Suriname, 2020).

3.4 Outline of BAU scenario

Based on the context analysis we can conclude that the baseline (current situation) for the ASGM sector is characterized by several unsustainable practices. First and foremost is the continued use of mercury in the vast majority of ASGM operations. Another important practice that decreases the sustainability of the sector is the deforestation of rainforest to make room for gold mining operations, exacerbated by the fact that lands are virtually never restored after mining operations end. In addition, concession rights do often not recognize the customary rights of local communities (both Indigenous and Tribal Peoples). This lack of local ownership can incentivize unregulated mining activity. The market for gold from sustainable ASGM is also underdeveloped and inhibited by illegal and informal sales of gold and imports of mercury. Lastly, social conditions for communities in ASGM areas are threatened by mercury pollution and illegal immigration and human trafficking are notable problems. All these issues are underpinned by a lack of insight, oversight and enforcement in the ASGM sector from the national government, which can be expected to continue under a business-as-usual scenario. The primary trends that we expect to continue in the BAU scenario are as follows:

Mining operations:

- Inefficient practices due to lack of professional knowledge leading to high mercury use.
- Unsustainable methods.
- Unstable livelihoods for miners.

Environmental:

- Continued deforestation
- Little to no rehabilitation of old mining sites
- Increase in mercury pollution and associated environmental and health related costs.

Governmental oversight:

- Lack of oversight and enforcement on the ASGM sector
- Lost royalties due to lack of monitoring and transparency

Gold Market:

- International demand for traceable gold increases, however, Suriname lacks a traceable gold supply.

The BAU scenario will assess the financial, socio-economic, and environmental effects of continuing with the business-as-usual management trajectory, making a projection into the future of the baseline. The outline of the BAU scenario was validated with stakeholders in Suriname. The next section provides a description of the interventions that are evaluated in the SEM scenario.

3.5 Outline of the SEM scenario

As the various impacts emanating from ASGM have become apparent, so have attempts been made to offer solutions. Some of these solutions have been copied from success stories from around the world, some attempts have been implemented to certain degree, while other are still pending. However, little has changed with respect to the scale, growth and processes within ASGM to advert the negative effects. There are, however, a lot of potential interventions that can be taken to intervene in the sector. Based on extensive stakeholder consultations, as well as through input gathered during the Inception Workshop, a suite of the most important interventions was identified. Operating on either specific parts of the value chain or on the value chain as a whole, the selected interventions are aimed at creating the enabling conditions to improve the sustainability of the ASGM sector, starting with better oversight while also recognizing the need for providing incentives for a transition to improve mining practices. The final selection of interventions in the SEM scenario is described below, identifying also the part of the value chain that they are targeted at:

3.5.1 Mining operations

The transition between the BAU and SEM scenarios for mining operations is focused on incorporating equipment into their operations to allow for more efficient Concentrate Amalgamation instead of Whole Ore Amalgamation and by adding retorts to the process of heating the amalgam to separate gold from mercury. To do the first part requires equipment that helps concentrate the gold particles from other soil particles through the use of gravity assisted methods. Primary examples of such equipment include centrifuges and shaker tables.

Due to the wide range of equipment used, soil types and working methods used by ASGM operations in Suriname it is hard to develop a set of consistent typologies for the types of mining operations. For the scenario analysis, we have assessed three hypothetical mining operations as examples for the three scales of operations as described in Table 1, namely micro-scale, small-scale and medium-scale. For each of these examples we have selected a combination of equipment that could typically be used under BAU (Table 3) based on the characteristics of these scales of operations as described in the NAP-S. Furthermore, we have also determined which equipment would need to be added in a transition to a SEM scenario (Table 3).

Table 3: Changes from BAU to SEM for the three operations examples.

Scale	Equipment under BAU	Equipment added under SEM
Somaye (micro-scale)	3-cilinder pump	Add centrifuge, and retort
Small-scale	6-cilinder pump, excavator, sluice box	Add centrifuge, shaker table and retort
Medium-scale	2 excavators, hammer mill, sluice box	Add centrifuge, shaker table and retort

3.5.2 Collection and refinement

In order to ensure that the collection and refinement stage of the value chain operates in a more environmentally friendly manner, the following interventions are envisioned in the SEM scenario, aimed at developing more stringent standards for the buying up and refining of gold produced by the ASGM sector:

- Set minimum environmental and social (e.g. child labor and illicit trade) standards for acquiring buying and exporting permits
- Ensure that certification of gold (e.g., Fairmined) is done by an independent strong institute or organization

3.5.3 Throughout the value chain

There are a number of interventions that are envisioned to affect and be influenced by the entire value chain. These are as follows:

- Introduction of a registration system for miners and gold flows, allowing for tracing gold throughout the value chain. Work with the private sector to identify and implement effective system to improve traceability.
- Applications for permits and concession rights should contain plans describing techniques used, rehabilitation plans and offsetting.
- Enforcement of existing legislation (i.e. no mercury sales).
- Concession and land rights should be well defined and consider Indigenous and Tribal Peoples rights (i.e. spatial planning).
- Development of a national nature rehabilitation fund and interior development fund, funded by royalties and other levies on the gold sector and preceded by a national level discussion and agreement on an appropriate benefit sharing mechanism.

4 Selection of criteria and indicators

4.1 Criteria and indicators overview

To compare the changes between the BAU and SEM scenarios, a set of qualitative and quantitative indicators was developed and validated through extensive stakeholder and expert consultation. Quantitative indicators selected fall into four types aimed at specific aspects of the ASGM sector. Firstly, indicators were developed to assess the financial consequences of the SEM scenario for mining operators, thereby providing insight in the business case for more sustainable mining techniques. Secondly, a number of macroeconomic indicators was selected to provide insight into the dynamics of the gold market in the country. Thirdly, environmental indicators were selected to evaluate the environmental pressures related to mercury use and change the value of forest ecosystems in Suriname. Exposure to mercury by local communities was selected to provide insight in potential health effects. Lastly, a selection of social indicators was established to assess the effects on local communities and people employed in the industry. Due to a lack in data, most social indicators could only be described in a qualitative manner. The next sections describe the scope for each indicator category as well as a justification for the selection of the indicators.

4.2 Financial indicators (Mining operations)

Indicators on the level of mining operators to provide insight in the profitability of a transition to a more sustainable form of mining. Environmental change in the sector is primarily driven by small scale operators, as they have a direct effect on mercury use, forest degradation and associated negative consequences. Consultations with stakeholders in Suriname strongly suggested that without financial incentives in place, it would be highly unlikely that alternative mining techniques would be adopted. As such, it is vital to identify whether there is a business case for transitioning to more environmentally friendly modes of small-scale gold mining.

To assess whether a business case can be made a number of indicators where assessed that relate to the profitability of mining operations in the interior of Suriname. These are listed in Table *4*, and focus on assessing the costs and revenues of three distinct scales of ASGM mining operations. As there is a large diversity in the size of mining operations, with a varied mix of mining equipment, these three distinct categories should be seen as three examples of mining operations, differing in terms size and complexity of equipment used. For these three distinct types we have assessed the necessary investment costs, operational costs, gold recovery rate and associated revenues.

4.3 Macroeconomic indicators

Macroeconomic indicators include ASGM production, traceability, royalties from exports. During consultations it became clear that there is an increasing demand from the global gold market for traceable gold. To meet these standards, an increasing percentage of the gold sold on the international should be traceable back to its source in Suriname. As such, if no efforts are made to develop the infrastructure for tracking gold throughout the value chain this could have consequences for the potential of gold exporters to sell gold on foreign markets.

To assess the potential losses and gains from gold exports under BAU and SEM, a range of indicators were identified, detailed in Table 4. Total gold production is evaluated to create insight in the total value of the industry. Next, the production of and demand for traceable gold provide insight in the market potential for more sustainable production. Total gold exports under both scenarios are evaluated to assess the effects of an increased international demand for traceable gold on the production in Surinam. Finally, government revenues are evaluated through potential changes in gold royalties. The royalty paid on gold in Suriname is set by state decree (S.B. 1989 no. 40) and is regularly changed. It currently stands at 4.5% (S.B. 2021

no.177). Between January 2023 and March 2023, the percentage temporarily stood at 5.5% (S.B. 2023, no. 10). Royalties are levied at the point of selling by miners to gold buyers.

An indicator to assess the level of benefit sharing that occurs under both scenarios was chosen to provide insight tin the potential share of Royalties that could be applied for interior development in the regions where ASGM takes place.

4.4 Environmental indicators

There are a number of avenues through which ASGM operations affect the environment. Mercury leakage and forest degradation are the primary environmental consequences of ASGM. These in turn have negative consequences for forest carbon stocks and other ecosystem services, as well as leading to mercury pollution of water, soil and air. The specific indicators are listed in Table 4.

Mercury use in the sector will be related to the distribution of ways of working with mercury as described in the NAP-S. The NAP-S also provides a scenario for changing to a more environmentally friendly mining sector, which was used as the basis for assessing mercury emissions under the SEM scenario. Furthermore, the UNEP Toolkit for mercury that lies at the basis of the NAP-S also provides estimates for the proportion of mercury pollution being released to water, soil and air respectively under different modes of working with mercury.

Forest degradation will be determined by the projected losses in forest cover resulting from ASGM activities, which were determined under Suriname's REDD+ project (AAE, 2017). Utilizing these projected losses the effects of ASGM on forest cover can be determined by assessing the number of hectares of forest that are lost. This could then be translated into associated losses in carbon stocks and other ecosystem services, providing an indication of the economic loss to society of environmental degradation. Rehabilitating former mining lands can counteract some of the environmental damage that is done by the sector. Though little to no rehabilitation of ASGM lands is currently occurring, under a SEM scenario such rehabilitation should form an integral aspect of limiting and compensating for the environmental consequences of mining.

4.5 Health effects

Data on social indicators in the interior of Suriname are scarce. The primary social effects of mining for which quantification is feasible occur through the effects of mercury exposure, particularly methyl mercury, which is the bioactive form of mercury. Indicators (Table 4) were selected to assess the effects of mercury exposure as well as the associated health effects.

4.6 Social effects

Due to data limitations a number of important social effects of the ASGM sector could not be assessed quantitatively. Some of these were mentioned during stakeholder consultations as being relevant to take into account, as they can strongly affect communities in the interior. As such, these are addressed qualitatively in the scenario analysis. They are listed in Table 5 and consist mainly of indicators that describe community effects of mining practices, such as illegality, the effect of mercury exposure to miners and the disruptive effects of mining practices on social cohesion in Indigenous and Tribal Peoples communities.

4.7 Indicator overview

Table 4 and Table 5 provide the selection of quantitative and qualitative criteria and indicators that were used for the evaluation of the BAU and SEM scenarios. The arrows in Table *4* and Table 5 illustrate the initial expectations for indicator change resulting from a transition from BAU to SEM. Upward arrows indicate increases, with double arrows indicating strong increases, downward arrows indicate expected decreases in the indicator

Table 4: Final list of quantitative indicators, alongside projected changes of the indicators between the BAU and SEM scenario on the short, medium and long term. Upward arrows indicate increases, with double arrows indicating strong increases, downward arrows indicate expected decreases in the indicator.

		Change in the transition from BAU-SEM		
Criteria	**Indicator**	Short term	Mid term	Long term
Financial	Investment costs per mode of mining and operational scale	↑	↑	↑
	Operational costs per mode of mining and operational scale	↑	↑	↑
	Gold recovery rate per mode of mining and operational scale	↑	↑	↑
	Gross revenue per mode of mining and operational scale	↑↑	↑↑	↑↑
	Net revenue for workers and service providers in ASGM	**- /** ↑	↑	↑↑
	Net revenue for mine operators in ASGM	↑	↑	↑
Macroeconomic	Total ASGM production?	↑	↑↑	↑↑
	Production of traceable gold	↑	↑↑	↑↑
	Demand for traceable gold	↑	↑↑	↑↑
	Royalties from ASGM	↑	↑↑	↑↑
	Funds going to development of the interior	↑	↑↑	↑↑
	Total costs of transitioning mining operations to SEM scenario	↑↑	↑↑	↑↑
Environmental	Mercury use per mode of mining annually / total	↓	↓↓	↓↓
	Mercury emissions	↓	↓↓	↓↓
	Area of rehabilitated lands	**-**	↑	↑↑
	Area of tropical forest deforested through ASGM activities	**-**	↓	↓↓
	Ecosystem services values	↑	↑↑	↑↑
Health	Mercury levels in woman and children in ASGM affected areas	↓	↓	↓↓

Table 5: Qualitative indicators to be assessed, including projected differences between the BAU and SEM scenario on the short, medium and long-term. Upward arrows indicate increases, with double arrows indicating strong increases, downward arrows indicate expected decreases in the indicator.

Criteria	Indicator	Short term	Mid term	Long term
Health	Social and environmental cost due to the use of mercury	↓	↓	↓↓
	Disease stricken days of workers in ASGM	-	↓	↓↓
Social	Gender participation in ASGM sector (man/woman)	↑	↑↑	↑↑
	Number of Illegal migrant workers in the ASGM sector in Suriname	-	↓	↓↓
	Number of Illegal activities occurring in ASGM areas	-	↓	↓↓
	Social cohesion in Indigenous and Tribal Peoples communities	-	↑	↑↑

5 BAU and SEM scenarios analysis and results

5.1 Financial indicators (Mining operations)

5.1.1 Investment and operational costs

Having determined the necessary equipment for a transition to a SEM scenario for different scales of mining operations (see Table 3), the associated costs and net revenue of these operations under BAU and SEM can be calculated. In this analysis, costs consist of one-time investment costs to obtain equipment and operational costs related to equipment use. For the purposes of the analysis, labour costs were considered to be a set percentage of revenue, as mine workers are typically entitled to a set share of the gross revenue of the operation, usually around 20%, with the remainder going to the mine operator, who is responsible for the investment and operational expenses (see section 5.1.3). One-time equipment costs are determined through various sources, described in more detail in Annex E. Operational costs consist mainly of fuel costs, which in the BAU scenario are estimated using the ratio between grams of gold produced per barrel of fuel used in the extraction process, which is often used as a measure of success by miners themselves (Social Solutions, 2016). Within Suriname, 15 grams of gold produced per barrel of fuel is generally considered as the economic cut-off point, with a lower yield per barrel of fuel considered as economically unviable (Social Solutions, 2016). For the analysis the 15 gAu/barrel of fuel parameter is used to determine fuel use per mode of mining (e.g., if 300 grams of gold are produced the fuel use is estimated at 20 barrels). For the SEM scenario fuel use is determined by adding annual fuel use for the additional equipment to the amount of fuel used in BAU. This implies that there is a lower yield per barrel under the SEM scenario, as the additional equipment requires extra fuel that is added to the g/barrel parameter after first calculating the fuel use based on grams of gold produced annually and the 15 g/barrel minimum.

Table 6: Costs and revenue (and underlying parameters) for the three operations examples under the BAU and SEM scenario.

		Somaye (Micro-scale)		Small-scale		Medium-scale	
		BAU	SEM	BAU	SEM	BAU	SEM
Costs	One-time Equipment cost	$750	$53,800	$127,500	$184,300	$255,000	$311,800
	Fuel (Diesel) costs (annual)	$22,896	$35,511	$45,793	$67,914	$91,586	$132,024
	Mercury cost (annual)	$1,210	$186	$2,420	$373	$4,840	$745
Revenue	Mine operator	$73,478	$102,869	$146,956	$205,739	$293,912	$411,477
	Mine workers (per team)	$20,994	$29,391	$41,987	$58,782	$83,975	$117,565
	Other service providers	$11,547	$16,165	$23,093	$32,330	$46,186	$64,661
	Throughput (production)/day (T)	50.00	50.00	100.00	100.00	200.00	200.00
	Ore grade (g/T at 90%purity)	1.50	1.50	1.50	1.50	1.50	1.50
	Purity	0.90	0.90	0.90	0.90	0.90	0.90
	Recovery rate	0.25	0.35	0.25	0.35	0.25	0.35
	Average gAU/year (12 hours a day, 5 days a week)	2,199.78	3,079.69	4,399.55	6,159.38	8,799.11	12,318.75
	Barrels of diesel	146.65	227.45	293.30	434.99	586.61	845.61
	gAU/Barrel of diesel	15.00	13.54	15.00	14.16	15.00	14.57

5.1.2 Gross revenue

Gross revenue is determined by assessing the amount of gold extracted based on a number of operational characteristics and with a gold recovery rate that increases between BAU and SEM. The gold recovery rate increases due improved techniques that allow for better concentration of gold particles. This means that less gold particles remain trapped in sediment and get lost in the process. In order to calculate the gold extracted and associated revenue we utilize a number of parameters that are given for each operation type and under each scenario in Table 6 (see Annex E for data references and underlying parameters). These consist of the throughput per day (T), describing how much ore each operation type can process per day. Second, the ore grade (OG) and purity (P) determine the amount of gold that can be extracted from a given amount of ore. Next, the recovery rate is theorized to be 10% higher under SEM compared to BAU. This 10% is based on a study done by Social Solutions (2016), which indicated that a transition to more gravimetric methods of working (i.e. the SEM scenario) could lead to a hypothetical increase in recovery rate (R) from 25% to 50%. To account for the hypothetical nature of this project increase a conservative increase in gold recovery rate from 25% to 35% is used in the analysis. With these parameters the the annual gold production can be determined, under the assumption that mines operate 12 hours a day, 5 days a week throughout the year. This production can then be multiplied by the share of the gold price that goes to the mine operator, workers and service providers (S) and multiplied by the gold price (GP) to determine annual revenue. Thus the following formula is used to calculate annual revenue:

$$Annual\ gross\ revenue = \frac{T * OG * P * R * GP * S\ * 365 * \frac{5}{7}}{2}$$

5.1.3 Net revenue mine operator

Based on stakeholder consultations it was made clear that mine workers generally subdivide roughly 20% of the gross revenue, in the form of the gold produced, whereas the mine operator receives roughly 70% of the gross revenue (i.e., gold). The remaining 10% is used to pay for other services that facilitate mining operations. The calculations described hereafter focus on annual net revenue for the mine operator. Annual net revenue is calculated by subtracting the annual expenses from the mine operator's share of annual gross revenue. The Net Present Value (NPV) of the net revenue for the three operational scales was also determined under a range of discount rates from 0% to 30% for both scenario's.

For micro-scale operations (Figure 6) the analysis also projects that cumulative net revenue will be higher in the SEM scenario in the third year after the initial investment in new equipment. The one-time investment costs is estimated at about 50 thousand USD. With a projected annual revenue of around 70 thousand USD under BAU, this could be considered a significant investment. Over a period of 10 years, the SEM scenario will lead to an increase in cumulative net revenue of 124 thousand USD compared to BAU.

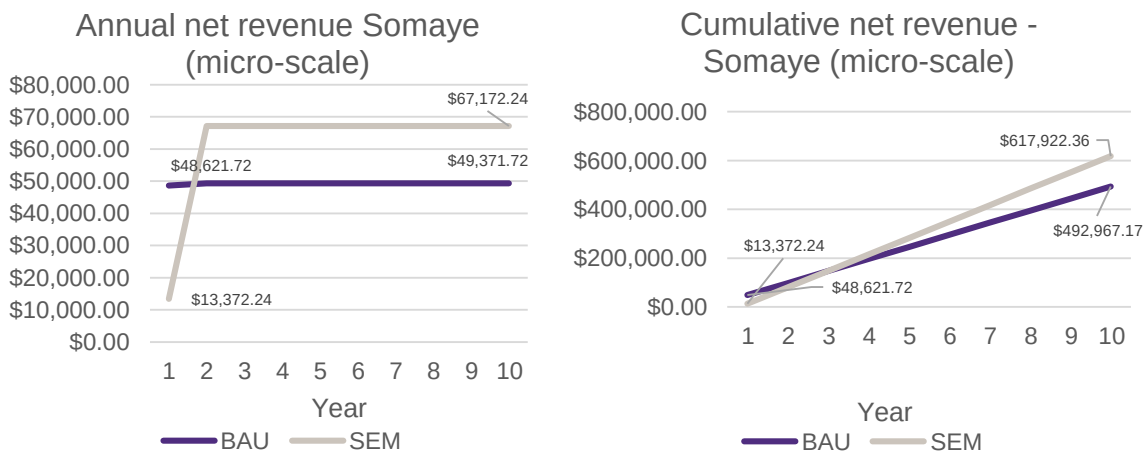

Figure 6: Cumulative net revenue and annual net revenue, composed of annual revenue minus investment costs and operational costs for a micro-scale operation for transitioning from Whole Ore Amalgamation (BAU scenario) to Concentrate Amalgamation (SEM Scenario).

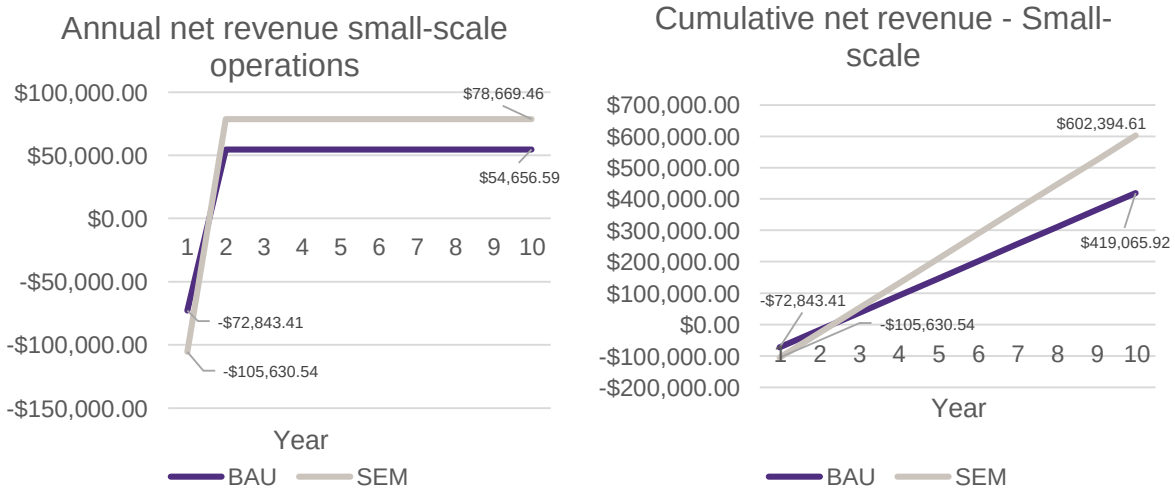

Figure 7: Annual and cumulative net revenue, composed of annual revenue minus investment costs and operational costs for a small-scale operation for transitioning from Whole Ore Amalgamation (BAU scenario) to Concentrate Amalgamation (SEM Scenario).

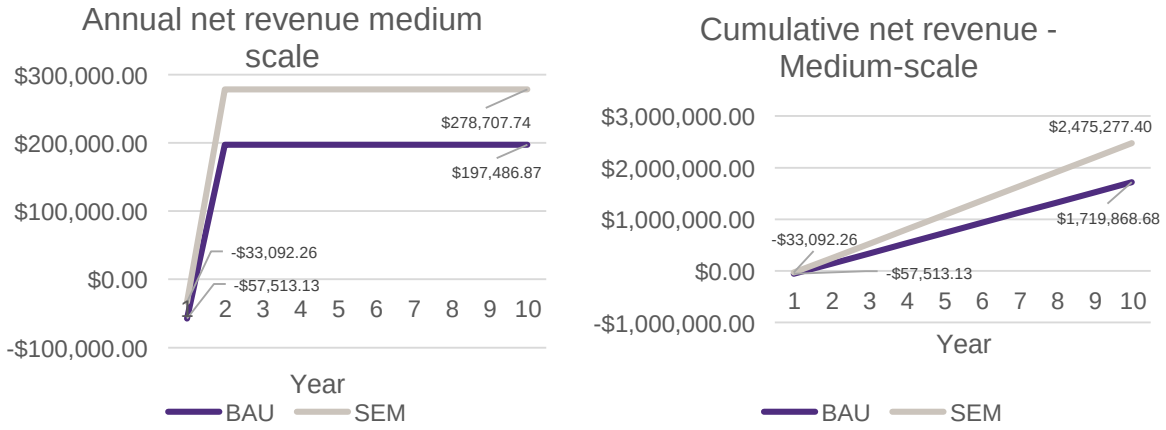

Figure 8: Annual and cumulative net revenue and annual net revenue, composed of annual revenue minus investment costs and operational costs for a small-scale operation for transitioning from Whole Ore Amalgamation (BAU scenario) to Concentrate Amalgamation (SEM Scenario).

For the small-scale operation, cumulative net revenue is projected to be higher in the SEM scenario in the second year after the initial investment (Figure 9). The total increase in cumulative net revenue from BAU to SEM amounts to 183 thousand USD over the 10-year period of the analysis. For medium-scale operations, the analysis projects that cumulative net revenue will be higher for the SEM scenario in year 1 already (Figure 8). Annual net revenue is projected to increase by 80 thousand USD from year 2. Cumulative net revenue over 10 years is expected to increase by over 750 thousand USD.

Figure 9 presents the Net Present Value (NPV) for a range of discount rates and for both scenarios. At all three operational levels, the results indicate that the NPV is higher in the SEM scenario for discount rates between 0%-30%. This implies that the additional benefits in the SEM outweigh the required investments, even at high opportunity costs. From these results, it can be concluded that the investments in more sustainable and efficient mining techniques are a worthwhile investment for mining operators at all three operational levels.

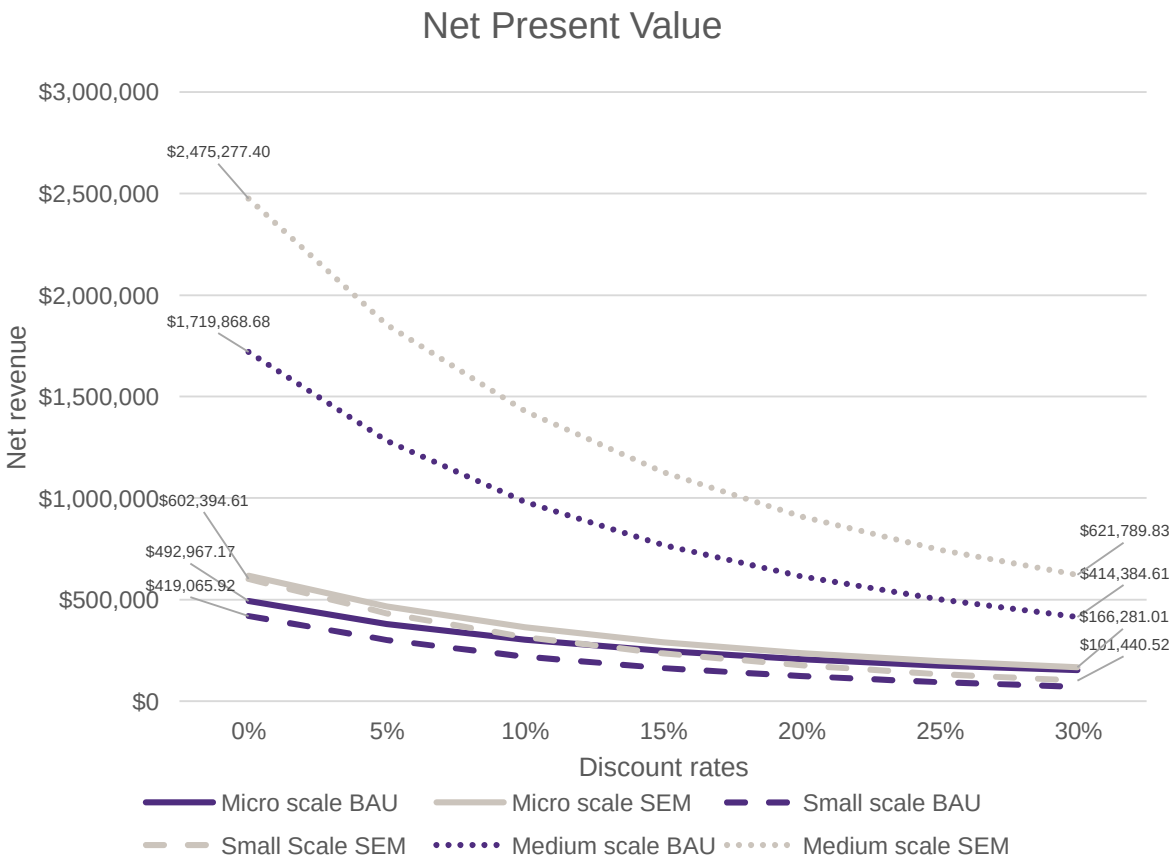

Figure 9: Net Present Value of net revenue over a period of 10 years for the BAU and SEM scenario under a range of discount rates.

5.2 Macroeconomic indicators

5.2.1 Total gold produced in the ASGM sector

At the basis of the analysis of macroeconomic indicators lies the gold production in the ASGM sector in Suriname. There are no projections available for future gold production in Suriname and figures on historic gold production by the ASGM sector are not always consistent between

sources. As such we work under the assumption that gold exports for ASGM equal gold production. The NAP-S provides export figures for ASGM gold based on unpublished Currency Committee figures (Table 7). It is noted that these export volumes might not solely originate from ASGM activities in Suriname but might also originate from activities in neighboring countries that have higher royalty levels. For the modelling of BAU and SEM a constant annual production level of 14,087.90 kilograms of ASGM gold is assumed, based on the average export of ASGM gold between 2015 and 2019 (Table 7).

Table 7: Historical export figures of gold produced by ASGM. Taken from the National Action Plan of Suriname under the Minamata Convention. Based on unpublished data by the Currency Commission.

Year	Gold exported (kg)
2015	14,302.65
2016	10,484.64
2017	14,529.35
2018	17,035.03
2019	15,175.91

5.2.2 Traceable gold exports

An important aspect to consider in the future of the ASGM sector in Suriname is the trends in the global market for gold, as most of the gold produced in the country is exported. Based on stakeholder consultations it was made clear that global demand for traceable gold is increasing. For example, the London Metal Exchange is planning to ban out sales of metals (incl. gold) tainted by human rights abuses in 2025[2], requiring traceability of the gold to the source. In addition, a gold exporter that was consulted for the present study confirmed that demand for traceable gold is increasing. At present, less than 1% of gold is produced in a traceable manner[3]. Traceable gold can fetch a price premium compared to non-traceable gold. For example, gold produced under the Fairmined standard can fetch a premium of 4 to 6 USD per gram (depending on whether chemicals are used)[4]. Though at present demand for traceable gold is still low, in the future this demand could strongly increase, leading to greater price differentiation between traceable vs. non traceable gold. In order to understand the potential effects on export value of an increase in the supply of traceable gold in Suriname we have assessed the present export value under hypothetical levels of supply of traceable gold and traceable gold price premiums, presented in Table 8. The hypothetical results indicate that export value could increase by up to 25 million USD under high price premiums and high supply.

Table 8: Hypothetical effects of increasing supply of traceable gold in Suriname, as percentage of production in 2021, and for different levels of price premiums for traceable gold on export value.

	Price premium for traceable gold (USD/kg)		
	$2,000	$4,000	$6,000

[2] https://mininglatamcongress.com/news/colombia-s-artisanal-gold-miners-now-part-of-a-traceable-global-supply-chain/
[3] https://singlemineorigin.com/blogs/journal/buying-wisely-types-of-traceable-gold
[4] https://fairmined.org/what-is-fairmined/

% of total gold supply that is traceable	*10%*	$2,8 million	$5,6 million	$8,5 million
	20%	$5,6 million	$11,3 million	$16,9 million
	30%	$8,5 million	$16,9 million	$25,4 million

5.2.3 Royalties from ASGM

Based on the estimated gold production figures, it is possible to provide insight in the potential government revenue from royalties. To illustrate this potential, it is assumed that in the SEM scenario the government raises the royalty percentage to a level that is in line with countries in the region. This would imply raising royalties on gold sold to gold buyers (those with a license to buy) from 4.5% to a higher percentage. The analysis considers the effect of raising the royalty percentage to 5.5%, 6.5% and 7.5% respectively, assuming a linear increase between 2022 and 2026. The results of this exercise can be found in (Figure 10) and show that under the SEM scenario where the royalty percentage is raised to 7.5% this could lead to an annual increase in royalties of multiple tens of millions of USD. Over the period analyzed it would lead to a cumulative increase in royalty income (or potential loss if there is no shift to SEM) of some 421 million USD. This additional revenue steam could provide the necessary budget to invest in a more sustainable and equitable ASGM sector, by supporting a transition to more gravimetric methods of working by miners to reduce mercury use and by increasing traceability in the sector to allow for better governmental oversight.

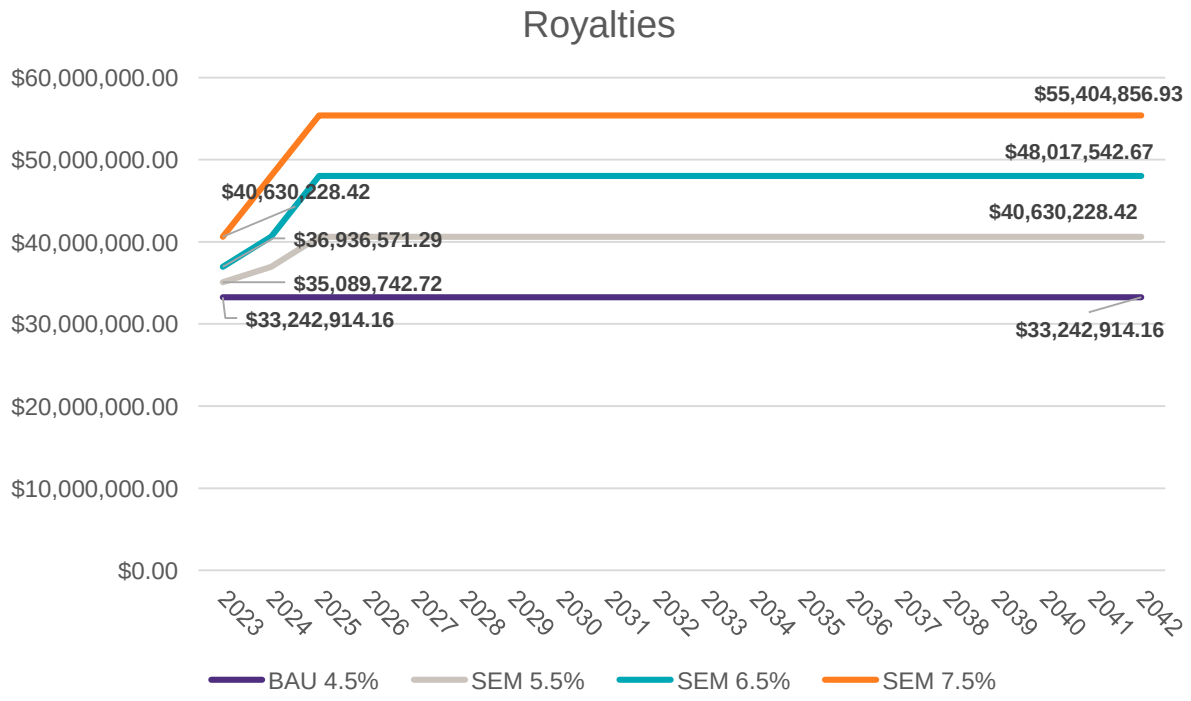

Figure 10: Annual royalties based on an increase in royalties under SEM from 4.5% in 2022 to 5.5%, 6.5% and 7.5% in 2026. Royalties are based upon the expected production of ASGM gold under BAU and SEM set at just over 14 tons annually.

5.2.4 Funds for interior development

In order to provide an idea of how much benefit sharing could contribute to interior development a basic assessment is made of how much funds could be made available for interior development. For this example, is it assumed that 10% of annual royalties will be earmarked

for interior development in the SEM scenario, with royalty percentage being set at 7.5%. This could generate some 6 million USD annually in the long term (Figure 10), and cumulatively over the period analyzed (20 Years) could raise around 108 million USD.

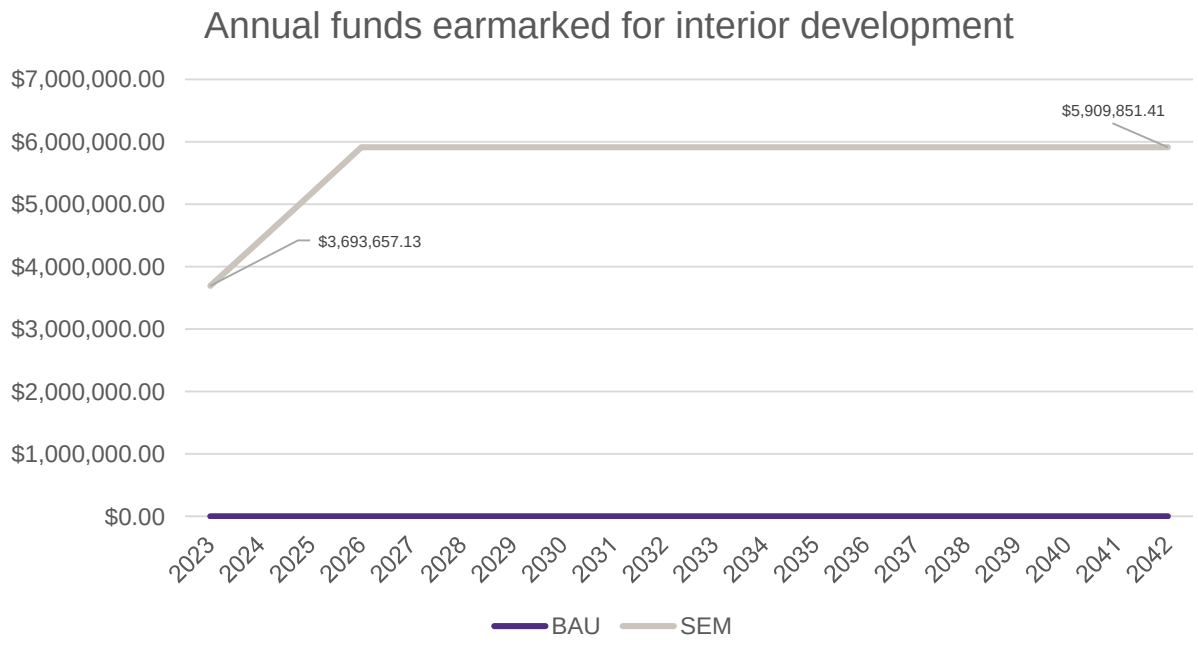

Figure 11: Annual funds to be distributed by a hypothetical National Fund for Interior Development, based on 10% of royalties, and considering a royalty percentage of 7.5%.

5.2.5 Costs of transitioning to a SEM scenario

Transitioning to a SEM scenario encompasses interventions over the whole value chain and by both the public and private sector. Given the breadth of interventions suggested for a change to the SEM scenario, it is not possible to provide an accurate estimate of the total cost of such a transition. Table 9 provides an estimate for the total cost of incorporating gravimetric equipment (see section 5.1) into existing mining operations as envisioned under the SEM scenario. Total costs for this transition are estimated at around 70 million USD total for facilitating the transition of all currently registered operations. Note that this only considers operations registered by the Commissie Ordering Goud Sector (OGS)(Committee for Regulating the Gold Sector) and thus likely does not include a significant number of operations, especially at the micro and small scale. Hence, the estimate of the cost of transitioning is coarse and can be considered an underestimation of the total effort required. Nonetheless, it provides some initial insight into the magnitude of costs required to reduce the use of mercury in mining operations.

Table 9: Projected costs for transitioning from BAU to SEM for operations registered by OGS. Numbers taken from the NAP-S; costs of transitioning based on scenario analysis. Note that linking the characterization of operations as used by the OGS do not fit perfectly within the hypothetical operational sizes used in the scenario analysis, but they do provide a a first estimate of potential costs of transitioning.

OGS definition	Number of registered operations	Hypothetical operational size	Cost gravimetric equipment and closed retort required in SEM per operation	Total cost of transitioning from BAU to SEM
Sluicing	549	Small scale	$56,800	$31,183,200
Hammer mills	656	Medium scale	$56,800	$37,260,800
Sluicing with screen	28	Medium scale	$56,800	$1,590,400
Ground sluicing	13	Somaye	$53,050	$689,650
			Total	**$70,724,050**

5.3 Environmental indicators

5.3.1 Mercury pollution

First, the TSA assessed the projected effects of the ASGM sector on mercury pollution. To do so, it followed a scenario developed in the NAP-S, where the required proportions (as percentage of the ASGM sector) of different modalities of working with mercury (Table 1) are projected to reach the goals set out in the NAP-S of 30% reduction of mercury pollution by 2032. The NAP-S, based on the National Inventory of Mercury Releases in Suriname developed in 2019 under the Minamata Convention, provides input factors for units of mercury per unit of gold produced for the four different modes of working with mercury. The input factor is highest for WOA without retort at 5 kilograms of mercury per kilogram of gold produced and is lowest for CAR at 0.55. Utilizing these factors in combination with the proportions of total gold production per mode of working and gold production by the ASGM sector, the total cost of mercury emissions by ASGM was estimated. The TSA team followed the high baseline proportions estimate described in the NAP-S which estimates that at present roughly 70% of mining operations use WOA and looked at the most conservative scenario for transitioning from Whole Ore Amalgamation to Concentrate Amalgamation (Scenario 1 in the NAP-S).

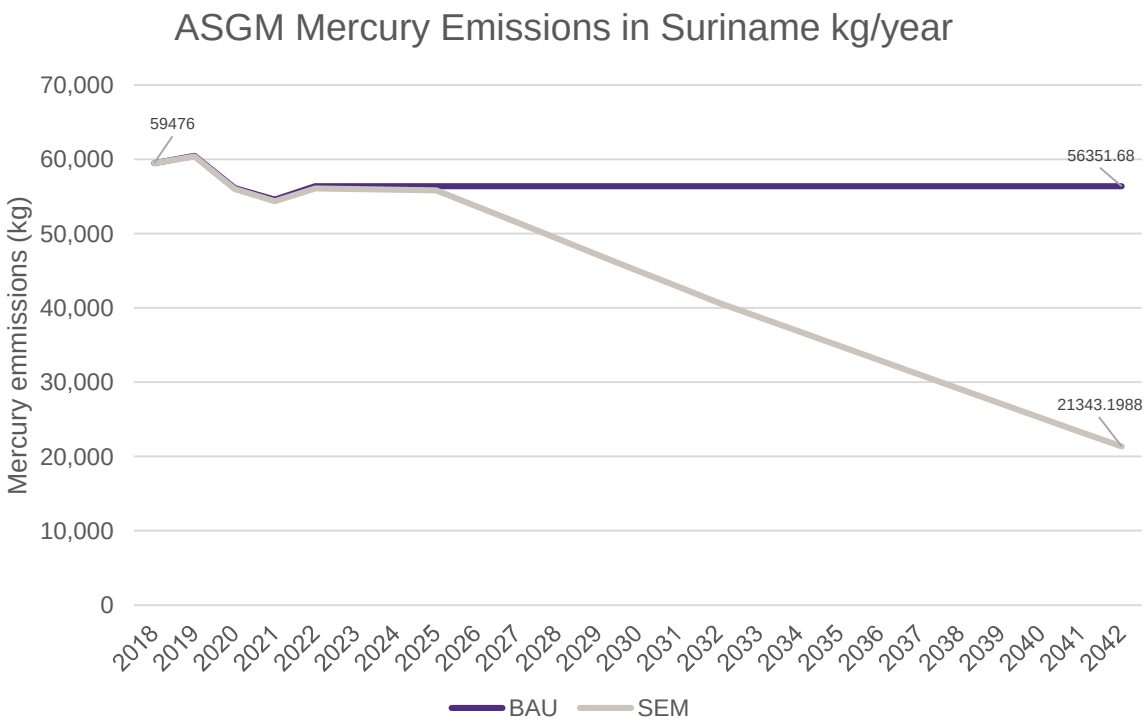

Figure 12: Mercury emissions under BAU and SEM based on projections of gold production in combination with current prevalence of modes of working with mercury (BAU) with a transition scenario to a higher prevalence of less mercury intensive modes of working (SEM)

The results of this analysis can be found in Figure 12, looking back to 2018 and forward to 2042. Due to the way in which gold production is determined in our analysis there is a sharp spike in production between 2021 and 2022. Due to the level of gold production chosen the results also do not line up with the targets mentioned in the NAP-S where under the chosen scenario emissions should drop by 30% in 2032. In our analysis the decrease in emissions under the SEM scenario is not as steep. However, the results clearly show the difference in mercury emissions under a BAU scenario (1127 tons of mercury emitted up to 2042) where no action is taken to improve mining practices and ways of working with mercury compared to the SEM scenario (798 tons of mercury emitted up to 2042) where there is a switch to more environmentally friendly ways of working, for an aggregate reduction of mercury emissions of more than 300 tons up to 2042.

5.3.2 Deforestation and ecosystem services

Deforestation in Suriname is largely caused by goldmining activities. Under the REDD+ program Suriname conducted a number of studies into the drivers of deforestation in Suriname and to assess annual deforestation numbers for the past as well as projecting them for the future (Government of Suriname, 2018). Goldmining in general was found by Foundation for Forest Management and Forest Supervision (SBB) to be responsible for some 73% of the deforestation in Suriname in the period between 2000 and 2015, of which 95.5% could be attributed to gold mining. A scenario analysis was also done to assess projected deforestation in the period up to 2035. Three scenarios were developed and assessed in the REDD+ study of which we follow the Business-as-Usual scenario as a reference for projected deforestation up to 2035 (Government of Suriname, 2018). Deforestation under this scenario is expected to be around 15,588 hectares per year up to 2035. We assume that this annual deforestation level will continue up until 2042. ASGM is then expected to be responsible for a little over 6 thousand hectares of deforestation annually in this period.

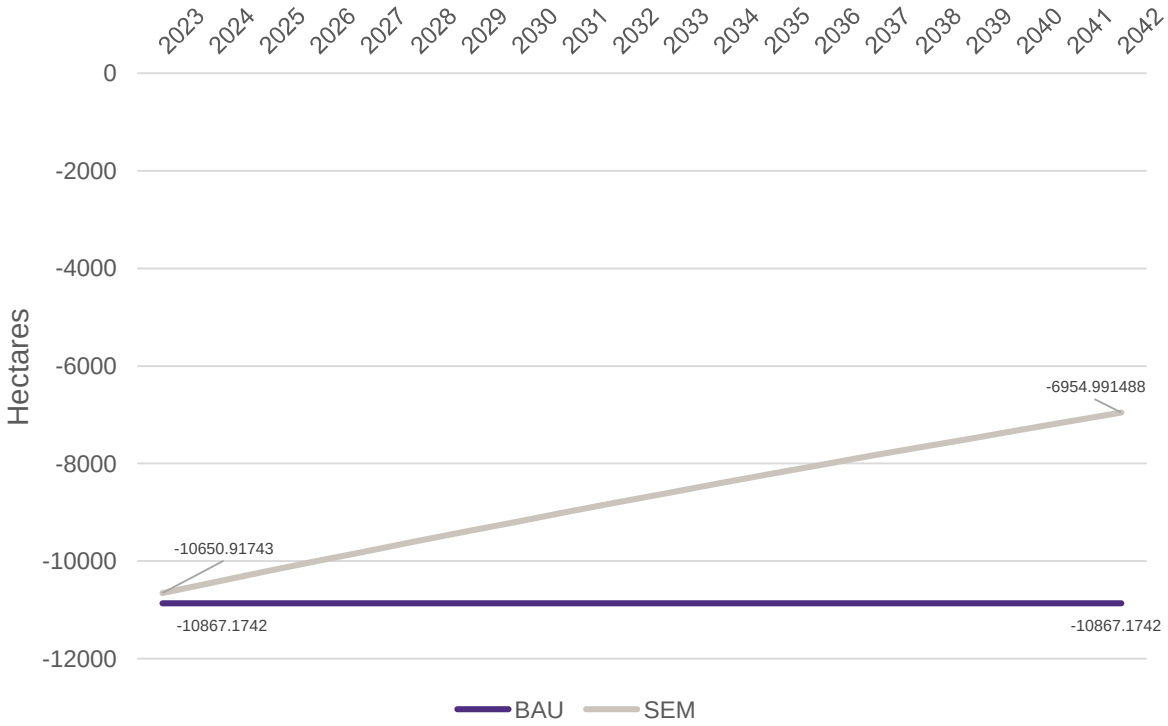

Figure 13: Annual Forest Cover change as a result of ASGM activities. Based on REDD+ projections and assumptions on rehabilitation of degraded lands as well as reductions in deforestation under SEM scenario

In order to assess the effects of transitioning to a SEM scenario the TSA team made assumptions on the level of reductions in deforestation as well an in the amount of former mining lands being rehabilitated. For the purposes of this analysis, it is assumed that starting in 2023 there will be an annual increase of 1% in the amount of land being rehabilitated as a percentage of land being deforested (thus leading to a 20% annual rehabilitation of former mining lands). Furthermore, due to increasing governmental oversight and stronger permit requirements it is also assumed that deforestation due to ASGM will decrease by 1% extra per year leading to a reduction in deforestation of 20% in 2042. These figures are based on assumptions, but are kept low to ensure that there are no overestimations on the speed and effectiveness of measures to halt deforestation and improve rehabilitation.

When looking at annual deforestation we can see that there is a significant decrease in annual deforestation under the SEM scenario (Figure 13). When adding up the decrease in annual deforestation under the SEM scenario an area of 425.2 square kilometers would be saved, larger than the area of the district of Paramaribo. In terms of ecosystem services lost we did not have average values for Suriname. As such we used estimates from a meta-analysis of Brazilian literature on the value of Amazon rainforest undertaken by Brouwer et al. (2022). The study found an average value of 411 USD per hectare of forest. When we combine this value with the area of forest saved between BAU and SEM then this compares to a prevented loss in ecosystem services value of nearly 17 million USD over the long term (Figure 14). This is a coarse estimate but if using the upper and lower ends of the 95% confidence intervals the expected value would lie somewhere between 7 to 26 million USD. As these ecosystem services originate would be lost in the interior, they are a potential source of economic value for interior communities that is being lost. When looking at the combined total loss of ecosystem services value over the analyzed period (20 years) this would be over 50 million USD in the BAU scenario. When expanding the analysis by assessing the Net Present Value under a range of discount rates, the TSA found that the SEM scenario leads to the highest Net Present Value in terms of preventing ecosystem service losses.

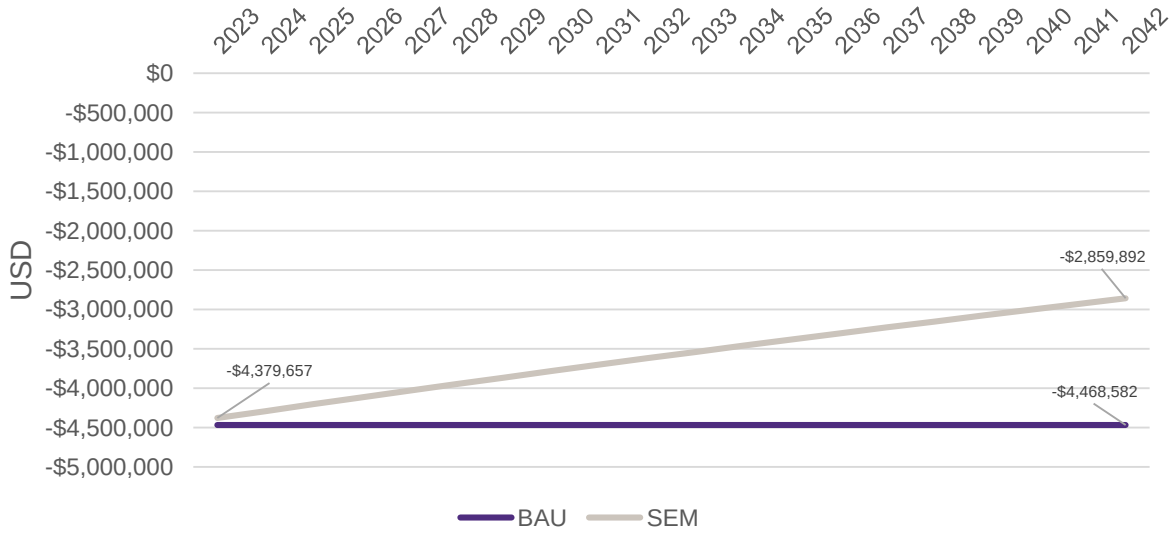

Figure 14: Annual losses in Ecosystem Services values (including carbon sequestration) as a result of changes in forest cover due to ASGM activities.

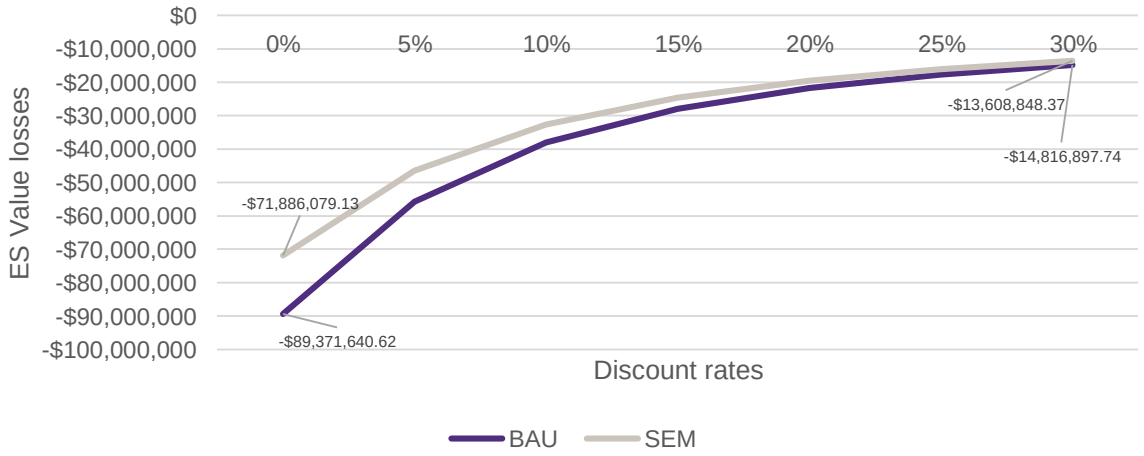

Figure 15: Net Present Value of ecosystem service losses under BAU and SEM considering a range of discount rates.

5.4 Health indicators

5.4.1 Mercury health effects

The social effects of the ASGM sector primarily operate through the mercury pollution affecting the environment for local communities and by the effects (both positive and negative) of the economic gains of the sector. The effects of mercury pollution can lead to negative health outcomes in local communities. To analyze the scale of these health effects we utilize a methodology developed by Bakker et al. (2021), that allows for relating mercury emissions in the water to exposure in a population through consumption of contaminated fish. We utilize the following formula to calculate the amount of mercury Z that is taken up over 50 years by people affected by mercury pollution, based on the methodology used by Bakker et al.:

$$Z = \frac{A * D}{Pop}$$

Where *A* is the total mercury emissions into water by ASGM on an annual basis and *D* is the methylation rate for these emissions which is the percentage of elemental mercury that will become the bioactive methylmercury. This methylation rate is set at 0.22% as this is the most conservative estimate described by Bakker et al. (2021). Mercury emissions to water are based on the NAP-S and were calculated for both BAU and SEM, taking into account the changing proportions of modes of working with mercury (i.e. WOA, CA, etc.).

Pop is the population that is affected by the mercury emissions. For the affected population an assumption was made as no exact figures are known for the number of people affected. As such we utilized the number of people that were listed as living in the interior in demographic data for 2021 developed by the General Office of Statistics of Suriname (Algemeen Bureau voor de Statistiek Suriname, 2023), which was estimated at 87,400.

In order to assess the health effects, the TSA team calculated the daily intake of methylmercury through fish consumption and compared this to the World Health Organization's tolerable level of methylmercury intake of 1.6 microgram per kg bodyweight per week (WHO, 2021). This could then be compared to the daily uptake level of methylmercury per kilogram of bodyweight, I, which was calculated as follows:

$$I = \frac{\frac{Z}{D}}{BW}$$

Where Z is the amount of methylmercury taken in over 50 years, D is the number of days in 50 years, set at 18250, and BW is average bodyweight which was set at a default value of 60 kilogram in absence of exact data.

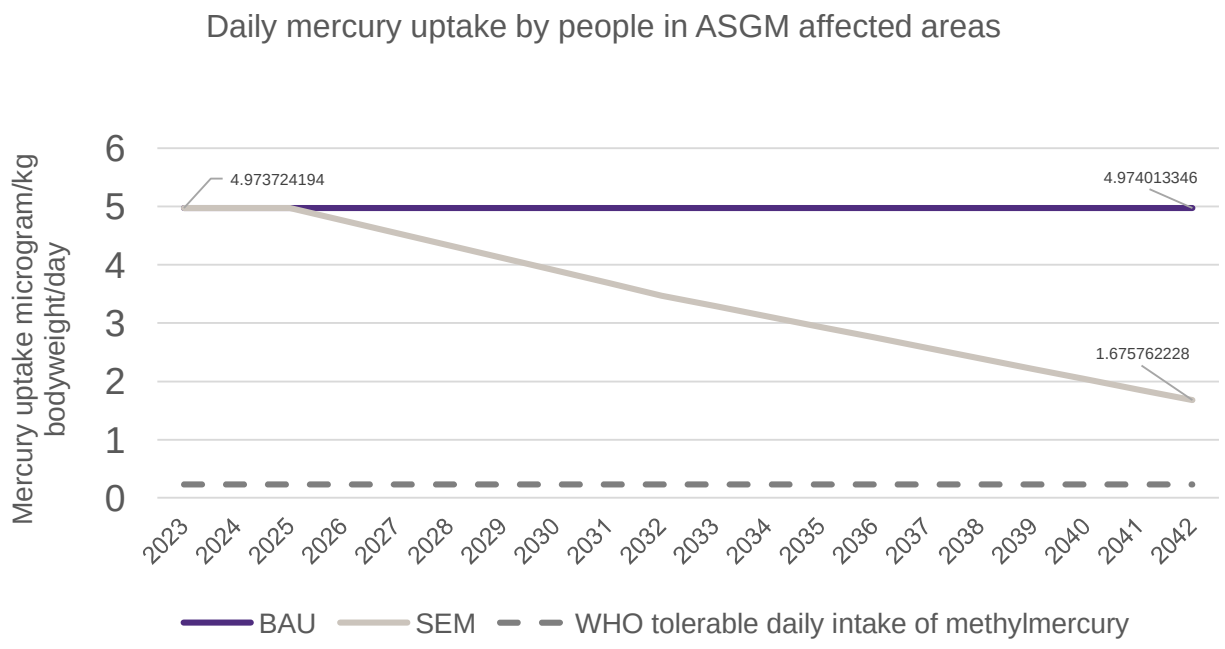

Figure 16: Daily mercury intake by affected individuals in ASGM area following the methodology developed by Bakker et al. (2021) under BAU and SEM, compared to the tolerable daily intake of mercury as determined by the World Health Organization

The results of the analysis show daily intake levels that far exceed the tolerable intake levels prescribed by the WHO (2021) (Figure 16. The population size affected by mercury is currently unknown, and therefore an important assumption to model the health effects of mercury.

However, even when applying a more conservative approach, where the total population of Suriname is assumed to be exposed to the effects of mercury pollution, the daily intake levels would still exceed the WHO tolerable daily intake levels. However, the SEM scenario leads to significant reductions compared to the BAU scenario, as is also apparent in Figure 16. It is important to note that the effects of methylmercury are primarily dangerous for fetuses and children although at higher doses they can also lead to neurotoxic effects in adults. The levels found in the analysis signify a large risk for negative health effects, particularly in communities close to ASGM areas. Though the present analysis does not include estimates of the economic impact of health effects resulting from mercury, a TSA study on the ASGM sector in Ecuador can provide some insight (UNDP, 2021). In this study it was estimated that annual mercury emissions of roughly 7 tons a year could lead to aggregated health costs of around 300 million USD. Though the context of mercury pollution in Suriname is different, given the higher annual emissions of mercury (>55 tons annually) at present in Suriname the economic losses for Suriname should be expected to be significant.

5.4.2 Disease stricken days of workers in ASGM

The incidence of mercury related health effects in ASGM workers population in Suriname is currently unknown. Though not quantified in the present analysis, it stands to reason that a transition to a higher proportion of operations that utilize Concentrate Amalgamation instead of Whole Ore Amalgamation is expected to improve the safety of workers. Health effects of mercury exposure on ASGM miners were assessed in a study by Wanyana et al. (2020) in Uganda, whose results clearly indicate that mercury exposure by miners leads to mercury levels higher than the recommended thresholds. Associated symptoms, established through high odds ratios by Wanyana et al. (202), include chest pain, numbness, back pain, fatigue and stress, among others. These effects can be expected to decrease significantly under the SEM scenario, as the amount of mercury used decreases and direct exposure will also become more limited through the use of retorts and by more targeted application of mercury to concentrated amalgam.

5.5 Social indicators

5.5.1 Gender balanced participation

Improving governmental oversight in the Artisanal and Small-scale Gold Mining (ASGM) sector in Suriname could significantly boost gender participation, especially if the new regulatory measures actively encourage and support the involvement of women. Studies into women's participation in the ASGM sector have focused on Maroon communities (Heemskerk, 2003). The artisanal and small-scale gold mining industry in Suriname has the potential to empower women from these communities economically, as the data indicates that women who engage in this sector can earn substantially higher incomes compared to traditional or informal jobs (Heemskerk, 2003). Given this opportunity, promoting women's participation in this industry can be a strategic step in addressing issues related to income disparity, economic autonomy, and gender roles. This could be achieved by implementing policies that promote gender equality, provide training for women in mining and related industries, and ensure safe working conditions for all. Crucial in doing so is recognizing the variety of gender systems in communities in gold mining areas and the interpersonal differences in women's preferences regarding participation in the sector (Heemskerk, 2000). Only by taking appropriate measures to address this variety can women's participation be improved.

5.5.2 Illegal workers, migration and illegal activities

Estimates for the number of people working directly in the ASGM sector vary, with estimates of around 20,000 to 35,000 (OAS, 2023), to even 40,000 (IGF, 2017). The true number of people working in the ASGM sector could be much higher, as a vast number of miners are not operating in a formal setting. Apart from people working in the mining sector itself, there also

an estimated 20,000 people working in jobs that are linked to the mining sector (OAS, 2023). An increase in governmental oversight of the sector could decrease the number of informal and illegal workers in the sector, and could decrease associated illegal activities and unsanctioned migration. Enhanced governmental oversight also plays a crucial role in curbing illegal activities in the ASGM sector. When regulation and enforcement are lax, the sector can become a magnet for illicit activities and informal, illegal migrant labour, resulting in a host of social and environmental problems. With proper oversight, the government can help formalize operations and provide miners with legal recognition and rights. As the mining operations become formalized, the number of illegal migrant workers would likely decrease, since legalized operations will have proper mechanisms to hire and manage labour legally. Further, a comprehensive regulatory framework will make it harder for illegal operations to persist, thereby reducing the opportunity for illicit activities.

5.5.3 Social cohesion and benefit sharing

A more formalized Artisanal and Small-scale Gold Mining (ASGM) sector could also bolster social cohesion among Indigenous and Tribal Peoples communities in the interior of Suriname. Formalization and recognition of community land claims brings about clear, legally defined roles, responsibilities, and rights, which can mitigate disputes and conflicts arising from unclear or overlapping claims. Moreover, a regulated sector where benefit sharing is legally required would likely lead to fairer distribution of mining benefits and profits, reducing inequalities that can be a source of social discord. This could also pave the way for community-based initiatives or cooperatives, empowering these communities to manage their resources, share profits equitably, and reinvest in their collective welfare, thereby fostering a greater sense of unity and solidarity.

Finally, a formalized sector also allows for the creation of social programs and infrastructure development funded by mining revenues. When implemented effectively, these can enhance the quality of life and opportunities for these communities, improving education, healthcare, and other social services, which in turn reinforces social cohesion. Furthermore, formalizing the ASGM sector ensures that mining practices adhere to environmental standards, preserving the natural habitats that these communities rely on and hold sacred, thereby avoiding environmental conflicts that could disrupt social harmony. Hence, formalization of the ASGM sector in Suriname could be a vital step towards promoting social cohesion

6 Conclusions and recommendations

6.1 Key Conclusions

The TSA provides evidence-based information that corroborates the economic, social, and environmental reasons to improve ASGM management and investment policies. The improvement, shifting from BAU to SEM, is essential to achieve more sustainable productivity and profitability and ensure the long-term provision of ecosystem services that support ASGM productivity. Below are the key conclusions that respond to the subset of questions included in Section 2.3:

- Due to increased efficiency of improved gravitational methods in SEM, mine operators are projected to have higher cumulative net revenues within one to three years of adopting new equipment, depending on the scale of the operation.
- For micro-scale operations, the SEM scenario will lead to an increase in cumulative net revenue of 124 thousand USD over 10 years compared to BAU. For small-scale operations, there is a projected increase in cumulative net revenue of 183 thousand USD over 10 years with SEM, while medium-scale operations are expected to see an increase in cumulative net revenue by over 750 thousand USD over the same period.
- The Net Present Value of additional investments under the SEM scenario is higher compared to the Business-as-Usual (BAU) scenario, even under a 30% discount rate. This implies a strong financial justification for transitioning to more sustainable mining practices.
- Suriname's ASGM sector could see an annual increase in export value by over 10 million USD by capitalizing on the rising global demand for traceable gold, given its potential for higher price premiums.
- By earmarking 10% of annual royalties for interior development in the SEM scenario, it is projected that around 6 million USD could be generated annually, amounting to approximately 108 million USD over the analyzed period.
- A proposed increase in government royalties from 4.5% to 7.5% under the SEM scenario could result in a cumulative increase in royalty income of around 421 million USD. This additional income could support environmentally-friendly working practices and increased traceability.
- Transitioning to the SEM scenario is a comprehensive effort, and while exact costs are challenging to determine, initial estimates suggest that incorporating gravimetric equipment alone would require around 70 million USD, which may not account for many unregistered operations.
- Shifting to Concentrate Amalgamation from Whole Ore Amalgamation would decrease health risks for miners and reduce mercury exposure symptoms such as chest pain, numbness, back pain, fatigue, and stress.
- The analysis reveals a distinct difference in mercury emissions between the BAU scenario, with 1127 tons emitted up to 2042, and the SEM scenario, which emits 798 tons, reflecting an aggregate reduction of more than 300 tons due to improved mining practices.
- Under the SEM scenario, there is a significant reduction in annual deforestation, potentially saving an area of 425.2 square kilometers, which is larger than the district of Paramaribo. Based on estimates from Brazilian literature, the SEM scenario could prevent losses in ecosystem services value ranging between 7 to 26 million USD, offering economic value to interior communities and presenting the highest Net Present Value in terms of preserved ecosystem service losses.

- Incorporating gender-sensitive measures in broader programs to formalize the ASGM sector could increase gender participation by implementing policies that champion gender equality and empower women to participate in the sector. This would increase economic autonomy and address income disparity in rural communities.
- Increased governmental oversight of Suriname's ASGM sector could reduce the prevalence of informal and illegal workers, leading to a decrease in unsanctioned migration and associated illicit activities.
- Formalizing the ASGM sector in Suriname can foster social cohesion among Indigenous and Tribal Peoples communities by defining legal roles, ensuring fair benefit sharing, promoting community initiatives, and funding social programs, all of which enhance the quality of life and sustain environmental standards.

6.2 Recommendations

This section presents the management and investment policy recommendations resulting from the TSA. The underpinnings of the TSA such as desk research, inception workshop, personal interviews, economic analysis, ASGM policy analysis, and other TSA studies have contributed to the formulation of these recommendations. The TSA recommendations are supported and justified by the economic data resulting from the analysis:

6.2.1 Improving overall ASGM governance

In order to promote any change in the ASGM sector it is vital that there is unity of purpose and commitment on the governmental and corporate levels towards achieving a more environmentally friendly sector. To this end, there have been many past efforts, which have not always achieved the desired results for a variety of reasons. The results of the scenario analysis clearly demonstrate that by increasing effective governance, the negative effects of the ASGM sector can be reduced. From the consultations and the validation workshop that took place during the implementation of this TSA study, it is clear that the following recommendations can be made to improve overall governance in the sector:

1. Promote strong collaboration among institutions and top government levels responsible for regulating artisanal gold mining, mercury use, transport, and handling. These include of the Ministry of Defense, the Ministry of Justice and Police, the Ministry of Economic Affairs, the Ministry of Finance and Planning (including the Customs and Taxation Office), the Ministry of Entrepreneurship and Innovation, the Geology and Mining Department (Geologische Mijnbouw Dienst – GMD), Ordering Goud Sector (OGS), NIMOS, the Foreign Exchange Commission, and the Office of the Public Prosecution. A small coordinating body could be instated comprised of member from all these institutions, with corporate sector support, that would be responsible for information and data sharing, and further the cooperation between its constituents towards the realization of the SEM scenario. This collaboration is vital for reducing mercury emissions and regulation of the sector in general, thereby preventing economic losses projected in the BAU scenario.
2. Finalization of the new draft mining law by the MNR and presentation it to the National Assembly. This new act would benefit from clearly stipulating the roles, accountabilities and responsibilities of the various entities involved (either directly or indirectly) in the (artisanal) (gold) mining sector. It also could benefit from setting out the main processes for collaboration between these entities. Without these clear definitions and assignments, the Government runs the risk of funding resources for institutions without the desired output. Inefficient governance could hinder the reduction of mercury emissions by the ASGM with associated negative economic, health and social effects.
3. Reach agreement with Indigenous and Tribal Peoples communities on the demarcation of community lands and on the relationship between community lands and mining concessions to the satisfaction of all parties involved. Effective land-use planning can help

limit the negative socioeconomic effects of ASGM operations in these communities. This should be done by finalizing the 'Collective Rights Act for Indigenous and Tribal Peoples in Suriname' as submitted to the Minister of Regional Development in 2019.

6.2.2 Promoting environmental remediation and rehabilitation and preventing deforestation

The results of the scenario analysis highlight the continued losses of forest due to ASGM as projected by the SBB. This forest loss leads to a loss in ecosystem services values, particularly for interior communities. To counter forest loss, it is vital that both remediation and rehabilitation occur, and that deforestation is limited. The following recommendations are made to achieve this:

- Adjust the ASGM concession framework to hold concessionaries liable for social and environmental mining damage on their concession areas in the new Mining Act. This implies that permits need to require clear mine closure plans (which need to be revisited and implemented in a progressive manner throughout the life of the mine), financial assurance, and a multi-stakeholder approach to mine rehabilitation.
- Abandoned areas need to be levelled and covered again with the original topsoil (which thus needs to be stored close to the mine). This would ensure that forests can recover far quicker than in the absence of the original topsoil, resulting in an earlier recovery of ecosystem services values and the benefits they provide for local communities. This should be enshrined in the new Mining Law, which should be aligned with the relevant forestry legislation.
- Facilitate collaboration between the GMD and SBB through cooperation between the Ministry of Natural Resources and the Ministry of Spatial Planning and the Environment to ensure that mining and forestry permits are integrated in the mining and forest regulations to promote the most optimal level of protection for forests. This could be accomplished by ensuring alignment between the new Mining Law and the policy governing forestry permits.

6.2.3 Improve transparency and organization in the sector

The study shows the benefits of transitioning from BAU to SEM scenario. To transition to a more environmentally friendly mode of working, it is crucial to have greater governmental oversight in the sector. In addition, given the growing demand for traceable gold it could also be beneficial to promote traceability of gold produced by ASGM operators. Greater oversight will allow the Ministry of Natural Resources (MNR) and the Surinamese government in general to identify how a transition can be supported and where funds and resources should be targeted. To do so, the following set of recommendations is proposed:

- The MNR can invest in assessing the cost of designing and setting up a system for registering all artisanal miners, including characteristics and parameters such as nationality, gender, age, mining method used, etc. Build upon the work done by the OGS and leverage private sector knowledge on tracing gold throughout the value chain. The private sector is already working with software to facilitate a transparent supply chain which could form a basis for a governmental registration system. Collaboration with private sector parties, some of whom have already indicated interest in such a collaboration, could facilitate effective and efficient implementation of such a system. It is critical that the detailed registration of all miners in the ASGM sectors is be enshrined in the new Mining Act.
- The MNR could invest in promoting small-scale gold miners to organize in associations by establishing a financial incentive under the royalty regulation framework for participants within these associations to transition to mercury of mining as well as for improving labor conditions. This will also facilitate better oversight of the sector as the associations can form a basis for data gathering and a platform for providing training. ASGM associations could be incorporated in the above-mentioned registry.

- The NNR can establish collaboration agreements (including shared responsibilities) with institutions such as the Ministry of Defense, the Ministry of Justice and Police, GMD, Taxation Office, and OGS to mobilize resources (networks, training, manpower, technical tools, equipment and material) needed to execute effective control. This requirement to provide adequate resources to enforcement agencies could be supported by the new Mining Act. If incorporated in the new Mining Act, clear roles and responsibilities should be defined. It was beyond the scope of this assignment to define the budgetary implications for the full implementation of this transition. It would be recommended to conduct a financial gap analysis to estimate the budgetary requirements for enforcement, and prepare a results-based budget with defined benchmarks.
- The MNR in collaboration with the Ministry of Finance can assess the cost of providing incentives to introduce sound production techniques (i.e., fewer resources and less environmental impact) and equipment to accelerate the production and certification of more sustainable gold, i.e., gold extracted without cyanide or mercury, with methods that minimally impact forest cover and replace the organic topsoil after mining. Doing so will maximize the value gains associated with a decrease in mercury pollution and forest degradation. A pilot site could be selected for testing the incentives in coordination with the Mining Training and Extension Centers (MTECs). The pilot will demonstrate the feasibility of the financial incentive with a transparent structure and high traceability.
- The MNR in collaboration with local authorities, indigenous organization and other key stakeholders can identify zones to be designated for artisanal mining; use can be made in this regard of the work done by the University of Suriname's NARENA mapping department to improve zonation of ASGM activities to reduce adverse environmental effects and improve productivity of the sector. Royalty income could be used to fund such exploration, through a one-time investment in a structured exploration of optimal zonation.

6.2.4 Introduce mining techniques that reduce mercury pollution.

The study clearly highlights the effectiveness of increasing the proportion of mining operations that use Concentrate Amalgamation instead of Whole Ore Amalgamation processes and the introduction of retorts, following the scenario analysis described in the National Action Plan for the Minamata Convention. The negative effects of mercury exposure on the health of local communities and workers have also been highlighted in the scenario analysis. It is thus crucial to start limiting the use of mercury in ASGM, to which end the following recommendations are presented:

- MNR can prioritize the invest needed to estimate the financial needs and gaps, and mobilize funding to finalize and implement the National Action Plan for (the implementation of) the Minamata Convention considering the SEM scenario. I.e., elimination (and banning) of mercury use. Given the popularity of mercury as a cheap, effective, and readily available aid to extract gold, policy interventions may be most effective if they initially seek to reduce mercury consumption, rather that immediately aim for the total elimination of mercury use. The stepwise reduction of mercury in small-scale gold mining can be a first stage of a broader policy aimed at a complete ban on mercury in small-scale gold mining by a to-be-determined target date. Implementing this recommendation could result in an estimated avoided cost that are substantial to the national economy of Suriname over the coming decades.
- Investing in demonstrating alternative techniques and technologies through MTECs is crucial to raising awareness to adopt environmentally friendly ASGM practices, therefore, it is a priority for the MNR. Thus, implementing MTECs needs expediting, especially those that can be hosted by prominent public and corporate actors in the sector. The overall vision of the MTECs is one of extension and service rather than one of enforcement. The MTECs are intended as places from which miners can access training, knowledge, technology, and material, as well as technical or legal support. Combined with a preferential access to

selected socio-economic services (e.g., education, telecommunication, market information, health services), the MTECs are expected to become poles where miners can congregate and for which they will develop a sense of ownership. The allocating of 10% or more of annual royalty income for interior development could finance this recommendation.

- Multi-sector investing and defining benchmarks to implement a stricter control on compliance with laws on mercury import and transportation by the Suriname Police Corps (KPS), the Coast Guard Authority Suriname, and the Suriname Customs department. Through enforcing stronger compliance with laws on mercury the availability of mercury will decrease, thereby increasing the price of mercury and providing a stronger incentive to switch to mercury-free methods of gold mining. Improving collaboration between agencies will be crucial for effective enforcement (see 6.1).

6.2.5 Promote community development.

Given the clear effects of mercury pollution and deforestation on communities in the interior, as well as the social disruption resulting from ASGM these communities would benefit from additional support from the central and local governments. The scenario analysis provides an initial estimate of the funds that could be raised for this purpose. To ensure that communities in the interior have an adequate share of benefits from gold mining in their surroundings and on their traditional lands, the following is recommended:

- Develop and have approved after consultations with all stakeholders, a National Benefit Sharing Scheme, which defines how monetary and non-monetary benefits from the ASGM sector are shared amongst stakeholders. This mechanism can address negative consequences of ASGM activities through rehabilitation of community lands, promote alternative livelihoods for people in interior communities, develop amenities and support overall sustainable development in the interior. The design and implementation of the revenue sharing scheme can be led by the MNR and the Ministry of Finances, and be incorporated in the new Mining Act.
- Earmark and allocate a proportion of government revenues from the ASGM sector for the National Benefit Sharing Scheme (e.g., from royalties, export fees, and mining prospecting licenses). The rehabilitation of degraded old mining sites will be included in the Scheme. This will help address the loss of forest and associated ecosystem services values.
- Develop a grievance redress mechanism, vested in the new Mining act, that provides both local communities and formal ASGM miners a legal avenue to address conflicts.

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Annex A: Bilateral consultations

Individual or organizations
Minister of Spatial Planning and Environment
Minister of Finance and Planning
Acting Attorney General
Director Mining of the Ministry of Natural Resources
Tax Director
Director of Regional Development and Sport
EMSAGS Project Management Unit
National Institute for Environment and Development of Suriname (NIMOS)
Foundation for Forest Management and Forest Supervision (SBB)
Foreign Exchange Commission
Amazon Gold
VIDS
KAMPOS
WWF
Reinardus Artist
Marieke Heemskerk
Max Huisden

Annex B: Representatives present at Inception Workshop

Organizations
Ministry of Spatial Planning and Environment
Suriname Trade and Industry Association
Office of the Attorney General
Director Mining of the Ministry of Natural Resources
Ministry of Natural Resources
Spatial Planning Association Suriname
UNDP Suriname and UNDP Food and Agricultural Commodity Systems (FACS)
National Institute for Environment and Development of Suriname (NIMOS)
Foundation for Forest Management and Forest Supervision (SBB)
Association SSM Paamaka
Ministry of Education
Suriname Business Forum
WWF
Commission for the Regulation of the Gold Sector (OGS)
Anton de Kom University of Suriname
Alliance for Responsible Mining
Conservation International
Belastingdienst
Bauxiet Instituut Suriname
Suriname Environmental and Mining Foundation
Ms. Chantal Landburg
Mr. Glenn Gemerts
Ms. Annette Tjon Sie Fat

Annex C: Inception Workshop invitation and agenda

Improving Environmental Management in the Mining Sector of Suriname, with Emphasis on Artisanal and Small-Scale Gold Mining (EMSAGS) Project
Datum: Donderdag 16 februari 2023
Tijd: 9:00 a.m. – 16:00 p.m.
Lokatie: Royal Ballroom, Royal Torarica

AGENDA	
8:30 – 9:00 a.m.	Registratie
BLOK 1: STAKEHOLDER PLATFORM MEETING	
9:00 – 9:10 a.m.	Opening door Wnd. Algemeen Directeur NIMOS, dhr. C. Nelom
9:10 – 10:00 a.m.	Presentatie en discussie: EMSAGS Project update Door: S. Bihari, Project Coordinator
10:00 – 10:55 a.m.	Presentatie en discussie: EMSAGS Engagement & Communicatieplan 2023 Indigenous and Tribal People Participation Plan Door: C. Elliott, Engagement Specialist
10:55 – 11:00 a.m.	Afspraken en Next meeting- EMSAGS PMU
11:00 – 11:15 a.m.	Koffiepauze
BLOK 2: TARGETED SCENARIO ANALYSIS WORKSHOP	
11:15 - 11:25 a.m.	Opening door de Directeur Mijnbouw van het Ministerie van Natuurlijke Hulpbronnen, Mw. P. Simons
11:25 a.m. – 12:00 p.m.	Presentatie: Introductie Targeted Scenario Analysis (TSA) studie
12:00-13:00 p.m.	TSA Workshop: Outlines Business-As-Usual (BAU) en Sustainable Ecosystem Management (SEM) Scenario
13:00-13:45 p.m.	Lunch
13:45-15:30 p.m.	TSA Workshop vervolg
15:30-16:00 p.m.	Afronding TSA workshop

Annex D: Policy analysis

Strategy

In Suriname the Government follows the Multi-Annual Development Plan. This document is conceived every 5 years according to the Plan Act and sets out the major directions for policy. These Plans are adopted by the National Assembly (i.e. parliament) and thus have binding force. The plan currently in force is the Multi-Annual Development Plan 2022-2026 which also provides the path forward for the decades to come (it utilizes an outlook till 2050). The plan was conceived with significant input from the private sector, ministries, state-owned companies, non-governmental organizations, grass roots organizations, etc., and passed through the National Assembly on the 20th of December 2021. The Sustainable Development Goals are part of this Development Plan and are integrated with its goals, outcomes and indicators. With respect to the gold sector in general – and thus also ASGM – it states the following (Stichting Planbureau Suriname, 2021):

1. The informal gold sector must be restructured (again). One of the highest priorities in this regard is to map the number of people involved and activities.
2. Specific areas must be designated for small-scale mining in order to limit further damage to the environment and health.
3. It needs to be checked which rights have been issued and what the options are for revocation, especially in case of inactivity.
4. The establishment of a rehabilitation plan for those areas already affected the implementation of which can be done through internationally available funds.
5. Options must therefore be considered to set up a Surinamese gold company (in accordance with the experience with Staatsolie), or at least purchase a significant share from the foreign companies that are currently conducting exploration activities.
6. The mining law dates from 1984 and needs to be adjusted / renewed. A new law should set clearer rules for rehabilitation, the informal gold sector, and issuance policies.
7. Implementation of gold mining without the use of toxic substances; use of mercury needs to be phased out.

These 7 strategic actions items have been ranked in Figure 17 below according to their degree of impact and their expected ease of implementation. In line with the SDGs the Plan depicts hard targets for goals relevant to ASGM, such as illegal immigration, forest cover, poaching, safety, safe drinking water, integrated water management, and the mining sector in general.

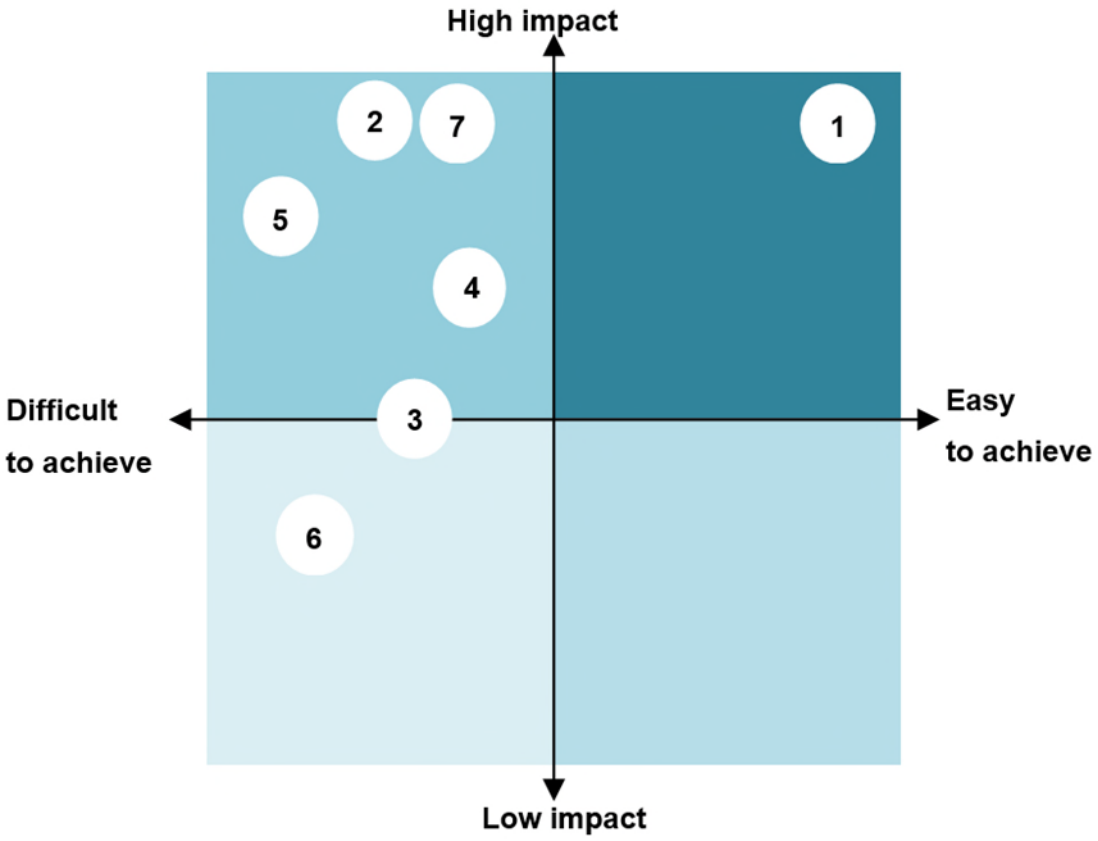

Figure 17: Ranking of strategic action items related to the gold sector in the Multi-Annual Development Plan 2022-2026

Strategic action item 2 can have immediate (strong) benefits, but involve respectively traditional / ancestral areas that aren't that likely to be limited for commercial activities (by inhabitants of the interior). In the case of strategic action item 5, the so-called Staatsolie model would yield large benefits, but the upfront capital requirement is difficult for the Government that has just ended its re-negotiation with its bondholders. Similarly, item 7 is expected to have positive impacts when it regards mercury use affecting health and environment, but the required investments, behavioral and belief changes, language barriers, etc. render it difficult to achieve. Another factor contributing to the notion that the majority of the action items are skewed towards a high difficulty of achieving them can be found in the fact that several actors in the ASGM have strong political and governmental connections. However, though traditional governmental agents that would have to be tasked with strategic action item #1 are not performing to that end (i.e. mapping of the ASGM), other ministries – in particular the Ministry of Defense – should be able to assist.

The strategic document also elaborates on the last strategic action item regarding the phase out of toxic substances as depicted in Figure 6 below. It envisions a full ban on the use of toxic substances in ASGM by the end of 2024.

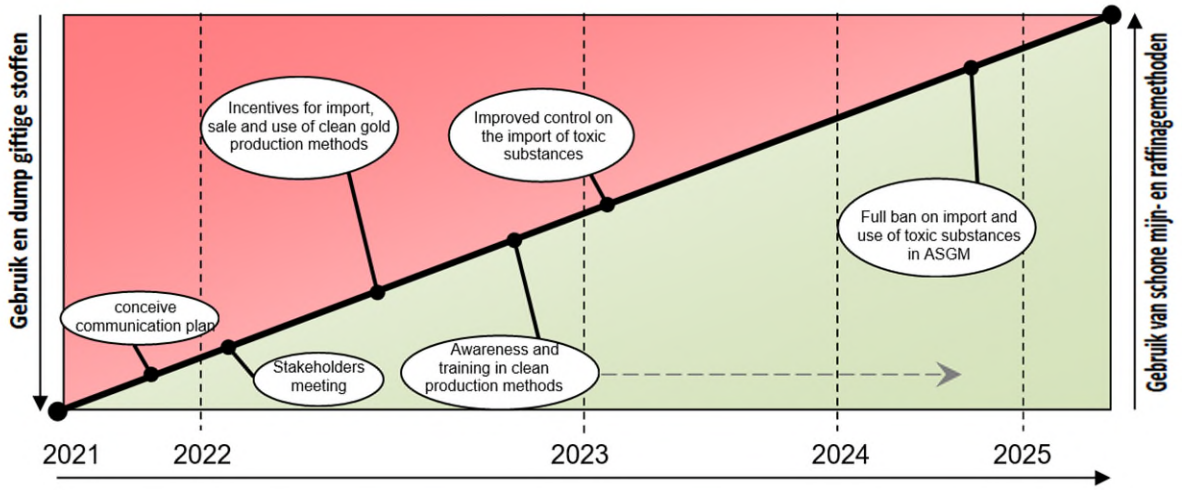

Figure 18: Sequencing of action to ban toxic substances in ASGM

Policy

It is the Government's intent to improve the regulation of the ASGM sector. Under the Minamata Convention, Suriname is working on the NAP-S to reduce the use of mercury, which is expected to be finalized in the near future. At the same time, it is of the opinion that people in the sector should not be criminalized since they seek a way out of poverty. It wants to attract help from multilateral institutes and other parties to disseminate awareness and information and stimulate they adoption of new methods and techniques. Simultaneously, the Government wants to keep the country as a High Forest cover Low Deforestation (HFLD) country, and assign specific locations for ASGM to prevent tensions between ASGM and large gold producing companies; administration and transparency is crucial in this regard, which in turn are also instrumental to increase government revenue from the ASGM sector (Stichting Planbureau Suriname, 2021).

Meanwhile, Value Added Tax was introduced in January 2023 by the government, to increase revenues emanating from the sector to lower the tax burden on tax payers and increase taxes from the ASGM sector. Also, attempts are made to combat fuel smuggling to the sector by obligating the sector to obtain their fuel from specifically registered and monitored location (while simultaneously also eliminating fuel subsidies). Also, within the environmental framework, environmental crimes are addressed by destroying large-scale floating gold production units, the so-called skalians, rendering these practices unproductive. These deposit tailings and mercury into fresh water and thereby pollute freshwater bodies. This causes a threat for those communities living in the vicinity whom depend on the fresh water ecosystems for water consumption and catching fish.

Legislation

Though ASGM is not explicitly mentioned in Suriname's constitution, it is considered as an integral part of the mining sector. As such, there are some provisions that relate to the financial and socioeconomic benefits of mining and protect worker safety, community health, the public, and ecosystems. The following provides an overview of all relevant legislative products that are relevant for the (apprehension of the) ASGM sector:

- **Constitution (Grondwet)**: Though Suriname's Constitution does not contain any specific language pertaining to the mining sector, it has many provisions that relate to mining and its governance. The Constitution proclaims that natural riches and resources are the property of the nation, and the state has the right to take possession of these natural resources to use them for the benefit of Suriname's economic, social

and cultural development. The state must also create and improve the necessary conditions to protect nature and preserve the ecological balance.

- **Plan Act (Planwet)**: This act stipulates that the Government should stimulate development for all its people throughout the country while taking into account the sustainability of ecosystems and the well-being of people.
- **Environmental Framework Act**: The Environmental Framework contains provisions for the protection and conservation of the environment and contains the basic international environmental principles, including the principle of transparency, participation and legal protection, the precautionary principle, the principle of the polluter pays, and the principle of the environmental impact assessment. The National Institute for Environment and Development in Suriname (Nationaal Instituut voor Milieu en Ontwikkeling Suriname, NIMOS) administers within this framework the Environmental Assessment Guidelines Volume II – Mining, viz. guidelines for conducting environmental assessments in the mining sector. These guidelines are followed throughout the assessment process, and are encouragingly stringent throughout the process.
- **Mining decree (Mijn decreet)**: The decree states general rules for the exploration and exploitation of minerals. The Mining Decree reiterates that the minerals in and on the ground in Suriname are to be considered property of the state and are separated from ownership of the land. The Decree states that mining should be carried out according to modern international techniques and methods and should be aligned with the norms tacitly assumed in the mining industry. Worker health and safety (and public health more generally) must be respected and protected by those operating in the industry, and they must follow norms for the protection of ecological systems.
- **United Nations Rio Conventions**: Suriname has signed onto all three Rio Conventions, those being the Convention on Biological Diversity, the Convention on Climate Change, and the Convention to Combat Desertification.
- **Minamata Convention**: Since 2018 Suriname formally entered the Convention which aims to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.
- **Extractive Industries Transparency Initiative (EITI)**: Suriname joined EITI in 2017 which is a global standard for the good governance of oil, gas and mineral resources. It seeks to address the key governance issues in the extractive sectors.

Five types of mining permits can be obtained from the Ministry of Natural Resources: reconnaissance, exploration, exploitation, small-scale mining, and quarrying building materials. Permits can be obtained for bauxite, radioactive minerals, hydrocarbons, other minerals, and building materials. Rights are only granted to those entities that have a proven financial position, technical and organizational competence, and experience with regard to the mineral in question. Upon termination of the right, the holder must, to the satisfaction of the Minister, take the necessary steps to respect public safety, conserve the deposit, rehabilitate the area and protect the environment. These rights may not be sublet to third parties.

A new Mining Act is in the works and aims to address a few key weaknesses in the current Mining Decree. Key changes are expected to include: integration of environmental and social impact assessments (ESIAs), Indigenous and Tribal People rights into the new Act, increases in financial penalties for non-compliance and infractions, and increased transparency requirements to help meet the country's future Extractive Industries Transparency Initiative (EITI) obligations. The decree is being revised through a participative process using best practices from abroad.

In addition to the new mining act, the Government is also on the verge of adopting separate legislative acts on the Protection of Ground Water, the Water Authority, Supervision on Water Quality, and Ground Water Protected Areas.

Regulation

The following regulation is in place to provide further depth and supportive measures to legislation:

- The Decision Negative List (Besluit Negatieve Lijst)– part of the law on the transportation of goods (Wet Goederenverkeer) – mandates the requirement of an import permit from the Ministry of Economic Affair, Entrepreneurship and Technological Innovation (formerly Trade and Industry) for mercury.
- The Foreign Exchange Commission subsides under the President and grants licenses to private sector companies to buy and sell gold.
- The Ministry of Natural Resources has initiated the Improving Environmental Management in the Mining Sector of Suriname (EMSAGS) project. This project seeks to improve the environmental management of mining in Suriname, particularly small-scale gold mining, which is the largest driver of deforestation in the country and contributes to biodiversity loss (through habitat degradation and pollution), climate change (through deforestation) and unsustainable land, water, and forest management. It addresses policy and institutional constraints to improved management of ASGM as a sector as well as to create an enabling environment for the dissemination of environmentally responsible mining practices. The project has the following outcomes:
    - Improve institutional capacity, inter-institutional coordination and increase available funding for improved management of ASGM. In this regard, training will be developed and delivered on assessing the effects of current gold mining practices, identifying, and implementing best environmentally responsible gold mining practices, overseeing and managing ASM, and ASM-related law enforcement. There are mainly two groups of stakeholders who need training: stakeholders in Paramaribo (government offices, the University, NGOs etc.) and the miners;
    - Strengthen the policy and planning framework for the management of the environmental impacts of ASGM;
    - Increase the uptake of environmentally responsible artisanal small-scale gold mining practices through demonstration projects. This will demonstrate the environmental and economic benefits of environmentally responsible mining practices and technologies. The model proposed is one that relies on the identification of benefits for miners that arise from the application of these practices and technologies, including social and economic benefits, as well as the design of a system of national level financial, fiscal and regulatory incentives to help re-orient the market towards more responsibly sourced gold.
    - Set up Mining Training and Extension Centers (MTECs). MTECs proposed in this regard are seen as an innovative approach to circumvent past challenges in transferring technology to small scale miners. The MTECs will house a mining technology demonstration facility, which will include equipment and methods to support the deployment of environmentally responsible mining practices. Training will be provided to miners using a flexible modality. The MTECs are intended as places from which miners can access training, knowledge, technology, and material, as well as technical or legal support. Combined with a preferential access to selected socio-economic services (e.g., education, telecommunication, market information, health services), the MTECs are expected to become poles where miners can congregate and for which they will develop a sense of ownership. The

project will ensure to enable the environment of reliable sources of finances at the local level, among public and private stakeholders. By suggesting financial mechanisms, it will set a greater potential of success and long-term sustainability of the project. For practical purposes, the MTECs will be located in a "central location" within a mining zone. The overall vision of the MTECs is one of extension and service rather than one of enforcement;

- Implement an upscaling strategy that will include knowledge sharing at local and national level, as well as with neighboring countries;
- The knowledge sharing will also benefit the design of policies and implementation of demonstration sites.

All four components of the major regulations listed above are implemented by national implementation partners in close coordination with other government stakeholders, civil society as well as with miners themselves.

Institutional Framework

There are a number of institutes involved in the ASGM sector. These are (but are not exclusive to):

- The Geology and Mining Department (GMD) is tasked with controlling that activities are not contracted to third parties and that holders of mining rights submit quarterly reports.
- The OGS (Ordening Goudsector Suriname) is a body that resides under the Ministry of Natural Resources. It is charged with overseeing the small-scale gold mining sector and managing tensions among small-scale miners and between large and small-scale miners. OGS is directly responsible for structuring the activities of small-scale gold miners and maintaining peace and security in this sector.
- Responsibility for control on compliance with laws on inputs for the ASGM sector and gold trade lies with the Suriname Police Corps (KPS), the Coast Guard Authority Suriname, and the Suriname Customs.
- District commissioners supervise a department on Environment and Health (milieu- en gezondheidsdienst) that is tasked to keep this within boundaries stipulated by law. In this task the commissioner can be aided by the Bureau of Public Health (Bureau Openbare Gezondheidszorg, BOG)

The figure below provides an overview of the governmental entities directly and indirectly involved in ASGM as mentioned above and in previous sections. It should be noted that currently efforts are underway to transform NIMOS into an Environmental Authority that can impose fines and penalties when faced with environmental non-compliance. Also, OGS will merge with GMD and the Bauxite Institute Suriname into the Minerals Institute.

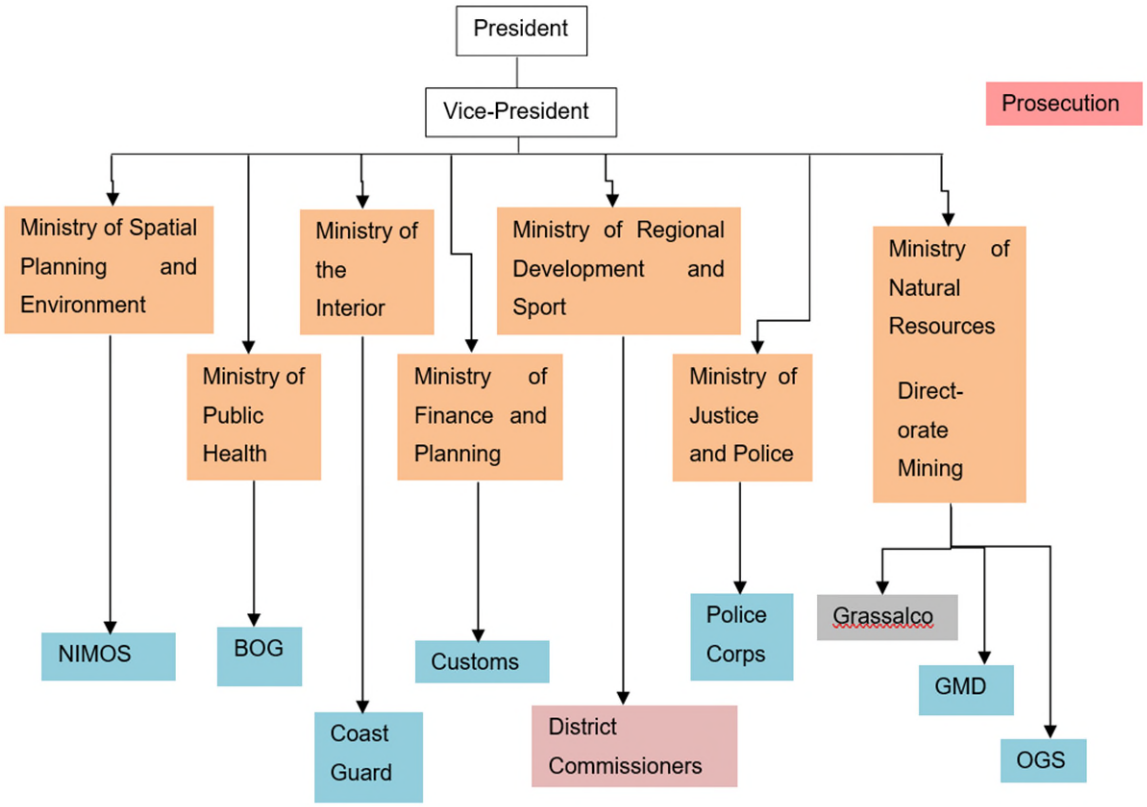

Figure 19: An overview of Governmental entities involved (entities in blue are relatively independent operating within the confines of their respective ministries, entities in grey are state-owned companies, and entities in light purple consists of government employees that act relatively independent of each other, the items in pink are operating independently from the Government)

Annex E Parameters and sources for scenario analysis

Equipment costs and characteristics for operational analysis

Type of equipment	Price	%addition for transport and installation	Total price	Motor power (kw)	Power used percentage	Fuel use (l diesel) annual assuming 12 hours of activity per day 5 days a week	Barrels of diesel	Annual cost of diesel USD(0.982 USD/L, 15 may 2023,	Sources
3-cilinder pump	500	0.5	750	30		28532.57143	179.4614217	28018.98514	https://www.alibaba.com/product-detail/3-inch-High-Pressure-Diesel-Water_1600340151798.html
6-cilinder pump	5000	0.5	7500	110	0.7	73233.6	460.6176489	71915.3952	https://lambertengine.en.made-in-china.com/product/YvzQbFhZLoRq/China-6-Cylinder-Water-Cooled-Diesel-Engine-Motor-Used-for-Generator-or-Water-Pump.html (price), https://www.alibaba.com/product-detail/IS-series-6-cylinder-diesel-water_1600212835805.html (power)
sluice box	30000	0.5	45000	-	-	-	-		National Action Plan Minamata (price)
Excavator	50000	0.5	75000	51.8	-	49266.24	309.8700547	48379.44768	CAT 310
Centrifuge	35000	0.5	52500	3.7	-	3519.017143	22.13357534	3455.674834	https://minerals.seprosystems.com/equipment/falcon-sb-gravity-concentrators/
Shaker table (GMS RP4 Shaker Table)	2500	0.5	3750	0.372849936	-	354.6122477	2.230405986	348.2292272	https://www.911metallurgist.com/equipment/rp4-shaker-table/
Hammer Mill	40000	0.5	60000	110	-	104619.4286	658.0252127	102736.2789	National Action Plan Minamata (price), https://www.alibaba.com/p

									roduct-detail/High-Performance-Small-Gold-Ore-Stone_1600616744914.html (Power, assuming highest capacity crusher listed)
Retort	500	0.1	550	-	-	-	-	-	National Action Plan Minamata (price), https://www.alibaba.com/product-detail/High-Performance-Small-Gold-Ore-Stone_1600616744914.html (Power, assuming highest capacity crusher listed)

Operational analysis parameters

Parameter	Value	Source
Transition BAU to SEM, recovery rate increase	0.1	Page 39, "Reducing the Use and Release of Mercury by Artisanal and Small-Scale Gold Miners in Suriname".
Hg/AU ratio (BAU - e.g. WOA)	5	National Action Plan Minamata
Hg/AU ratio (SEM) - e.g. WOA)	0.55	National Action Plan Minamata
Gold price 2020 (USD/kg)	52437.22	World Bank
Percentage of gold going to mine operator	0.7	Stakeholder consultations
Percentage of gold price going to mine operator	0.91	Stakeholder consultations
Mercury cost USD/kg	110	https://dialogochino.net/en/extractive-industries/37382-mercury-the-gold-rush-threatening-the-worlds-greenest-country-suriname/#:~:text=The%20Chinese%2DSurinamese%20trader%20claims,and%20sell%20it%20for%20%243%2C200.
Diesel use per kWh (l/kWh)	0.304	Average diesel use per kWh by generators of 0.304 liter of diesel. Based on " Paul, U., Hasan, M. M., Labib, L., & Roy, N. K. (2017, December). Optimal design of hybrid microgrids for readymade garments industry of Bangladesh: A case study. In 2017 3rd International Conference on Electrical Information and Communication Technology (EICT) (pp. 1-6). IEEE."
Minimum operating g/barrel	15	Page 39, "Reducing the Use and Release of Mercury by Artisanal and Small-Scale Gold Miners in Suriname". Utilizing the highest price if multiple options for the same type of equipment are available.
Diesel cost (USD/l)	0.982	https://nl.globalpetrolprices.com/Suriname/diesel_prices/#:~:text=Suriname%20%2D%20dieselprijzen%3A%20De%20weergegeven%20prijzen,op%2001%2Dmei%2D2023
Liter diesel per barrel	158.99	