Social Solutions

Socio-economic, health and environmental impacts of mining in Suriname, with a focus on Artisanal and Small-scale gold Mining

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Abbreviations

ABS	General Bureau of Statistics (*Algemeen Bureau voor de Statistiek*)
ADEK	Anton de Kom (University of Suriname)
AIDS	Acquired Immune Deficiency Syndrome
ALCOA	Aluminum Company of America
a.o.	among others
ASM	Artisanal and Small-scale gold Mining
ATM	Labour, Technological development and Environment (*Arbeid, Technologische ontwikkeling en Milieu*), Ministry of
ATV	All Terrain Vehicle
Au	Gold (chemical symbol)
BIS	Bauxite Institute Suriname
BOG	Bureau Public Health care (*Bureau Openbare Gezondheidszorg*)
cabaret	Brothel in the ASM areas
CAN	Canadian
CARICOM	Caribbean Community and Common Market
CBvS	Central Bank of Suriname (*Centrale Bank van Suriname*)
CI	Conservation International
CO2	Carbon dioxide (chemical symbol)
COGASUR	Gold Miners' Cooperative Suriname (*Cooperativo de Garimpeiros Suriname*)
curetela	gold miners' community
CSW	Commercial Sex Worker
DC	Districts Commissionar (*Districtscommissaris*)
DNA	The National Assembly
DoS	Department of State
€	Euro
ECD	Economic Control Service (*Economische Controle Dienst*)
e.g.	for example
EPA	Environmental Protection Agency (USA)
ESIA	Environmental and Social Impact Assessment
et al.	and others
FPIC	Free, Prior and Informed Consent
FSP	Full Sized Project
g	gram
garimpeiro	Gold miner (Brazilian Portuguese)
GDP	Gross Domestic Product
GEF	Global Environment Facility
GMD	Geology and Mining Department (*Geologisch Mijnbouwkundige Dienst*)
GNI	Gross National Income
GoS	Government of Suriname
Grassalco	N.V. Grasshopper Aluminum Company
ha.	hectare
HFLD	High Forest cover Low Deforestation

HIV	Human Immunodeficiency Virus
HIV+	HIV-Positive
HSE	Health, Safety and Environment
HSEL	Health, Safety, Environment and Land
hg	mercury (chemical element)
Ibid.	ibidem; as in the previous
ICZM	Integrated Coastal Zone Managment
i.e.	"that is to say"
ILO	International Labor Organization
IOM	International Organization for Migration
JAP	Johan Adolf Pengel (international airport)
Kg	Kilograms
Km^2	Square Kilometer
KPS	Suriname Police Corps (*Korps Politie Suriname*)
LBMA	London Bullion Market Association
LSM	Large-Scale Mining
Mln	Million
MMO	Marine Mammal Observer
MoU	Memory of Understanding
MZ	Medical Mission Primary Health Care Suriname (*Medische Zending*)
NATIN	Technical college (*Natuurtechnisch Instituut*)
NGO	Non Governmental Organisation
NH	Natural Resources, Ministry of
NIMOS	National Institute for Environment and Development in Suriname *(Nationaal Instituut voor Milieu en Ontwikkeling in Suriname*)
NH	Natural resources (Natuurlijke Hulpbronnen), Ministry of
NV	Public Company (*Naamloos Vennootschap*)
OGS	Regulation of the Gold Sector (*Ordening Goudsector*)
PAHO	Pan American Health Organization
pers. com	personal communication
POC	Paramaka Negotiation Committee (*Paamaka Onderhandelingscommissie*)
RBT	Regional Support Team (*Regionaal Bijstands Team*)
RDA	Residue Disposal Area
REDD+	Reducing Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.
SBB	Foundation for Forest Management and Control (*Stichting Bosbeheer en Bostoezicht*)
RGM	Rosebel Gold Mines N.V.
SEMIF	Suriname Environmental and Mining Foundation
SHMR	Foundation Mining Title Holders (*Stichting Houders Mijnbouw Rechten*)
SGMT	School of Geology and Mining Technology
SMART indicators	Specific, Measurable, Achievable, Realistic, Time-bound indicators
SMMP	School of Mining and Mineral Processing

SORTS	Foundation for Development of Radio and TV in Suriname (*Stichting voor Ontwikkeling Radio & TV in Suriname*)
SPL	Spent Pot Lining
SRD	Suriname Dollar (*Surinaamse Dollar*)
STAR allocation	System for Transparent Allocation of Resources
SUR	Suriname
SURALCO	Suriname Aluminum Company
SWM	Suriname Water Company (*Surinaamse Waterleiding Maatschappij*)
TIP	Trafficking in Persons
µg	Microgram; one millionth of a gram (10^{-6}g)
UMC	University Medical Center
UN	United Nations
UNASAT	University of Applied Sciences and Technology
UNDP	United Nations Development Program
UNEP	UN Environment Program
US	United States
US$	Unites States dollar
USGS	U.S. Geological Survey
WHO	World Health Organization
WWF	World Wide Fund for Nature
yr	year

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Acknowledgements

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- Mr. Paansa, Chief exploration and geology, Geology and Mines Department (GMD)
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    - Ms. V. Sabajo, Geologist
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    - Mr. A. Ramkhelawan, Mining Engineer
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- Ms. D. Stijnberg, Monitoring and Evaluation Manager Ministry of Health
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- Mr. R. Finkie, Instructor Mining, Minerals department. ADEK University
- Mr. P. Scheepers, Associate Professor Toxicology, Radboud University Nijmegen

From the large-scale mining sector:

- Ms. A. Lalta, Environmental specialist, N.V. Grassalco
- Mr. A. Nandlal, Suralco Health, Safety, Environment and Land specialist
- Mr. R. Halfuid, Director Suralco
- Ms. M. Riedewald, Community Relations Officer Staatsolie
- Ms. D. van Dijk, Institutional Relations Manager, Newmont Suriname

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- Ms. K. Schafer, director Artminers

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- Mr. “Para”, Equipment owner at Antino
- Ms. Bellarmina and spouse, Equipment owners at Antino
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- Mr. J. Plein, Equipment owner and board member of Makamboa gold miners’ association at Nieuw Koffiekamp

- Mr. M. Asalobie, Equipment owner and traditional rights holder at the Merian area
- Mr. Delano, Mine coordinator/manager at Yellow Star Mining Company, Dehoy (Benzdorp general area)
- Various Nana Resources staff
- Gold miners and mining service provider incl. ATV drivers, show owners etc. at Benzdorp, Antino, Antonio do Brinco, Peruano
- Ms. Iolete, Bar/restaurant owner, Paramaribo North

Finally, we appreciate the thorough review and constructive comments provided by the UNDP project unit and environmental specialist Noordam, who helped fine-tune the environmental section of this report.

Summary

Country map and key statistics

Figure 1. Map of Suriname with its districts

Table 1. Fact sheet Suriname

Variable	Value
General	
Total Population, 2015 (Mid-year population)	567,291 (ABS 2017)
Land area	163,820 km^2 (ABS 2017)
Economic	
GDP market prices, 2015 (market prices, in SRD Mln)	16,667.3 (USD 4845.7 Mln)(ABS 2017)
Real GDP growth, 2015	-2.7% (ABS 2017)
Per capita national income, 2015	SRD 29,215 (USD 8492.7)(ABS 2017)
% of population in severe poverty	2% (UNDP 2013)
Hourly minimum wage, per January 1st, 2017	SRD 6.15/hr (USD 1.79) (Government of Suriname, undated website[1])
Unemployment rate, total 15+ (2017 Male, 15+ Female, 15+	9.9% (ILO modeled estimate) 6.8% (ILO modeled estimate) 15.1% (ILO modeled estimate)
Mining (bauxite, oil and large-scale gold sectors)	
National Oil Company	Staatsolie Maatschappij Suriname N.V.
State mining company (gold and construction materials)	Grassalco N.V.
Multinational mining companies active in Suriname	IAMGOLD (CAN) Newmont Mining Cooperation (US)
Total government revenue (SRD Mln) Mining Non Mining	 303 SRD Mln 3,096 SRD Mln (CBvS 2016[2]; 2015 data)
Government mining revenue in % of GDP	6,2%
Mining sector government revenue, 2015 Gold Oil Bauxite	 58% 33% 9% (CBvS 2016, 2015 data)
Mining sector employment, as % of total employed (only formal sector)	3.4% (CBvS 2016; 2014 data)
Mining sector employees, 2013 Gold Oil Bauxite	 1577 910 729 (CBvS 2014)
Exports (US$ Mln) Total, 2015 Gold Oil Alumina	1,652 Mln 917 Mln 156 Mln 233 Mln (CBvS 2016, 2015 data)
Small-scale gold mining (SSGM)	
Estimated number of ASM miners, incl. service sector in the interior	11-15 thousand (Heemskerk et al., 2016)
Amount of gold produced by ASM in 2015	18.9 tonnes (CBvS, 2016)
ASM gold production as a percentage of total gold production, 2014	65.4% (CBvS, 2016)
Royalty on gold produced by ASM	2.75%

[1] URL: http://www.gov.sr/themas/werk-en-loopbaan/minimumloon.aspx

[2] Central Bank of Suriname (2016). Suriname Country Profile.
https://www.cbvs.sr/images/content/statistieken/CP/Suriname_Country_Profile_19jul2016.pdf

1 Introduction

1.1 Project background

Suriname is situated on the Northern tip of South America. With 15.2 million ha of forest cover (93% of its total area) and an annual deforestation rate of 0.07%[3], Suriname is one of the most forested countries in the world and considered a 'High Forest Cover- Low Deforestation Rate' (HFLD) country (Unique, 2017). Mining is a vital sector of Suriname's economy (Table 1). Of the various forms of mining (bauxite, oil, building materials), gold is most important in terms of economic revenues generated and environmental impacts (Tables 1 and 2).

The majority of mining is taking place in Suriname's Greenstone Belt, which covers 24,000 km^2 of Central-East Suriname. Spatial analysis indicates that within the greenstone belt, actual mining activities are concentrated around the Brokopondo Lake and in the East of Suriname, bordering French Guiana (Unique, 2017) (Figure 2). Of particular concern is artisanal and small scale gold mining (ASM), which, due to its largely unregulated and uncontrolled nature, is causing significant negative environmental impacts on forests, freshwater, fish and other groups of species (Table 2).

Table 2. Sample of reported environmental impacts of mining, with a focus on ASGM, in Suriname

Environmental impact	Value
Deforestation caused by mining, 2000-2015	Total: 62098.46 ha Gold: 59,553.86 ha Building materials: 762.14 ha Bauxite: 727.55 ha Other/unknown type mining: 1058.53 ha (SBB, 2016 data)
% of annual deforestation caused by gold mining, 2015	73% (SBB, 2016 data)
Estimated annual loss of mercury into the natural environment by ASM miners	63.0 T Hg/yr (Heemskerk, Negulic and Duijves, 2016)
Estimated length of rivers and streams polluted by ASM	8,597 km (Rahm et al., 2015)
Estimated GHG emissions as a result of gold mining	55.05 million tCO2, total 2000-2015 (Unique, 2017)

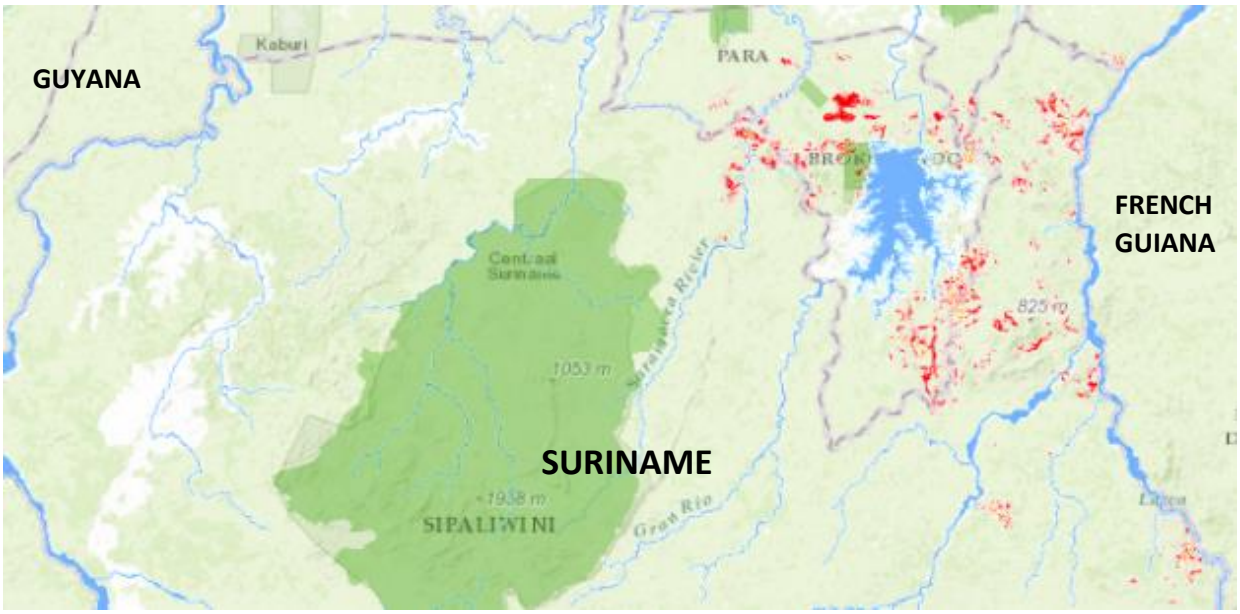
The government of Suriname through the Office of the President has requested the United Nations Development Programme (UNDP), which is a GEF Implementing Agency, to provide support in:

[3] In the period 2009-2015. This is an increase from the period 2000-2009, when the annual deforestation rate was 0.02% (Unique, 2017).

The design, preparation and elaboration of the Full-Sized project (FSP) entitled "Improving Environmental Management in the Mining Sector of Suriname, with Emphasis on Gold Mining" from the Suriname STAR allocation under GEF-6 funding to support this Multi focal area solution.

The present socioeconomic and environmental impacts analysis was performed to provide solid background information as a point of departure for the design of pilot projects aimed at improving the environmental management of ASM in Suriname.

Figure 2. Central Suriname with mining concentrations (in red) around the hydropower lake and in the East.



Source: Amazon Conservation Team 2016 (2014 data)

1.2 Objectives

The main objectives of this report are:

- Documentation of the environmental impacts of mining in Suriname, with an emphasis on gold mining by small-scale miners.
- Provide baseline information on both the positive and negative socio-economic impacts of mining in Suriname, in particular small-scale gold mining;
- Identification of the socio-economic barriers to reducing the environmental impacts of gold mining;
- Support identification of appropriate project interventions to address socio-economic issues and to promote sustainable livelihoods.

The present report is not a stand-alone document, but part of a more extensive FSP document which also contains a gender analysis, a technical component, proposals for project interventions, "SMART" indicators and a Tracking Tool.

1.3 Methods

Data were collected in March and April 2017, on the basis of literature review, stakeholder interviews, and a field visit. Consulted literature include consultancy reports, media reporting on the mining sector (newspapers, magazines), government documents, and academic papers. Stakeholder interviews were conducted in person, by phone/Skype and e-mail. Consulted stakeholders are listed in Annex 1.

From 18-20 March, the consultant –together with one UNDP representative and a field assistant- visited the Benzdorp general area. The main objectives of this visit were to obtain information about (a) Hg-free and reduced mercury ASM methods previously and currently used in this area, (b) ASM environmental and social management tools used by Nana Resources, and (c) trafficking in persons and other forms of criminal activity often associated with ASM. The research team stayed at the mining camp of Nana Resources at Antino, and traveled by All Terrain Vehicle (ATV) and boat to other locations. During the field visit, both formal interviews and informal conversations were conducted with:

- Staff of Nana resources
- ASM equipment owners and gold miners, male and female
- ASM service providers; e.g. ATV drivers, shop owners (M/F), owners of *cabarets* (brothels),
- Commercial Sex Workers (CSW); 7 Brazilians and 7 Dominicans, in 4 different cabarets.

Even though this report focuses on ASM, the report also briefly assesses the environmental impacts of other forms of mining, including the mining of gold (large-scale), bauxite, oil, and construction materials.

1.4 Report outline

After this introduction, the report proceeds as follows.

Chapter 2 briefly documents the main environmental and social impacts of Large-Scale Mining (LSM), considering mining of oil, bauxite, gold and construction materials.

Chapter 3 describes the social context in which ASM takes place. It starts with a listing of the main stakeholders, and next presents information about the demographic and social structure of the ASM population, national revenues and miners' incomes, community development, crime, and migration and trafficking.

Chapter 4 focuses on environmental impacts of ASM. It presents data on deforestation and landscape alteration, climate change, sedimentation of water bodies, mercury use, and impacts on wildlife. The chapter concludes with a discussion of past projects aimed at reducing the environmental impacts of mercury and the lessons learned from these projects.

Health impacts are assessed in **Chapter 5**, which describes the main chemical, biological, biomechanical, physical and other hazards associated with ASM.

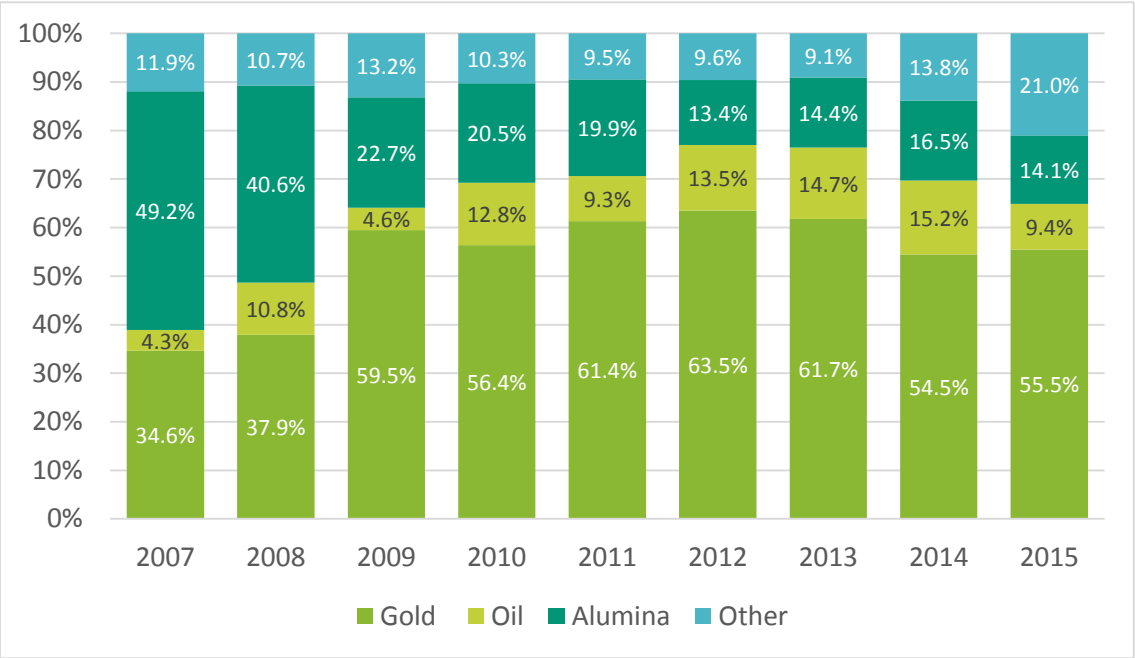
The study concludes with a gap analysis in **Chapter 6**. It identifies the socioeconomic, environmental and health topics for which little or no information is available, and where additional research is warranted.

2. Large-scale mining impacts

2.1 Summary of Large Scale Mining impacts

Mining has been the pillar of Suriname's economy for over a century. Corporate income taxes, royalties and dividends applied to gold and oil continue to be a major source of government revenues (World Bank, 2015). In the past decade, mining products have contributed 80 to 90% to the value of national exports (Figure 3). Since 2009, gold has become the economically most important export product, surpassing bauxite/alumina[4]. Due to this enormous economic dependence on mineral extraction, Suriname is highly vulnerability to changes in volatile commodity prices (ibid.).

Figure 3. Composition of exports (in USD million) as % of total export value



Source: Central Bank of Suriname, 2016

In terms of social impacts of the large-scale mining sector, a consistent theme across all types of mining has been insufficient acknowledgement of the customary rights of Indigenous and Maroon peoples, as required by international guidelines. Customary land claims are frequently disregarded and Free Prior and Informed Consent (FPIC) procedures are rarely - if ever- applied in Environmental and Social Impact Assessment (ESIA) studies and in exploration and exploitation planning and execution. In this context it is encouraging that one of the large-scale mining firms in its ESIA planning for a new mine explicitly requests consultants to work according to FPIC guidelines in their contact with possibly affected communities.

Table 2 summarizes large-scale mining impacts in Suriname, considering oil, gold, bauxite and sand mining. The impacts listed in the table are described in greater detail below.

[4] Bauxite production has stopped since November 2015

Table 2. Large-Scale Mining impacts in Suriname

Form of mining	Environmental impacts	Socio-economic and health impacts
Oil – land based exploration and production	▪ Loss of swamp habitat through polder development ▪ Removal of vegetation ▪ Oil spills from wells, pipelines and oil tankers with minor to moderate pollution of land, swamps, rivers and canals ▪ Minor impacts on: - noise, vibration and air pollution - hydrology, water flow, swamp level, water quality - increased risk of peat fires on fauna and vegetation	▪ Benign; most sparsely populated or uninhabited areas. ▪ Minor nuisance of dust and smell ▪ Unmet expectations for community development projects ▪ National revenues (e.g. corporate income taxes, royalties and dividends) ▪ Employment, direct and contractors
Oil – near shore and offshore exploration	▪ Disturbance of fish and marine mammals due to seismic surveys.	▪ Risk of damage to fishing nets – none recorded to date ▪ Temporary restrictions on fishing activities in exploration areas
Gold – Rosebel Gold Mines (RGM) and Newmont Suriname	▪ Deforestation ▪ Formation of tailing ponds with chemicals (i.e. cyanide) ▪ Fuel and chemical spills ▪ Noise disturbance from blasting, excavation and transportation	*Negative* ▪ Forced displacement of ASM, including local tribal gold miners ▪ Income loss for local ASM community and service economy ▪ Conflicts about customary land rights and claims. ▪ IamGold; damage to local infrastructure due to blasting *Positive* ▪ Establishment of Community Fund (Newmont) and a national fund to promote sustainable development of the mining sector – SEMIF (RGM) ▪ Social responsibility programs/ community projects ▪ National revenues (e.g. corporate income taxes, royalties and dividends) ▪ Employment, direct and contractors

Bauxite	Remaining impacts after closure: ▪ Deforested areas ▪ Red mud lakes polluted with caustic soda and other metal and minerals. ▪ Landfills with batteries, Spent Pot Lining (SPL) and other industrial waste. ▪ Abandoned pits full of water, with high pH and possibly heavy metals ▪ Presence of settling ponds with chemical compounds. ▪ Risk of impact on aquifers that serve to collect drinking water.	▪ Previously; employment and government revenue but since closure of Suralco (2015) few positive social impacts. ▪ Some short-term jobs related to rehabilitation activities. ▪ Pending the outcomes of negotiations with Onoribo, possibility of some community development projects.
Construction materials (sand, stone, gravel, crushed stone)	▪ Removal vegetation/deforestation ▪ Creation of small lakes (sand and shell mining in the Young Coastal Plain) and crater landscapes (sand mining in the Old Coastal Plain and Zanderij Belt) ▪ Noise and dust from project traffic along access roads ▪ locally: blasting at quarries near residential neighborhoods ▪ Damage to archeological sites ▪ Some soil pollution from fuel leakage Sand mining on beaches: ▪ disturbance of sea turtle nesting zones ▪ loss of coastal protection; damage to estuary Gravel production ▪ Dust generation (gravel processing) ▪ Noise pollution	*Positive* ▪ Employment ▪ Local incomes and national revenues ▪ In some cases (e.g. Grassalco) community projects *Negative* ▪ Disturbance archaeological sites

2.2 Oil[5]

The first oil exploration started in the 1960s with exploration drilling in the offshore area. Since then a large number of seismic surveys have been conducted in the offshore, the nearshore and the onshore coastal area of Suriname. Exploration drilling is, however, mostly limited to the onshore area, with the focus on the wider Tambaredjo area in the Saramacca District. In the offshore and nearshore areas only a limited number of exploration wells has been drilled, but activities are increasing in recent years. The national oil company, Staatsolie Maatschappij Suriname (Staatsolie), has traditionally led the sector, playing the role of regulator and operator (World Bank, 2016).

Seismic surveys and exploration drilling in the offshore and nearshore area are usually undertaken by international companies under a production-sharing contract with Staatsolie. The recent World Bank Suriname Extractive Policy Note (2016) named off-shore oil mining as the “most promising prospect” for the Suriname government, with a “very strong growth potential”.

Presently oil is commercially produced only from the Tambaredjo and Calcutta oilfields in the Saramacca District producing approximately 16,000 barrels of oil per day. Oil production occurs primarily in uninhabited swamp areas and to a limited extent on farmer’s lands. In the past a swamp area of over 60 sq km has been turned into a so-called "oil polder" in order to facilitate dryland operations. Since about 2000 also wetland operations are undertaken in the swamp areas. Most of the latter operations occur in open (grass and herbs) freshwater swamps and part also in swampwood and swamp forests. In recent years also some operations are found near or even inside the southern mangrove belt, be it that operations are still at considerable distance from the Atlantic Ocean (over 2 km).

Since 1994, Staatsolie has comissioned Environmental and Social Impact Assessments (ESIA) for all its projects, including the activities regarding the refinery, pipeline construction, exploration drilling and seismic surveys and production development. Environmental Management Plans (EMP) set out the management and monitoring measures required to minimize the environmental impacts of construction and operations of the various activities. These plans ensure that responsibilities and appropriate resources are efficiently allocated to the project. With proper implementation of the Staatsolie procedures and regulations, and implementation of the preventive and mitigation measures in the EMP, no significant negative impacts should occur for the physical, biological and social environment. Positive impacts include employment and investments in the local economy.

In terms of environmental impacts, oil exploration/exploitation requires vegetation clearing in swamps of the Young Coastal Plain. Clearing will continue to take place for the next decades, as new drill sites, including access routes and pipeline corridors, are established for exploration and production wells. Also more mangrove forests will be cleared, but this will be done with permission of the Suriname Forest Service (Lands Bos Beheer-LBB)[6]. It should be noted that the Staatsolie activities take place within the so-called "blocked" mangrove zone, in which gradual die-off of mangrove naturally takes place, because tidal influence in this zone is no longer effective and the environment is gradually renewing itself.

[5] This section only covers exploration and mining, not the refinery

[6] Pers. Com, Ms. M. Riedewald, community relations officer Staatsolie. 23-02-17

Another impact of Staatsolie's' activities in Saramacca is that on the swamp hydrology. In 2010, several newspaper articles reported flooding of agricultural land along the Gangaram Pandayweg; the farmers blamed Staatsolie activities as the cause of the elevated swamp levels. In a presentation for LBB and NB on July 23, 2013, Noordam (2013) addressed this issue and came to the conclusion that, apart from natural causes (heavy and prolonged rainfall, and reduced drainage to the ocean), activities of both Staatsolie and the farmers could have affected the swamp water level. Staatsolie has sponsored a study to solve the problem and recommendations have been presented to the District Commissioner.

Noise and air quality impacts are few due to the uninhabited character of most of the concession area.

The use of airboats and a Hoover drill rig lead to noise impacts to wildlife, with in particular impacts to breeding colonies of birds in the mangrove zone. Localized and incidental noise impacts could occur during drilling in agricultural areas.

Air quality issues are of minor significance, with dust from passing traffic (among which Staatsolie traffic) being the most common problem mentioned by people along the Gangaram Pandayweg. Frequent watering of the road did not yet fully address the problem. A problem with incidental gas releases from storage tanks near a temple at Huwelijkszorg was solved to the satisfaction of the local stakeholders.

Oil spills and leakages occasionally result in (usually localized) pollution of soil, water and/or vegetation, depending upon the location where it occurred. Staatsolie's National Oil Spill Contingency Plan (if necessary implemented in collaboration with international oil companies) describes the procedures that are followed in the case of oil spills. In the case of damage to the property of third parties, compensation is paid. Spills are cleaned, investigated and monitored. The reports are kept in an Incident Management Database.

In recent years, Staatsolie has introduced more environmentally conscious policies, as is evident in Staatsolie's Health, Safety and Environment (HSE) Policy and the Environmental and Social Management Plans for the various drilling sites. In the case of certain potential environmental impacts, the Environmental section provides proposals for alternative development strategies and compensation, as evident in the drilling program 2015-2020.

In 2015, in order to monitor the impact of its operations on wildlife, Staatsolie commenced a wildlife monitoring program (including macro invertebrates, birds and mammals) in the Tambaredjo North West oil field, which continued during 2016. The bird monitoring is done in close collaboration with Suriname's Forest Services (Staatsolie Annual Report 2015). Noise and air quality monitoring also take place on a regular basis.

In 2016 the Staatsolie Foundation supported a mangrove rehabilitation pilot program to enhance sediment accretion at the Weg naar Zee resort, about 10 km north of Paramaribo.

Offshore exploration has so far failed to lead to commercially recoverable reserves, in part due to a lack of quality seismic data (McKenna, Rhodes and McDonald, 2014). A specific concern related to seismic exploration is the potential impact on fish and marine mammals, particularly cetaceans. Different mitigation measures are being applied to minimize the impacts of seismic surveys, including Soft Starts (i.e. the gradual increase in the seismic source as stipulated from low power to the required working power) and the use of certified Marine Mammal Observers (MMOs) on board of seismic survey vessels; a seismic survey is stopped when mammals are observed within a certain distance of the survey vessels.

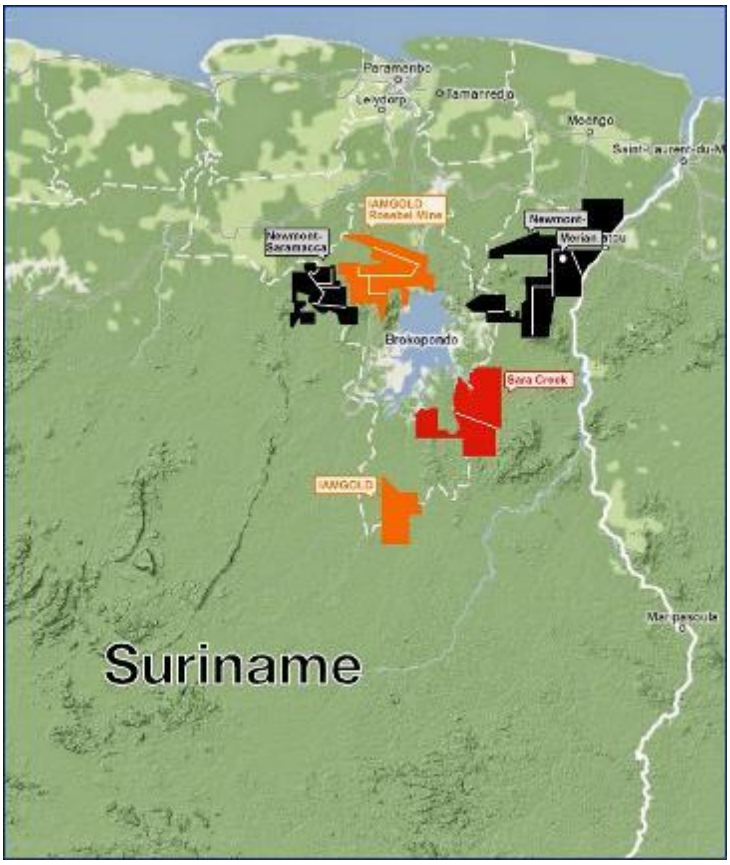
Seismic programs are executed in close collaboration with the local Fisheries Department, the Marine Authority and the Coast Guard. Safety zones are in place and temporary restrictions could be enforced regarding ocean traffic and fisheries in the exploration zones.

Socioeconomic impacts of oil exploration and exploitation in Suriname have generally been benign, mostly because oil related activities are undertaken in sparsely populated areas. Land users and/or owners are informed in person and through public meetings. Individuals, mostly farmers, have been compensated for the presence of drilling and mining equipment on their land. Complaints from people living near oil concession areas have focused on the generation of dust (from vehicles on sand roads), unpleasant smells, and the limited benefits to the local population. The Community Relations department works with local stakeholders to resolve such grievances.

2.3 Gold

Two multinational gold mining firms are involved in commercial gold production in Suriname: IAMGOLD and Newmont (Table 3; See Figure 4 for their locations).

Figure 4. Location of the Merian (Newmont) and Rosebel (IamGold) mines and concession areas



Source: De Surinaamse Krant, 2014

Table 3. Large-scale mining companies in Suriname

<table>
<tr><th></th><th>Newmont Suriname</th><th>IAMGOLD</th></tr>
<tr><td>Mine name & location</td><td>Merian, Sipaliwini</td><td>Rosebel Gold Mines, Brokopondo</td></tr>
<tr><td>Start production</td><td>October 2016</td><td>2004</td></tr>
<tr><td>GoS share</td><td>25%, through Staatsolie</td><td>5%</td></tr>
<tr><td>Annual production</td><td>2.95 tons (Oct-Dec 2016)</td><td>8.93 tons (2015)</td></tr>
<tr><td>Royalty, % (USD)</td><td>6% (3 Mln US$; Oct-Dec 2016)</td><td>2.25% of gold production in refined gold; when the price of gold exceeds US$ 425/troy ounce, the firm pays extraordinary royalty of 6.5% (in cash) over the excess amount.</td></tr>
<tr><td>Employment</td><td>Total Newmont employees 1151, of which 216 Pamakan, and 797 other Suriname Nationals (May 2017)</td><td>371 from Brokopondo, and 1291 other Suriname Nationals (December 2016).</td></tr>
<tr><td>Total earnings GoS (income tax, tax on wages, dividend and royalties)</td><td>Royalty: US$ 3 Mln
Payroll tax: US$ 17.4M</td><td>US$ 37.4 miljoen</td></tr>
<tr><td>Community projects 2016</td><td>Community projects: US$ 340,000</td><td>1. Donations: US$ 62,586
2. Community Development: US$ 146,358</td></tr>
<tr><td>Total deforestation</td><td>800 hectares (by May 2017) cleared, with a total approved area of 3425 Hectares life of mine.</td><td>3,646 ha (to end of 2016)
<table><tr><th><u>Type disturbance</u></th><th><u>Size (ha)</u></th></tr><tr><td>Current mining pits</td><td>941</td></tr><tr><td>Buildings and infrastructure</td><td>109</td></tr><tr><td>Water management</td><td>44</td></tr><tr><td>Waste dumps, borrow pits, stockpiles</td><td>1103</td></tr><tr><td>Tailings dam facilities</td><td>953</td></tr><tr><td>Roads/trails</td><td>270</td></tr><tr><td>Access roads (except for haul roads) and support facilities</td><td>226</td></tr><tr><td>Total</td><td>3,646</td></tr></table></td></tr>
<tr><td>Biodiversity offsets</td><td>Active, with pilot trials to commence in 2017. It is not public or available for consultation.</td><td>No biodiversity offsets plan</td></tr>
</table>

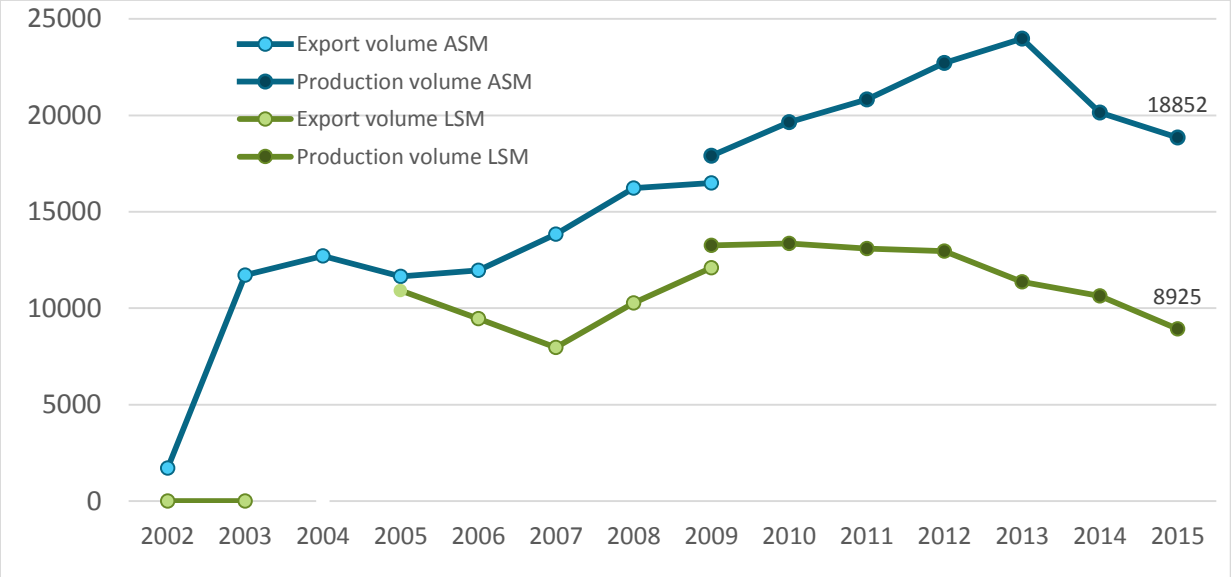
Sources: Ms. Herkul, Iam Gold Legal Counsel, pers. com. 13 April, 2017; Ms. Van Dijk, Institutional Relations Manager Newmont Suriname, pers. com. 9 May 2017.

Commercial Large-Scale gold Mining (LSM) production in Suriname started in 2004, when Rosebel Gold Mines N.V. (RGM) went into operation – then owned by Cambior. In 2006, IAMGOLD acquired Rosebel as part of its acquisition of Cambior in late 2006. In 2015, RGM produced 8.9 tons of gold (Figure 5). In late 2016, Newmont Suriname started operation of its Merian mine, producing 3 tons of gold between October and December of 2016. The operation of Merian will likely increase the total amount of gold produced by LSM in upcoming years.

Large-scale gold mining contributes substantially to GoS revenues. Rosebel Gold Mines (RGM) pays income tax (36% of net profit) and 25% employee tax (*loonbelasting*) (Theije and Heemskerk, 2011). Production from the Rosebel mine is subject to a fixed royalty of 2% of production, paid in-kind[7], and a price participation royalty of 6.5% on the amount exceeding a market price of $425 per ounce of gold, when applicable, payable to the Government of Suriname. In addition, a fixed royalty of 0.25% of annual production is paid in kind to the Suriname Environmental and Mining Foundation (SEMIF)[8] (IAMGOLD, 2011). For example, for a gold price of $ 600, the total royalty payable is $24.88 per ounce, comprised of 2.25% x US$600 or $13.50 per ounce and 6.5% x (US$600 – US$425) or US$11.38 per ounce.

In 2014 and 2015, the GoS received respectively US$ 107 million and US$ 53.4 million and US$ 37.4 miljoen in income tax, dividend and royalty payments from RGM (resp. Starnieuws 22 May 2015, and Ms. Herkul, Iamgold Legal Counsel, pers. com., April 13, 2017).

Figure 5. Amount of gold produced (and exported) by small (ASM) and large-scale (LSM) gold producers, in Kg



Source: Heemskerk, 2010 and Heemskerk et al. 2016. All gold listed under LSM was produced by Rosebel Gold Mines N.V.. No data could be found for LSM gold export in 2004.

Newmont Suriname went into production in 2016. Newmont will pay the GoS income tax once the company starts making a profit, but considering the investment expenses (~USD 80 Mln), Newmont

[7] State mining firm Grassalco manages these royalties in name of the GoS.

[8] SEMIF was established by RGM, Grassalco , and the Government of Suriname to promote the local development of natural resources. The Suriname Environmental and Mining Foundation's board is composed of two representatives from RGM, two from Grassalco and one from the Government of Suriname.

projects that it will take three to five years before the firm starts paying tax on its profits. In the meantime, the GoS will receive employee tax and 6% royalty over the Net Smelter Returns (articles 11.2, 11.3 and 20.1 of the Mineral Agreement) in refined gold, unless payment in cash money is preferred. In a recent presentation, the Newmont External Relations manager conveyed that of every US$ 100 produced in gold, US$ 31 stays in Suriname. Once taxes are paid on the profits, this amount will increase to US$ 61 per every US$100 in produced gold (De Ware Tijd, 12/01/17).

In May 2017, Newmont Suriname employed approximately 1013 Suriname nationals, including 216 from the local Pamaka area. Around the same time, IAMGOLD employed 1662 Suriname nationals including 371 individual from Brokopondo district. Both companies have a Social Responsibility (SR) program that executes projects in surrounding communities. Examples of 2016 SR activities of IAMGOLD include:

- *The Brokopondo Fellowship Program*: The best graduated students from the middle school in Brokopondo are awarded a full fellowship for further study at the high school and college level in Paramaribo. They receive technical, social and financial support.
- *Youth talent Development Programs*, including:
    - A school quiz; pupils from different elementary schools compete against one another
    - A speech contest; students from Brokopodo district are trained and guided to participate in a public speaking contest.
- *Soccor field* for the community of Nieuw Koffiekamp

SR projects executed by Newmont Suriname in 2016 include:

- Infrastructural projects in Pamaka communities, e.g. constructions of docks & mortuary,
- Upgrade/restart local community radio station, radio Ajawde,
- Financing of the school boat,
- Community water project

The main environmental impacts of the large-scale gold mining firms in Suriname include:

- Loss of biodiversity due to clearing of vegetation.
- Changes to ground and surface water quality; mitigated through treating water before discharge off-site and pumping back seepage from tailings storage facility.
- Potential spills; e.g. fuel, chemicals
- Aerial emissions

Both firms have environmental management procedures in place to mitigate these impacts. At Merian, for example, the majority of cleared land will be re-vegetated after mine closure, and the portion that cannot be re-vegetated will be offset through the restoration of ASM impacted lands.

With regard to environmental impacts ESIAs have been performed prior to development of the RGM and Merian mines. As part of their environmental management, the firms involve in monitoring. Newmont Suriname, for example, monitors at 140 sample points at different frequencies. This includes surface and groundwater, air quality, sewage, drinking water, and waste. This monitoring is completed by Newmont Suriname personnel with the Pamaka community involved as part of the Participatory Monitoring Committee. NIMOS is provided monitoring results through the Annual Environmental and Social Report.

Also both mines have a mine closure plan, which is regularly revised. The Mine Closure plans of IAMGOLD (not public) and Newmont (public) foresee filling the mined-out mining pits with water to create pit lakes. One concern regarding such lakes with standing water is that they may form breeding grounds for mosquitoes that transmit malaria, dengue, and other vector diseases. Also, the development of optimal pit lake ecology will require input from ecologists prior to filling up the lakes. Poor ecological management may result in algae blooms and unhealthy, stinking pools. The acidity and toxicity levels in these lakes must be closely monitored for many years post-closure.

Both Newmont Suriname and IAMGOLD have implemented policies and procedures for preventing accidents, which adhere to international standards. As part of their policies, all employees and their families are insured with medical, dental and dentist coverage. Additionally, the firms have an Alcohol and Drug policy to provide a safe, alcohol and drug-free workplace.

Both companies have a health facility on site. For any medical screening or testing that cannot be performed at this location, the employees are referred to the medical clinic in Paramaribo (Ms. Van Dijk, Institutional Relations Manager at Newmont, pers. com. March 15, 2017). Health lifestyles are encouraged by the presence of a gym and by providing balanced meals with a variety of meal choices and fresh fruit.

2.4 Bauxite

For a century[9], bauxite/alumina was a significant source of export/government revenues, jobs and a contributor to international reserves accumulation (World Bank, 2016). In 2014, the Suriname Aluminum Company (Suralco), a daughter company of the US-based Alcoa and then the only remaining bauxite firm in Suriname, announced closure of its operations. In January 2017, Alcoa publicized its intention to permanently close the Suralco alumina refinery and bauxite mines in Suriname, fully curtailed since November 2015 (Alcoa 2017). Mine closure has caused a substantial loss of GoS revenues and jobs. The World Bank calculated that closure of the Paranam refinery and related mining operations caused the loss of about 6,000 jobs (i.e. around 6% of the workforce), with 24,000 people (i.e. around 5% of Suriname's population) potentially being affected (World Bank, 2016)

Bauxite has been extracted from three main locations, as indicated in Table 4 (also Annex 2). Since 1991 ESIA studies for bauxite mines have been conducted by BHP Billiton: Lelydorp, Successor mines and Bakhuis, the latter in joint venture with Suralco. In 2011 Suralco undertook an ESIA for the Nassau Mine in eastern Suriname, but no other relevant environmental studies were done for older mines. Suralco declares that it works according to its own international standards for rehabilitation (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17).

Table 4. Bauxite mining locations

District	Mines
Marowijne	Coermotibo/Moengo,
Para	Lelydorp/Onverdacht/Paranam
Commewijne	Older mines: Rorac, Truly Hill, Rac a Rac; Successor Mines: Klaverblad, Kaaimangrassi, and Caramacca

[9] Suralco started working in Suriname in 1916, and was fully closed in 2015

Since Suralco is in its mine-closure phase, socioeconomic benefits (job creation and government revenues) are no longer experienced. During the operational years, mining has taken place on old plantation lands and near indigenous communities without proper consultations (Artist, 2016). In some cases agreements have been signed with plantations, and Suralco paid a fee to the plantation authorities (e.g. Onoribo). Since 1994, local area inhabitants have been involved as stakeholders in rehabilitation planning. As part of Suralco's rehabilitation process, local area inhabitants are asked whether they have preferences with regard to land uses. If there are no specific desires, Suralco will re-vegetate the area with local species (BIS, pers. com., 02/03/17).

The main lasting environmental impacts of bauxite mining in Suriname include:

Mined-outs in the Moengo-Coermotibo area: In Marowijne, bauxite was mined by Suralco on hill tops. Mined-out areas cover about 4,000 ha. Part of this land has received another destination, and one part is covered with natural regeneration. From Google images it appears the former mines are not yet properly rehabilitated in the sense that the mined out surfaces still only carry low vegetation with incomplete coverage of the soil (Figure 6). The remaining footprint is about 1000-1300 ha. Reforestation with local species is still taking place, using ~60 species of legumes, pioneer species and commercial woods. Manual work is mostly performed by local people; of the 60-75 persons are working on this project, including 25-30 are women who do most of the planting. There is no information on the progress of the natural regeneration processes.

Figure 6. Google Earth image showing low vegetation coverage of mined-outs in Marowijne district

Mining pits: Most other bauxite mines in Suriname (Lelydorp/Onverdacht and Successor Mines) have been deep seated mines, which are up to 30m in depth. After removal of overburden and bauxite the pits

remain, which fill up with water and form lakes. The water in these lakes displays high pH levels (up to 11) and probably contains heavy metals. When water levels are too high, water from these lakes is neutralized and diverted to the Para River. Suralco monitors water quality in these lakes for pH but not for the presence of other pollutants (BIS, pers. com. 02/03/17).

Future land-use for the lake areas is still a question. The mines are very deep; they cannot be used for agriculture and it is virtually impossible to fill in the lakes. Most logical would be to develop water recreation areas, whereby Suralco should ensure and guarantee that the lakes are safe and suitable for recreational use (Noordam, Environmental Specialist, pers. com. 05/04/17). The lake areas are now in part given out in concession to third parties/investors (e.g. Acaribo lake).

Red mud lakes: For every ton of alumina extracted, more than a ton of red mud (bauxite residue) is produced. Caustic soda[10], which is added during the refining process, stays behind in the red mud. In addition, the red mud contains other metals and minerals that are released during processing, including traces of mercury[11] and other heavy minerals (Nandlal, Suralco Health, Safety, Environment, and Land specialist, pers. com. 15/03/17). The residual red sludge is pumped into huge settling ponds where as much water is removed as possible. Red mud must be chemically treated to lower the pH. Until the late 1990s, red mud was stored in wet storage ponds, but later Suralco shifted to dry stacking. The dry mud has been deposited on top of the wet mud lakes. Rainwater that seeps through the red mud obtains a high pH value, and is collected in channels around the Residue Disposal Area (RDA). Suralco's total Residue Disposal Area (RDA) is ~500 ha. Suralco is now executing a closing scenario to encapsulate the RDAs (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17). At least one RDA (north swamp) is possibly contaminated with mercury (BIS, pers. com. 02/03/17).

There is still no good solution to clean or recycle red mud. What is clear, is that alternative land uses of the former RDAs are limited. For example, the area is not suitable for the production of food crops or as a residential area. Also, a pilot project was executed to use the red mud material to make bricks; however, the materials is lightly radio-active (a.o. contains thorium) and using the bricks for housing may be a health hazard (BIS, pers. com. 02/03/17). Suralco has suggested that the RDAs may be used to plant energy crops or commercial tree species (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17), but environmental experts have named this option "unrealistic" (Noordam, Environmental Specialist, pers. com. 05/04/17).

Spoil areas: During the preparation of mining of subsurface bauxite, the overburden is removed and stored in so-called spoil areas. Some overburden is dumped in the mined out of older mines. The type of spoil varies from soft and acid clay to stiff clay. The acid clay spoil may still be able to generate acid drainage with impacts to surface water. Today, the largest share of the abandoned mining area in Para and Commewijne consists of lakes and spoil areas.

Suralco re-vegetates the spoil areas according to its Integrated Closure Planning Framework. The firm does not use exotic species for re-planting, but focuses on the economic value of the reforested area (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17), i.e. planting commercial timber species that are wanted in the local wood market, such as Basralocus (*Dicorynia guianensis*) and Kopi (*Goupia glabra*). The

[10] Caustic soda has a pH value of >12

[11] Mercury has been mined in small quantities as a by-product. Mercury used to be stored and shipped to the US; with the latest shipment taking place in 2013. There is still some mercury in storage, and after final dismantling the plant and evaluation, Suralco will decide how to deal with it.

total footprint of this area is +- 6,000 ha, including the lakes and spoil areas. Physical work (e.g. re-vegetation) will be performed on +- 500-1000 ha (ibid.). The company does not have biodiversity targets (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17).

Land Fills: An estimated 15-19 landfills have been created to deposit waste, including oil, batteries, Spent Potlining (SPL)[12], and other industrial waste (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17). In the final days of Suralco, these waste materials were separated, but before that all waste was placed together. Suralco does not know exactly know what landfills contain what types of waste (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17). The Bauxite Institute Suriname (BIS) contents that Suralco has not provided it with adequate data about the types and amount of waste, and construction of the landfills (e.g. are they sealed to prevent leakage). Hence it is difficult to estimate the true environmental impacts and possible health hazards for local area residents and the Suriname population at large. The old landfills have been closed on top.

Figure 7. Suralco's Klaverblad bauxite mine

Drinking water: The Suriname Water Company (SWM) obtains part of Suriname's drinking water from aquifers that are located beneath the old plant, mining locations, and the landfills, including the Zanderij aquifer. Suralco emphasizes that it monitors water quality (surface and ground) around the landfills according to international protocol (Nandlal, Suralco HSEL specialist, pers. com. 15/03/17). To date, no impacts on Zanderij aquifer have been measured. Independent water monitoring –by the government,

[12] Primary aluminum smelting takes place in electrolytic cells that are known as pots. The pots are made up of steel shells with two linings. During the operation of the cell, substances, including aluminum and fluorides, are absorbed into the cell lining. After some years of operation, the pot lining fails and is removed. The removed material is Spent Potlining (SPL). SPL was listed by the United States Environmental Protection Agency (US EPA) as a hazardous waste (EPA 2000). Hazardous properties of SPL are: (1) Toxic fluoride and cyanide compounds that are leachable in water, (2) Corrosive - exhibiting high pH due to alkali metals and oxides, (3) Reactive with water - producing inflammable, toxic and explosive gases. During the final dismantling, SPL was deposited in a separate landfill (an old mine), which has been constructed according to current engineering standards.

NGOs or the University- has not taken place. Nevertheless, monitoring data are shared and in some instances sampling occurs jointly with the Suriname Water Company (SWM) (ibid.). BIS representatives named it “an enormous problem for Suriname” if this aquifer is polluted by chemicals.

Closure and rehabilitation: Negotiations between Suralco and the GoS about the clean-up of environmental damage and rehabilitation of mine sites are currently ongoing. Suralco is unwilling to rehabilitate the old mines (from the 1950s and ‘60s) in Marowijne, Commewijne and Para districts because the company did not allocate a budget for rehabilitation of those mines at the time (BIS, pers. com. 02/03/17). At present, Suralco is working on rehabilitation/re-vegetation of its mines at Coermotibo/Moengo, Lelydorp/Onverdacht and Commewijne (Successor mines), which has to be finished within 5 years. Rehabilitation is done according to own insights; if the GoS wishes to do it differently they themselves will have to pay for it. About 1000 ha still needs to be rehabilitated.

According to BIS, a lot of research is necessary to understand the extent of contamination at the different sites, with regard to the lakes, the red mud, and the landfills. Different options for rehabilitation must be studied and piloted, where also the land-use wishes of local inhabitants must be considered. In addition, the extent of health risks must be investigated, including possible pollution of the national drinking water supply. Independent research by the government is necessary; now they depend on the research and data that Suralco present. Such independent research will take several years.

At this moment it is difficult to predict future developments in the bauxite industry, but according to the BIS the prospects are not good (pers. com. 02/03/16). Expenses in Suriname are high and ore grade of bauxite is low as compared to that in other countries. Meanwhile the largest markets (e.g. China) are far away, increasing transportation expenses. With the current low prices, which are projected to continue for years to come, bauxite mining in Suriname would not be profitable. The GoS and Alcoa are working on definitive agreements concerning Suralco’s remaining activities in the country and the future of the bauxite industry in Suriname. Pending completion of those agreements, Alcoa will continue to operate the Afobaka hydroelectric facility (Alcoa 2017).

2.5 Construction materials (small-scale)

Sand mining starts at Coesewijne formation (white sands) and in the coastal districts (e.g. Wanica, Commewijne) from the Zanderij formation northward. In most cases sand mining does not take place on *domeingrond* (government owned land). Mining for gravel and river sands (*scherpzand*) mostly takes place in the Suriname River, and to a lesser extend in the Nickerie and Marowijne Rivers. Stone are mined from a couple of quarries located south of the Savanna area (Mr. B. Paansa, GMD, pers. com. 15/03/17).

The extraction of crude construction materials occurs mostly by several domestic private companies. In addition, state mining company Grasshopper Aluminium Co. (Grassalco N.V.) processes waste rock from Rosebel Gold Mines N.V. to produce gravel, and is preparing the development of a sand mining operation in Commewijne (A. Lalta, environmental specialist Grassalco, pers. com. 07/03/17). There are also larger companies with another core business, who have a license to mine for own use (e.g. Dalian) (Mr. B. Paansa, GMD, pers. com. 15/03/17).

The main positive social impact of mining and processing of construction materials is the creation of jobs, local incomes and national revenues. On the downside, mining of shells and shell-sand disturbs archaeological sites, which are prominent on the coastal shell ridges.

The main environmental effect of sand mining is deforestation/removal of vegetation – though some areas where sand mining takes place were already deforested prior to operation. In addition, sand mining leaves large pits that are typically not filled in. Abandoned mining pits become small lakes when the pits are abandoned (Finkie, instructor mining at ADEK University, pers. com. 09/03/17) Extraction of some sands (e.g. *opvulzand*) occurs partly in residential areas. When public roads are used, there is a risk of road damage (due to the heavy loads) and dust development. In addition, there may be noise nuisance to the neighborhood (ibid.). In addition some sand mines pose visual pollution, showing severely disturbed surfaces.

Mining in the river beds, particularly when going deep, may change the river course and disturb hydrology and/or bottom ecology. The mining areas are free of clays, and hence there is little sedimentation. Impact on aquatic life has not been researched. The extraction of stone from quarries involves blasting, which produces noise pollution and dust. There may also be some removal of vegetation/deforestation where rock formations are covered with vegetation. Minor impacts are caused by road construction and building of camps.

GMD performs control on mining of construction materials, focusing on depth (max. 3m. for sand), distance from neighbors, and dewatering. In agreement with NIMOS, no ESIA studies are performed for sand and gravel mining. The reasons are that the concessions are usually small (max. 400 ha) and not in a (primary) forested area. Nevertheless, Grassalco N.V. is planning an ESIA study for its Commewijne interest (A. Lalta, environmental specialist Grassalco, pers. com. 07/03/17).

At present much publicity is given to sand mining at Braamspunt beach; a marine estuary and sea turtle nesting location in the far north of Suriname (Anthony, 2016). A recent WWF report concludes that sand mining at this location is:

> … deleterious to the integrity of the subsisting beach since it not only lowers available nesting beach space but also the beach's sediment budget, and hence its wave buffering capacity. […] large-scale sand removal by mining can lead to a threshold point wherein an already strongly depleted beach can, in the face of repeated spates of high wave episodes (such as would be expected in the present El Nino years), completely collapse through massive washover and wave recycling of sand into the Suriname estuarine sink. The total collapse of Braamspunt beach could have very damaging feedback effects (irreversible change, with no possibility for resilience), […] exposing the estuary and the water-front of Paramaribo to incident Atlantic waves. (p. 66-67)

With regard to health impacts, sand mining has been associated with the presence of the illness Bilharzia (schistosomiasis) (N. Emanuels, National Project Coordinator UNDP, pers. com. 25-04-17). Bilharzia is caused by a worm, the schistosoma. The larvae of this worm swim in freshwater and can enter the skin. Freshwater snails, which can be present in abandoned sand mining pits, are the host for the worm and discharge the larvae in freshwater bodies.

3. Socioeconomic Impacts of ASM

3.1 Stakeholders

Gold mining is a crosscutting issue with direct and indirect links to virtually all sections of government, as well as many private firms and NGOs. The key government departments and organizations with responsibilities in, or links to, the gold mining sector are listed in Table 5 below.

Table 5. Main stakeholders in the ASM sector

Organization	Tasks/responsibilities/impacts related to ASM
National Government	
Ministry of Natural Resources (*Natuurlijke Hulpbronnen*, NH)	▪ Development and control of mining policies and regulations ▪ Extension of reconnaissance, exploration, exploitation or small-scale mining rights to both small- and large-scale mining firms ▪ Development, signing, and implementation of mineral agreements (*delfstoffenovereenkomst*) with the multinational mining companies.
Geology and Mining Service(*Geologische Mijnbouwkundige Dienst*, GMD)	▪ Control and preparation of concession applications for the Ministry of Natural Resources ▪ Control of quarries and mine sites for construction materials.
Office of the President's Commission for Regulation of the Gold Sector (*Commissie Ordening Goudsector*, OGS)	▪ Mandate to re-establish government authority in small-scale gold mining areas in Suriname ▪ Registration of ASM operations ▪ Control and policing in ASM areas
Medical Bureau of the Division for Labour Inspection	▪ Research on occupational exposure to mercury in Suriname, particularly from mercury fumes released by gold buying firms.
Central Laboratory of the Bureau Public Health care (*Bureau Openbare Gezondheidszorg*, BOG)	▪ Subdivision of the Ministry of Health ▪ Measurements of mercury in people through hair and urine samples, among others, particularly in exposed communities
Environmental Office within the Cabinet of the President	▪ National coordination point for environmental issues in Suriname ▪ Development of environmental policy
National Institute for Environment and Development in Suriname (Nationaal Instituut voor Milieu en Ontwikkeling in Suriname, NIMOS)	▪ Practical working arm for the Environmental Office ▪ Field inspections ▪ Preparation of Suriname for Minamata Convention (e.g. development roadmap)
Ministry of Finance Tax Department (*Belastingdienst*)	▪ Tax collection from gold mining operations
Central Bank of Suriname (*Centrale Bank van Suriname*, CBvS)	▪ Registers gold that is legally exported from Suriname
District Commissioner (*Districtscommissaris*- DC) and his staff	▪ Representative of the national government in the various districts

Mining companies	
Newmont Suriname, multinational	▪ 66 km north of Moengo, 500,000 ha ▪ 75% Newmont, 25% Republic of Suriname (via Staatsolie)
Rosebel Gold Mines N.V. (RGM), daughter company of IamGold, multinational	▪ 85 Km South of the capital city of Paramaribo, 17,000 ha ▪ 95% IAMGOLD, 5% Republic of Suriname ▪ IamGold has rights to nine other exploration areas with a total of approximately 420.000 ha
N.V. Grasshopper Aluminum Company (Grassalco), state mining company	▪ Gold mining concession and operation of mining plant without use of mercury at Maripaston ▪ Crushed stone production (waste material from RGM)
Concession title holders[13]	▪ Hold title to mining areas, and collect concession fees from gold miners operating on their concession, usually 10%
ASM equipment owners	▪ Suriname nationals and migrants
Gold miners (laborers)	▪ Perform physical work to extract the gold
Stakeholder networks and interest groups	
Mercury Free (Kwikvrij) Partnership	▪ Representatives of: the OGS, Conservation International (CI) Suriname, World Wildlife Fund (WWF) Guianas Suriname office, BOG, NIMOS, the Environmental Office of the Cabinet of the President, and ADEK University of Paramaribo
Stichting Houders Mijnbouw Rechten (Foundation for Mining Rights Holders -SHMR)	▪ Organized group of mining concession owners, headed by Ms. Toney, director of mining firm Sarafina N.V.
Makamboa	▪ Gold miners from the Maroon community of Nieuw Koffiekamp ▪ Serves as a discussion partner in conflicts between local gold miners and Rosebel Gold Mines
Stichting Platvorm Binnenlandse Ondernemingen (Foundation Platform for Interior Entrepreneurs)	▪ Umbrella organization for ASM cooperatives from different regions, to represent their interests ▪ Is presently inactive
Communities	
Population in gold mining concessions	▪ About 50 communities, with a population of 10-15 thousand, are located within gold concessions, or in their zones of impact
Ndyuka Maroon village of Nieuw Koffiekamp	▪ Situated in the industrial zone of the IAMGOLD concession
Paamaka Onderhandelingscommissie, POC	▪ Consists of seven active board members, which have been appointed by heads of all ten Paramaka villages (dorpshoofden) ▪ Represent the interest of the Paramaka community in the relation and negotiations with Newmont ▪ Help manage the Newmont community fund

[13] In 2015, there were 123 exploration titles covering 1,882,514 ha; 60 exploitation titles covering 307,185 ha and 55 small-scale titles covering 10,037 ha (World Bank, 2015).

3.2 Demographic and social structure

3.2.1 Demographics

Estimates of the size of the ASM population vary. Based on different sources, we estimated the total number of inhabitants of ASM areas at about 12-15 thousand, including service providers (Heemskerk et al., 2016). This figure excludes persons outside ASM areas (e.g. in Paramaribo) who indirectly earn a living from the ASM sector, such as bar- and restaurant owners, equipment sellers and so forth.

Suriname nationals active as gold miners in the gold fields are most often of Maroon ethnic descent, though the owners of mining concessions are typically non-Maroon Surinamese. About two-thirds to three-quarters of ASM sector workers are migrants, mostly Brazilian *garimpeiros* (gold miners). Smaller numbers of migrant gold miners and mining service providers come from Guyana, other Latin American and Caribbean countries and in exceptional cases from elsewhere.

The number of women working in the ASM sector seems to have increased over the years, and is larger among migrants than among local people. Women are most prominently present in the mining service sector as traveling saleswomen; shop owners; hairdressers and beauticians (e.g. nail salons); owners and managers of hotels, bars, restaurants and brothels; cooks; Commercial Sex Workers (CSW); transport providers (e.g. ATV driver) and so forth. In addition, women are equipment owners and mine managers, or they may be present as the spouse of a gold miner. Counting women in these various professions, they may constitute 15-20 percent of the ASM population (incl. service sector) (Heemskerk et al, 2016). More information about women in the mining areas is provided in the Gender Report.

It is not uncommon for women to take their babies and infants to the mining areas, particularly when the women work at a fixed location with their husband/partner. When these children get to be school-aged, they usually leave the mining areas to attend school – most often in Paramaribo. Today, there are also quite some children from ASM workers attending middle- and high school. In *curetelas* (gold miner villages) along the Suriname-French Guiana border, some migrant miner families send their children to school in French Guiana (e.g. Maripasoula). Youngsters under the age of 18 are seldom encountered as workers in the ASM sector and related service economy (see 7.2.3).

Apart from the gold miners (and sometimes their families), ASM communities and camps are inhabited by mining service providers; persons making a living through the delivery of services to the gold miners. Mining service providers in the ASM areas include:

- Cooks (Mostly female -F- but sometimes male -M)
- Backhoe excavator operators, either independent (rendering services by the hour) or as part of a team (M)
- Fuel man/assistant to the excavator operator (M)
- Mechanics (M) – either independent or as part of a mining team
- Transport providers, incl. for boat, ATV, car (M/F)
- ATV repair shops (M)
- Supermarket and shop owners in the ASM areas (M/F)
- Fuel sellers/provisional gas stations
- Traveling salespersons (M/F)
- Hotel, restaurant and bar owners (M/F)
- Brothel owners (M/F) and Commercial Sex Workers (CSW; F)

- Security guards (M)
- In some of the more established ASM communities: hairdressers (M/F), sail salons (F), church workers/pastors (M/F), pharmacies (M/F), formal and informal health workers (M/F).

In the ASM areas, these services are typically paid for in gold, which is weighted on the spot (Figure 8), and much more expensive than in Paramaribo city. The US$ is also accepted as payment, and in areas near the French Guiana border service providers tend to prefer payment in Euro.

Figure 8. Payment in a supermarket in the Benzdorp ASM area

Our experience in ASM areas suggests that the ratio of gold miners to service providers is about 1:1, so for every active gold miner there will be an active provider of auxiliary services in the area. This estimate excludes persons in Paramaribo who provide services to gold miners, such as hotels, restaurants and bars; cab drivers specialized in working with gold miners –often also serving as their translators; mining equipment stores; gold buying houses; CSW; and so forth.

3.2.2 Organizational structure

Virtually all locations where ASM occurs are either part of a formal concession – either titled to a multinational company or to a Suriname firm or individual – or part of a traditional Indigenous or Maroon land claim. ASM equipment owners (i.e. bosses, *dono do baranco*) typically recognize these claims and comply with the regulations imposed upon them by the official or de-facto mining title holder or land lord. Problems sometimes arise where there is more than one land claimant. In addition, there have been a few cases where land is occupied by ASM who do not recognize third party rights.

Formal mining title holders are people with a mining title extended by the Ministry of Natural Resources, either directly or through the Geology and Mining Department (GMD). Regardless of whether or not the concession title holder operates a mining plant, the largest share of the concession is typically sublet to independent ASM. The equipment owners who sublet typically have to pay 10-12 percent of their gold to the concession owner. In order to make sure that the equipment owner pays his dues, he or she may only process the gold concentrate in the presence of security staff of the concession owner.

Not only the gold miners, but also mining service providers such as shop and brothel owners are often obliged to pay the concession title owner or land lord; usually a fixed fee. In exchange for payment to the mining title holder, the equipment owner is allowed to mine on the concession, and people who do not pay are evicted by security staff. By law, the mining title holder is not allowed to sublet the concession but this practice is tolerated by the Government of Suriname (GoS) (Heemskerk et al, 2016). Moreover, migrant Brazilian miners like this system because they are familiar with a similar organizational structure in Brazilian ASM areas, and paying a fee provides them with a sense of legitimacy.

Traditional or customary land claims are territorial claims on the basis of historic Indigenous or Maroon tribal residency in, or use of, a specific area. Under Suriname law, Indigenous peoples and Maroons do not have any formal rights to the land they live on and use for livelihood activities. Nevertheless, the various tribal groups and clans within these groups claim specific land areas, which are widely known and respected within and among the tribal groups. Members of traditional communities may, like legal title holders, ask ASM on their territory to pay a concession fee; usually 10 percent but in some places or contexts less. Because tribal customary land claims are not recognized by law, they may – and often do – overlap with mining (and logging) rights that have been granted to third parties (Heemskerk et al, 2016).

When a gold miner starts working on land claimed by a tribal group, either on his own account or on the invitation of a tribal land claimant, he will be requested to pay a concession fee. Since the land is not personal but communal property, tribal regulations dictate that this money belongs to the entire clan. In practice, however, the money is usually pocketed by the person who collects it. Foreign and outside ASM typically pay to tribal land claimants as it provides them with a sense of legitimacy. Locals from the same tribal group often do not pay, either because they are not requested to pay or because they refuse to do so (ibid.).

3.2.3 Child labor

Child labor in ASM areas is very uncommon (Heemskerk and Duijves, 2012). Yet because ASM –as performed in Suriname- involves the use of mercury and exposure to a variety of health and safety risks it has been classified among the Worst Forms of Child Labor (WFCL). It is important though, to understand the involvement of children in the Suriname ASM sector in the context in which it takes place. There is no indication that children are forced or put under pressure to work in ASM, and the working conditions for young children (<15) tend to be benign. Particularly in locations where gold deposits are located near a traditional village, local children (virtually exclusively boys) of elementary school age (6-14) may be seen panning the tailings. They -often playfully- work on weekends, after school, or during school holidays to earn some pocket money and help out at home. In most cases they live at home and go to the mines with friends or older brothers when they feel like it. Only very rarely do young children structurally leave school to work in mining.

Older children (15-18) are slightly more likely to work in ASM, but also their numbers are low. They are typically Maroon boys who no longer go to school and, in the absence of alternative employment or educational opportunities, travel with an older brother or uncle to the mines. These teenage boys usually start with light jobs such as cooking, and gradually get involved in heavier mining related work. In this context, it is important to realize that in Maroon culture boys of 15 and older are considered young men with social and financial responsibilities. Among Brazilians, the presence of teenagers in the ASM sector is very rare. Also in the service sector, one rarely encounters children, and if they are present they tend to be older teenagers.

3.3 National Revenues

3.3.1 Royalty payments, license duty and statistical fee

Gold buying houses pay the gold miner (or other person selling gold) the actual London Bullion Market Association (LBMA) spot price, compensated for the purity, minus 6 - 7%. The reduction is composed of 2.75% royalty to the Central Bank of Suriname, license duty and statistical fee (*consent en statistiekrecht*; 1.5%), fee to Kaloti (0.25%), expenses (processing, transportation, administration; ~1.5%), and profit margin of the buying firm (~0.5%):

> Cash received for gold = (LBMA spot price * % purity) – 2.75% royalty – 1.5% other fees to government – 0.25% to Kaloti – 0.5% buyer's profit margin

Hence every person who sells his/her gold to a buying house automatically pays royalties and other government fees. It is possible that some gold miners sell their gold to illegal vendors but interviews with gold miners suggest that this is uncommon. Particularly migrant gold miners and the larger Suriname gold entrepreneurs appreciate the safety and trustworthiness of gold buying houses, and few jewelers buy gold on the street for the same reason. In 2013, the GoS earned 9.6 Mln USD in royalties from ASM (Deviezencommissie, 2014)

It also is possible that gold is smuggled to neighboring countries, but there is no evidence that this is a substantial share (Heemskerk et al., 2016). On the contrary, there is little logic in smuggling. Smuggling to Guyana does not make sense because one receives a better price for gold in Suriname. Also smuggling to French Guiana is uncommon, since gold buying houses in French Guiana request proof that the gold was mined legally from a legal concession, which most gold miners cannot provide. In fact, interviews with gold miners and informed stakeholders suggest that many (migrant) gold miners working in French Guiana sell their gold in Suriname. There may be some smuggling to Brazil, but probably not on a large scale (F. Amier, policy advisor Eastern Region KPS, pers. com. 07/04/17). It is more common that Brazilian gold miners and mining service providers sell their gold "in Brazil" through a middleman. In that case, the gold miner hands his gold to the informal buyer, and a partner of the buyer in Brazil deposits cash on the Brazilian bank account of the gold miner. In that case, the gold physically stays in Suriname, and will be sold at some point of time – most likely in Suriname.

3.3.2 Income tax

Tax collection from the large-scale companies follows standard procedures, but tax collection from small-scale gold miners has been a challenge. Tax department staff has occasionally visited the gold mining areas but the department lacks the staff and resources to consistently collect taxes and execute control on tax payments from people in the interior. In 2011, the director of the tax department acknowledged that the –still used- tax system did not generate sufficient taxes for the government (Starnieuws 06/01/2011). More than half of the gold mining firms (19) and natural persons (96) who are registered with the national tax department do not submit a tax form, and of those who do, a substantial share claim that they made a loss. For 2009, the total tax payments of both groups totaled SRD 118,728 (~USD 35,978). Natural persons registered as gold producers paid, on average, merely SRD 200 (~USD 60) annually (ibid.).

3.4 Mining incomes

Payment systems for workers and service providers in the ASM sector are largely comparable across Suriname. The division of earnings within the mining team for different types of operations are listed in Table 6.

Table 6. Payment systems for workers in different types of mining operations

Mining method (*Sranantongo*)	Typical number of workers per 12h shift	Payment system
Sluicing without excavator (*spoiti-soigi*)	~ 6 total: two workers with spurting hose, one worker with suction hose, two workers collect stones. One supervisor	Equipment owner 70%, workers 30%
Sluicing with excavator (*spoiti soigi + pockline*)	~ 6 total. 5 workers: two work with spurting hose, one with suction hose, two collect stones. One excavator operator. One supervisor.	Equipment owner 80%, workers 20%
Sluicing with screen and excavator(s) (*isri daal*)	~ 5 total: 2 workers with spurting hoses. 2 excavator operators. One supervisor	?
Ground sluicing (*Sumajé*), manual (w/o excavator)	1-3 total: 1 or 2 with spurting hose, 1 removes large stones	Equipment owner 70%, workers 30%. Or 50%-50% in shared ownership
Ground sluicing (*Sumajé*), with excavator	1-3 total: 1 or 2 with spurting hose, 1 removes large stones	Equipment owner 80%, workers 20%. Or 50%-50% in shared ownership
Long Tom (*Long tom*)	1-2 total: 1 with spurting hose, 1 feeds material	Equipment owner 80%, workers 20%. Or 50%-50% in shared ownership
Hammer mill (*Kroesjer*)	~ 3 total: 1 worker with spurting hose, 1 worker feeds crusher and breaks stones, 1 excavator operator, one supervisor.	Equipment owner 80%, workers 20%.
Panning (*Draai baté*)	1	100% to equipment owner
Metal detector (*Piewpiew*)	1	100% to equipment owner
Dredge, manual (*Pondo*)	~ 2-4 total: 1-2 divers, 1 communicates with divers, 1 pump operator	?
Dredge, mechanized (*Skalian*)	~ 4-5 total. 1 operates control panel, 1 watches sluice box (in 4-5 hr shifts during the 20hr mining cycles). 1 welder	Equipment owner 80%, workers 20%

Table composed based on consultations with gold mining equipment owners in different mining areas, the consultant's experience, and input from Mr. B. Paansa, Chief Exploration and Geology GMD.

In addition to people earning a percentage share of the production (Por: *porcentistas*), there are often people on the team who earn a fixed amount. The cook usually earns a fixed wage of between 30-40 g Au/month. If the cook cooks for two sets of equipment, her wage will increase to somewhere to 45-50 g Au, up to 60 g Au/month. Cooks at a skalian make typically slightly more than cooks at a land-based operation; between 40-50 g Au/month – though we also spoke with one skalian owner who paid the cook 170 USD/week (~20 g Au/months). In some operations, the cooks get paid a percentage share of

production. In those cases the cooks receive the same share as the workers, but their payment is deducted from the owner's share.

Excavator operators on a team tend to get a fixed wage of ~ 80-100 g Au/month. When an independent operator is hired (with his own excavator), the expense is ~ 6-7 g AU/hr. A consulted skalian owner reported that he has a welder[14] on the team, who receives a fixed wage of USD 1500/month. Some mining teams may hire security staff, either from a security firm or private contractors – including retired and active police and military personnel. Security staff may be present 24/7, or be hired just for the high-risk moments (e.g. burning gold and transportation). These costs are deducted from the mine owner's earnings. Particularly when the earnings are disappointing, however, it often happens that operators and cooks do not get paid for months, as the equipment owners need all of their share to buy new fuel and keep the operation going.

Because mining incomes are highly uncertain, volatile and intermittent, it is difficult to estimate a typical or average" monthly or annual wage. Nevertheless, interviews with gold miners give some indication and suggest that earnings have remained surprisingly similar over the years. In 1998/99, Heemskerk found that the largest share of surveyed gold miners (laborers) at Sella Creek earned between 20-40 g Au/month, with an average of 43 g Au/month[15]. More recently we estimated, based on a series of miner interviews in Brokopondo district, that miners typically earn between 20-30 g Au/month. At a price of 33-34 USD/g paid by gold buyers in Paramaribo[16], this suggests monthly earnings per miner of ~840 USD, or annual earnings of ~10,000 USD (Heemskerk et al., 2016). In 2002, the *Cooperativo de Garimpeiros* Suriname (COGASUR)[17], an interest organization for Brazilian ASGM in Suriname, estimated that the average Brazilian miner earned between USD 500 and USD 1500 a month (Healy and Heemskerk, 2005), which is in the same general range. A consulted mine operator in the Koffiekamp area reported that workers need to earn a minimum of 10-15 g Au/month; when their earnings get less they will leave to search for better locations.

Finally, it would be valuable to test the efficiency of currently used ASM methods in Suriname, as sources contradict each other in this regard. While ASM specialists have long asserted that ASM methods are very inefficient, there is increasing evidence that innovations in ASM techniques have improved recovery rates of artisanal miners (Teschner et al, 2017). A recent study by the Colorado School of Mines, based on field work in Suriname, indicated that the sluice at the study site captured 91% of gold that entered the sluice system (ibid.).

3.5 Community development

ASM has contributed sadly little to sustainable community development in the interior of Suriname. Other than large-scale gold mining companies, ASM companies do not typically have a Community Relations or Corporate Social Responsibility team, program or budget. In cases where a "concession fee" is paid to a community member in name of the community/clan, the money is seldom used for the general

[14] During the mining process, the teeth on the router at the end of the suction hose are worn down by the river material. After each 20-hour mining cycle, the router is replaced, and the welder will repair the used router for re-use.

[15] At the time, 43 g Au sold for USD 387 in Paramaribo, but at current prices this would be approx. USD 1500

[16] Two consulted gold buyers bought gold at 262 SRD/g Au, or 33/34 USD/g Au.

[17] This Brazilian gold miners' cooperative n longer exists

development and well-being of the community. Instead, it is usually pocketed by one or a selected few persons for their personal benefit.

Gold miners from the communities typically respond to specific needs, for example they contribute for a funeral or other community ceremony. Also, ASM firms working near a community may provide fuel for the community generator or give other gifts. However, these contributions are seldom structural and usually depend on the earnings of the moment. Many Maroon gold miners from the interior do not even invest in their own house in the forest community. When earnings are good, they prefer to buy a piece of land and a house in Paramaribo city, so that their families can move and the children can attend better schools.

There have been some efforts to collect contributions for ASM miners for the common good, but most of these efforts have been short-lived. For example, for some years gold miners' association Makamboa from the community of Nieuw Koffiekamp collected fees from all gold miners on community lands. These fees were, among others, to build a luxury community meeting room, to construct a new school (in collaboration with Rosebel Gold Mines N.V.), and construct a recreation hall. After financial mismanagement, Makamboa stopped collecting fees though, and it is again every miner for his own. Also the community of Klaaskreek had a community committee, which collected percentage shares from gold miners on the Bewojo mining site – which is considered community land. The money has been used to build a community meeting hall, and to develop a system for garbage collection in the community.

At present, through interference of the Minister of Natural Resources, the various skalian owners with dredges on the hydropower lake pay a fixed fee to the community funds of the Sarakreek communities in the lake; Lebidoti, Baku and Pisian. It is unclear how these funds are managed and whether the money has been used for community projects.

3.6 Crime

3.6.1 Armed robbery

Gold brings criminals in its footsteps. Every mining area attracts criminals. There are criminal gangs of Brazilians and gangs of Maroons, and occasionally mixed gangs. Urban criminals are seldom found in the mining areas (F. Amier, policy advisor Eastern Region KPS, pers. com. 30/03/17). Furthermore, criminals may be distinguished between professionals with heavy weaponry, and regular guys who take a chance. The latter are typically armed with hunting rifles with a shortened barrel. Criminals work with inside information, about when the mining team will clean the sluice box/crusher (a process locally known as: *jitten*), and the expected amount (Paansa, Chief exploration and Geology GMD, pers. com 15/03/17).

Robberies are a continuous process but they typically only reach the news media when the take was large or when people have been killed. For –particularly migrant- gold miners in some areas, robberies have become part of the "normal" company risk; they count on loosing part of their earnings to robbers (Paansa, Chief exploration and Geology GMD, pers. com 15/03/17). The police is hardly ever notified, as gold miners do not feel that the police will do anything to resolve or prevent crime. Moreover, some victims are threatened by the criminals to prevent them from talking. Various stakeholders voiced the impression that crime has increased in recent years, but without the victims reporting the crimes it is difficult to provide evidence.

Robberies may occur everywhere, both along access roads (e.g. Patamaka pasi) and in the mining zones. Nevertheless, their occurrence seems not equally distributed across ASM areas. Even though we never conducted systematic research on robberies in the mining areas, conversations with gold miners in ASM areas throughout Suriname suggest that robberies are most common in locations that have easy road access and are located on a relatively short distance from Paramaribo – allowing criminals to escape rapidly (e.g. ASM areas in Brokopondo). To the Benzdorp area, for example, there are only two main access points for boats and one for planes. At each point of access, one would need the cooperation of people living in the area to safely escape.

The answer to robberies is security, in different degrees of formality. At some locations, such as at Nana Resources (Antino/Benzdorp general area), the firm has its own security guards, who can be called upon 24/7, contributes to safety. When the equipment owner is ready to "jitt" (wash the sluicebox and collect gold), he will call security. If the production is substantial, security travels with the mine boss to bring the gold away (e.g. to the airstrip). A gold miner who had worked for the past 20 years at the Antino concession reported that he never had a problem with criminal attacks, which he attributed to the high level of respect and social control in the area.

Other operations hire security specifically for the process of jitten. These security providers may be part of a formal security firm, but also active or former policemen or military who earn a significant extra as "security consultants". In many camps, gold miners may also have their own weapons, usually a hunting rifle or shotgun. In order to improve security, gold mine operators or their foremen may also ask their workers to hand over their mobile phones prior to washing the gold, and transport the gold at night. In addition, camps have dogs for security, and more recently pit bulls have been introduced to guard the sluicebox and the boss' camp.

3.6.3 Illegal possession of weapons

Every camp has an (most often illegal) weapon; to guard the sluicebox and for hunting (F. Amier, policy advisor Eastern Region KPS, pers. com. 30/03/17). Most weapons are hunting rifles, but some camps also have pistols, revolvers or even automated weapons. Some larger mining firms have their own security, e.g. Nana Resources. Others hire formal security companies, e.g. Mozart, but not so much anymore because of poor experiences. In many cases police officers and military are (secretly) performing security services for certain camps to earn extras. Also bars and brothels that organize a party may arrange (paid) police protection to keep possible incidents related to drunkenness under control.

3.6.4 Fighting crime

In and around the gold fields (Sipaliwini and Brokopondo), there are about 12 permanent police posts, at: Antonio do Brinco, Kabanavo, Papaiston, Gransanti (new), Snesi Kondre, Albina, Brownsweg, Brokopondo Centrum, Koffiekamp, Saracreek, Atjoni, and Kwakoegron. The size and conditions of these posts vary. For example, at Albina there is a full police station with some vehicles and other resources. At Antonio do Brinco, the Suriname Police Corps (*Korps Politie Suriname* - KPS) hires a building from the next door Chinese store owner, and at Gransanti (Suriname side) five Chinese store owners have bundled to pay for the transportation, accommodation and food to station two police officers at this location.

The Police officers in the ASM areas prioritize the most severe cases: murder, rape, assault, violence, possession of drugs, and robberies. Offenses such as an expired residency license are not actively persecuted, and also the possession of small amounts of drugs typically goes unpunished. The conditions

of the KPS in general, and particularly of the stations in ASM areas, severely limit the efficiency and ability to act of police officers.

In the first place, the KPS is severely understaffed and underfunded. This situation has aggravated as a result of the present precarious national economic situation. Police stations have a severe lack of fuel and transportation, as well as the most basic supplies such as paper, printer ink and computers/laptops for reporting. Secondly, if a criminal is arrested, it is a problem to send the person to Paramaribo to be kept in jail, and there are no facilities to lock up people at most interior posts. So the KPS officers confiscate forbidden goods/weapons and next send the person away with a warning. Only in the case of severe cases (e.g. murder) criminals are sent to Paramaribo (S.Sokarijo, Chief of Police at Antonio do Brinco mining area, pers. com. 19/03/17).

Another problem is that in some cases, victims do not provide relevant information because they are threatened by criminals (e.g. criminals may threaten to hurt family). "The threats are real and it kills police work; people are afraid to talk", reported the previous Police Commander for the Eastern Region (F. Amier, policy advisor Eastern Region KPS, pers. com. 30/03/17).

A final, but not less important issue severely hampering police work in the gold mining areas is corruption within the Police Force. For example, agents of police at a control post may be ordered by higher ranking officers to let certain individuals or cars pass the check-point unbothered (anonymous sources). Also, various migrant miners accounted that when they pass the police check-points, they place a certain amount of money in their passport to be able to pass despite an expired residency permit.

3.7 Irregular migration and overstay

Most migrants in the mining areas enter Suriname at Zanderij or, to a lesser extent, the coastal border posts at Albina and Nickerie. It is difficult to estimate the number of legal and undocumented migrants in the ASM sector because of the open borders and the form in which migration data are recorded (IOM, 2014)[18]. The largest migrant group in the ASM sector are Brazilian nationals. In 2014, Suriname's General Bureau of Statistics and the UN Department of Economic and Social Affairs (DESA) population division reported the presence of, respectively, 5,027 and 7,159 Brazilian migrants in Suriname – but their figures only counted registered migrants[19].

Most migrants working in the ASM sector enter Suriname legally at the Johan Adolf Pengel (JAP international airport. Suriname has a visa waiver program with Brazil, which allows Brazilians to enter and stay in Suriname for a period of three months without a visa. In addition, smaller numbers of Brazilians enter the country illegally at the borders with French Guiana (e.g. along the Lawa River) and Guyana (IOM, 2014) - typically not because they want to hide from the border authorities but because that point of entry is most practical at the moment. Migrants from the Dominican Republic enter with a tourist card, which can be bought at Zanderij international airport (€30 or USD 35), also for a period of three months.

[18] For example, in 2012, a total of 19,643 Brazilians legally entered Suriname. This figure records every border crossing as one case, and hence it is likely that a substantial share of the total number consists of persons who have crossed the border more than once.

[19] The difference between these figures may be explained by the fact that the UN data include both foreign-born migrants and foreign citizens. The General Bureau of Statistics, by contrast, counted foreign-born and foreign citizens separately (IOM, 2014).

Migrants from Guyana may enter backtrack, or they can enter as CARICOM nationals[20], which allows them to stay in Suriname for a period of six months.

Even though migrants working in the ASM sector can easily enter Suriname legally, the sector is characterized by a large number of irregular migrants[21]. The main reasons are overstay –staying for a longer period than authorized- and failure (or nonchalance) to either apply for or renew the required residency documents. In the period November 2012 to September 2014, the Border Management System of the Ministry of Foreign Affairs recorded 54,883 overstayers. With 15,921 Brazilians accounted for the largest group of overstayers (IOM, 2014). A consulted police commissary estimated that about half of migrants does not have legal residency.

There are many reasons for failure to comply with the required procedures for legal stay, including:

- Distance and high price of travel between the forest (where people work) and Paramaribo (where the residency license must be obtained).
- Lengthy period of time for processing legal residency requests by the Suriname Department of Alien affairs (*vreemdelingenzaken*), sometimes up to a year.
- Difficulty in obtaining original documents from Brazil, such as a birth certificate and declaration of criminal antecedents.
- High cost of the application procedure, including application fee, health insurance, and middlemen for non-Dutch speakers.
- Expired Brazilian passport. In case that the person has not voted for the national elections, which is obligatory, a fine has to be paid in Brazil prior to be able to obtain a new passport.
- Fact that all paperwork has to be completed in Dutch, an all communication with migration officials has to be in Dutch or Sranantongo. Brazilians often hire Portuguese speaking cab drivers to mediate.
- Limited functional literacy of many migrants working in the ASM sector.

Furthermore, lack of legal residency is no barrier for working in the ASM sector. Apart from very incidental actions/raids, neither concession owners nor local police systematically control residency papers. At Zorg and Hoop airport from where flights to the interior leave, or at several roadside posts, foreigners have to show an ID but there is no control of legal residency. Consulted Brazilians reported that in cases where there is control at road blocks, they can place money in their passport and continue the journey.

3.8 Commercial sex work

Given the male-dominated workforce in ASM, the relative isolation of many ASM areas, and the long periods of time that men stay in the forest, it is not surprising that many gold mining areas feature brothels, locally know as *cabarets*. The cabarets are owned by Suriname nationals and foreigners, and

[20] Suriname incorporated the Revised Treaty of Chaguaramas of the Caribbean Community and Common Market (CARICOM) into national legislation in 1995. The free movement of persons is a critical component of Chapter 3 of the Revised Treaty of Chaguaramas (IOM 2014).

[21] The International Organization of Migration (IOM) distinguishes irregular migration from illegal migration, where an irregular migrant refers to person who, owing to unauthorized entry, breach of a condition of entry, or the expiry of his or her visa, lacks legal status in a transit or host country. Meanwhile the IOM restricts use of the term "illegal migration" to cases of smuggling of migrants and trafficking in persons.

may work with any number between one and more than ten women. Women of different nationalities work in the cabarets; Suriname, Dominican, Brazilian, a small number of Venezuelans (more recent) and incidental others. Earlier research in the mining areas suggests that foreign nationals dominate the Commercial Sex Work industry in Suriname ASM areas (Heemskerk and Duijves, 2012a). Most foreign CSW in the gold mining areas enter Suriname legally at Zanderij, and travel via Paramaribo to the interior.

CSW rely on an extensive (nationality specific) information network to find out where work is best. Once in the goldfields, CSW may have different types of arrangements with the *cabaret* owner. In some cases, the women pay a daily fee for the room and have to make their own arrangements for food. In many other cases, the women stay for free and sometimes also receive their meals. The *cabaret* owner makes her or his money from the drinks the clients buy – for themselves and for the women. The level of organization and security differs a lot per site. The Benzdorp mining village (*curetela*), for example, is exceptionally well organized. When one *cabaret* organizes a bingo drive or party, the other cabarets will not plan their event at the same day and all Chinese stores close early. The *cabarets* hire local police officers to be present at such events to prevent and occasionally resolve incidents – mostly related to drunkenness.

The prices paid for CSW in ASM areas may vary, depending on location, state of the gold business (booming or weak), and looks and nationality of the CSW. In the Benzdorp general area, CSW generally asked for 3 g Au or €50- for a short time (30 min.), with some room for negotiation. Brazilian women from different clubs complained that women from other nationalities provide their services for less (down to 1 g Au or €30-); a reason to prefer work in a *cabaret* with only Brazilians. Interviewed Dominican women, however, denied this allegation. The price for an entire night varied from €100-, to 8-10 g Au. The prices in g Au have remained surprisingly stable in the past couple of years. In 2011, based on interviews with CSW in cabarets throughout the Suriname interior, we reported short-stay prices of 1.5-5 g (then €60-200), and 8-10 gr for a night (at the time €320-400).

Girls below the age of 16[22] seldom work in *cabarets* in ASM areas – though there are incidental exceptions. A survey with 127 CSW in four different mining regions found a median age of 29, with one underage girl (age 14) and the oldest CSW being 51 years of age. Young Suriname girls (13-15 years of age) who work in interior cabarets are most often cases of run-aways, who have come to the interior with a girlfriend or boyfriend (Dragtenstein, Senior Superintendent TIP Department KPS, pers. com. 27/03/17). In some cases a loverboy is involved. In these cases, the problem is that the girls (esp. in Paramaribo) are in love with the boy who brings them in the situation. So they refuse to file a complaint and do not want the boy to go to jail (F. Amier, policy advisor Eastern Region KPS, pers. com. 30/03/17). Over the past couple of years, three cases involving underage girls have been investigated by the Trafficking in Persons department of the KPS, at Sella Kreek (~2014) and Krabudoin (2011, 2012) (ibid.). In the 2011 case, a 13-year old girl was liberated by the police from a cabaret (brothel) at Krabudoin after she was reported missing. She had been lured with promises of domestic work, but forced to work as a commercial sex worker (Starnieuws, 28 October 2011). In 2012, also at Krabudoin (Brokopondo), a 14-year old girl who had run away from home with a boy she had fallen in love with, was forced to perform sexual services under threat of violence and withholding of food. A year later, a fifteen-year old Guyanese girl was rescued from a cabaret at Kabanavo, near the French Guyana border.

[22] By Suriname law, the age to be considered a sexual offense (*zedendelict*) is 16 years.

A police officer with many years of experience as Commander for the Easter Region (where most ASM areas are) recalled one case about 8 years back, of young Brazilian girls with suspected falsified passport. They were deported to Brazil (F. Amier, policy advisor Eastern Region KPS, pers. com. 30/03/17). The officer also has experienced two or three cases where young Brazilian girls –13-14 yr- had been instructed by their mother on how to earn gold as CSW. More recently, there was a case of a 14-year old girl, who was brought by her mother to a gold boss. The KPS tried to find the girl in Paramaribo, but she has disappeared.

In short, available data suggest that CSW by teenage girls is not unheard of in the mining areas, but these cases are exceptions. Particularly cases of young girls (13-15 yr) are very rare.

CSW by men in the gold mining areas is incidental and hidden. There are no cabarets with male CSW. The possible health impact of CSW, including the spread of HIV-AIDS, are described in chapter 5.

3.9 Trafficking in persons

There is no evidence suggesting that trafficking in persons is a substantial problem in the Suriname ASM sector. All CSW who were interviewed during the field visit asserted that they were able to come and go whenever they wanted, and all but one of the women had arranged their own travel to Suriname. The interviewed CSW reported that they had not heard of cases of trafficking or forced CSW in the mining areas. Also consulted stakeholders with many years of field experience in the ASM sector, either as mining entrepreneurs or as government officials (e.g. police officers, health workers), reported that nowadays, trafficking of persons in the ASM sector and auxiliary services is extremely rare.

One Brazilian woman who was interviewed during the field visit had come through an intermediary to Suriname. She was placed in a club in Paramaribo, where she had been forced to stay for two months, until she had paid off her plane ticket, room and board, and the laundry lady. In fact, all cases of limitations in movement of freedom reported to us by CSW referred to Paramaribo. In these cases, women are usually recruited by a person in the home country, who will get them to Suriname for a certain price – much more than the price of a plane ticket. Upon arrival in the club in Paramaribo, the passport and return ticket are confiscated so that the women in question are forced to stay until the debt is paid off. Because the CSW may be obliged to rent a room in the club and have to pay for other expenses, it may take quite a while before they have settled their debts.

The above accounts are in line with our findings during earlier work with CSW in both urban areas and the ASM areas throughout Suriname (e.g. Heemskerk and Duijves, 2012a). CSW in the gold fields are typically independent, extremely mobile entrepreneurs, who check their information networks for the best places to do business. They have chosen, often driven by poverty, to make fast money in the sex industry. Cases where women who work in interior cabarets are not free to leave may occur but are rare (Heemskerk and Duijves, 2012b)

The Chief of Trafficking in Persons (TIP) of the Police Corps (Korps Politie Suriname- KPS) in Paramaribo confirmed that as far as the TIP Department can ascertain, there is no substantial number of victims of trafficking in the mining areas (Dragtenstein, Senior Superintendent TIP Department KPS, pers. com. 27/03/17). Given its limited resources, the TIP department cannot be present much in the interior and the department relies on police officers and other intelligence in the field. The TIP department also provides trainings to police officers at checkpoints along the roads leading from the interior to Paramaribo (e.g. Stolkersijver) to recognize cases. In addition to funding, extended competencies to act – as stipulated in

the draft Law on Special Investigative Competences[23]- will enhance the department's ability to respond swiftly and efficiently to possible incidences.

Only incidentally, we have heard of cases where women were lured with false promises and next forced to perform sexual services in the mining areas (Heemskerk and Duijves, 2012b). Recently, for example, the TIP Department liberated three Chinese women who had come to Suriname to work in a curtain shop, but upon arrival were brought to a gold mining area to work in a *cabaret*. When they came back in Paramaribo, the TIP department took care of the women and arrested the exploiter and the financer. In 2013, newspapers reported about three Guyanese teenage girls were rescued by the police from a *cabaret* at Kabanavo (Benzdorp area), where they had been forced to perform sexual services under threat of violence (Obsession Magazine, 11 November 2013). They had been told that they were going to work in a shop in Suriname. One of the girls was 15 years old, and had been reported missing by her parents in Guyana. The two other Guyanese girls were not present during the police raid. A consulted police chief of the Regional Support Troops (*Regionaal Bijstands Team*- RBT) at Antonio do Brinco *curetela* confirmed that there were cases of trafficking some years ago, but in the past two years he had not been aware of any cases in the Benzdorp area (pers. com, 19/03/17).

We have never heard of cases of trafficking to perform any work other than sex work in the mining areas. Also the TIP Department has not encountered proven cases of human trafficking to work as a mine laborer (Dragtenstein, Senior Superintendent TIP Department KPS, pers. com. 27/03/17). Again, this account was confirmed by many stakeholders with long-term presence in the ASM sector.

Other sources contradict our data and suggest that trafficking of persons in the interior of Suriname is a huge problem and increasing. The US Department of State (DoS) 2016 Trafficking in Persons Report states that:

> Reported cases of trafficking in Suriname's remote jungle interior […] have increased in recent years; limited government presence in the interior renders the full scope of the problem unknown. Women and girls from Suriname, Brazil, Dominican Republic, Guyana, and Venezuela are subjected to sex trafficking in Suriname, including in remote and illegal gold mining camps in Suriname's interior[24].

This situation, coupled with the fact that Suriname is not making significant efforts to meet the minimum standards, has resulted in the US DoS placing Suriname placed on Tier 3 Watch List – the worst status when it comes to human trafficking. Because the US DoS does not cite any sources, it is difficult to know where the information comes from or to verify the data.

3.10 Influence of religious and cultural belief systems

Both traditional animist religious belief systems and Christian religions play an important role in many gold mining areas. In gold mining areas that are part of the traditional homelands of Maroon groups, cultural rules and regulations may dictate when and where to mine, for example. Many Maroon mining areas have a *kina-dey* (taboo day); a day that physical work is forbidden[25]. Also Brazilians working in such

[23] This law has been awaiting governmental approval for many years.

[24] This phrase may refer to a 2011 case, when a 13-year old Maroon girl to perform sexual services in Brokopondo

[25] For example, in parts of Brokopondo Thursday is kina-day; a day that the gold miners are not allowed to work. Our observations suggest that not all miners comply with these regulations and that some teams or individuals will mine anyway.

an area will not be allowed to work on kina-day. A variety of other regulations may apply, including menstrual taboos and the conservation of certain spiritual sites. It also occurs that gold miners build a traditional shrine for the forest spirits near their camp, and/or make offerings to Mother Earth.

Brazilian churches, mostly Pentecostal and Evangelical denominations, are active in virtually all mining areas where many Brazilians are present and frequented by people different nationalities. The preachers are typically church professionals, who have come to Suriname specifically for the purpose of running a church. The Brazilian churches are not only important as instruments to spread religious thought, but they also play an important role as support networks and social workers. For example, when someone is ill, the church means of transportation may be used to transport the person to a clinic, or the church may collect money to send the person away. Suriname churches (Roman Catholic, Protestant and Jehovah) are present in communities surrounding mining areas, but do not commonly establish church buildings in the mines. It does occur that individual preachers travel through the mining areas on Sundays to speak with people.

4. Environmental Impacts of ASM

4.1 Deforestation and regeneration

With more than 85% of forest cover and historical rates of deforestation below 0.1%, Suriname is classified as a High Forest cover, low Deforestation rate (HFLD) country (Rahm et al. 2015). Its forests form part of the Amazon Biome, the largest tropical rainforest on earth, which houses at least 10% of the world's known biodiversity (WWF 2017). Suriname's forest provides income and food security for forest communities, national income from logging and mining, and climate mitigation and biodiversity preservation for the global society at large. Most ASM is undertaken in creek valleys and on lower hill slopes, thus in particular affecting creek forests.

Even though gold mining does not account for a large absolute amount of deforestation, on a national level it is a relatively important source of deforestation. Between 2000 and 2015, gold mining accounted for 73% of total deforestation (59,554 ha), and 95.9% of mining induced deforestation (SBB, 2015; LULC working session 2016; Table 7). Even though the SBB data do not differentiate between LSM and ASM, Landsat images suggest that the largest share of such deforestation was caused by ASM.

Table 7. Amount of deforestation caused by different types of mining, 2000-2015

Mineral	Area (ha, 2000-2015)	% of mining induced deforestation
Gold	59,553.86	95.9%
Building Materials	762.14	1.23&
Bauxite	727.55	1.17%
Others / Unknown	1058.53	1.7%
Total	62098.46	100%

Source: Data from SBB. In: Unique, 2017

Fluctuations in gold prices and exhaustion of easily accessible ore supplies have not slowed down mining-induced deforestation. In the past 15 years, Suriname's gold mining impacted area increased from 8296 ha in 2001, to 27254 in 2008, to 53669 ha in 2014 (Rahm et al. 2015). Indeed, in the past five years (2008 and 2014) gold mining induced deforestation in Suriname doubled as compared to the 2001-2008 period (+97%) (ibid.).

After mining, ASM miners typically leave the area behind without efforts at rehabilitation (Heemskerk, 2011). Based on fieldwork on abandoned mine sites, Peterson and Heemskerk (2001) concluded that the massive repeated soil movement that accompanies ASM greatly slows regeneration, and produces vegetation cover that is qualitatively inferior compared to regeneration following other land uses. Unlike areas in nearby old-growth forest, large parts of mined areas remain bare ground, grass, and standing water (Figure 9 and 10). A side effect of deforestation near waterways is that it causes erosion, which in turn causes turbidity and re-circulation of historic and/or natural mercury (Rahm et al. 2015).

Figure 9. Active ASM site (left) and (mostly) abandoned ASM sites with minor (middle) and more substantial vegetation regrowth (right)

Finally, any efforts at reforestation of mined-out areas should take into account that abandoned sites are frequently re-mined; often more than once. Active reforestation measures will only make sense in areas for which it is certain that gold miners will not return, for example because there was no gold to start with.

Figure 10. Abandoned mine site on the ground

4.2 Landscape alteration

ASM creates both small (~ 5 m depth) and large (>20 m depth) open pits, which are most often not refilled after mining. In some cases, old pits are filled with the tailings of new pits. In other cases, they fill with water and become smaller and larger ponds, which form breading grounds for disease vectors such as the malaria mosquito (Figure 9 above). Particularly the very large pits remain huge craters in the landscape; leaving a legacy for generations to come (Figure 11).

Figure 11. Large mining pit with a depth of ~ 20m

4.3 Climate change

In the 2017 report for Suriname's Reducing Emissions from Deforestation and forest Degradation (REDD+) program, it is estimated that from 2000-2015, gold mining resulted in GHG emissions of 55.05 million tCO2 (3.67 million tCO2/year). Land-based emissions related to deforestation were believed to amount to 49.35 million tCO2 and 3.29 million tCO2/year on average, including aboveground, belowground and soil carbon pool. The remaining 5.7 million tCO2 (0.38 million tCO2/year) were attributed to diesel fuel consumption to extract gold.

Atmospheric emissions related to ASM –other than mercury- are mostly related to fumes from burning fossil fuels. The above-mentioned report estimated that emissions related to diesel fuel consumption in the ASM sector results in average GHG emissions of 91.5 tCO2/ha (Unique, 2017).

4.4 Sedimentation of natural water bodies

Many inhabitants of interior communities, particularly women - who are responsible for bringing clean water to their households- consider increased turbidity of rivers and creeks the largest nuisance related to ASM (Heemskerk and Olivieira, 2004). Rivers and creeks that used to provide water that was suitable for drinking, cooking and a multitude of household uses is now murky and deemed unsuitable for human consumption. Many interior communities are not connected to the public water net. So especially in the dry season when people cannot rely on rainwater, the poor water quality is a large problem that causes diarrhea and other waterborne diseases (Heemskerk and Olivieira, 2003). Surveys in two Maroon communities (2016) found that in more than half of households, women and girls were the main person responsible for fetching water. In other homes, fetching water was mostly a shared task[26].

ASM contributes to erosion and siltation of streams due to both the method of gold extraction and the removal of the riparian forest along the stream (Wantzen and Mol 2013). Because land-based operations rely on water to wash the ore, they are never located far from creeks and streams. The water is pumped from these natural water bodies, mixed with the ore, and after gravity separation the tailings flow into the forest or directly back into the creeks, which subsequently flow into the main rivers (Figure 12). The additive discharge of numerous “muddy” tributaries with gold mining in their catchments even affects conditions in these large rivers.

Figure 12. Water based mining from a raft (left), and land based hydraulic mining (right); in neither one of these cases are the sediments contained.

[26] Data from surveys conducted in Asigron and Nieuw Lombe, presented in unpublished project documents from the Ministry of Regional Development and the Ministry of Natural Resources.

During the mining process, creeks and streams may also be diverted to be better accessible or out of the way, thus increasing their sediment load. Based on field measurements at a 2.5 km2 mine site, Wantzen and Mol (2013) estimated the sediment discharge of a mining-impacted stream in Suriname at 310 tonnes year km2 (of which 95.6% was produced by the mine site) as compared to a sediment discharge of 13 tonnes year km2 in an undisturbed neighboring stream

When mining from rafts in rivers or the lake, the tailings directly flow back into the larger waterways (Figure 11).

It is difficult to estimate the quantity of rivers and streams that suffer from increased sediment loads due to ASM. Based on Landsat images and modeling, a recent REDD+ study estimates that 4,989 km of Suriname waterways is in direct contact with gold mining activities (Rahm et al. 2015). It is likely that most or all of these waterways suffer to some degree from sedimentation. The length of the network of impacted waterways in reference year 2014 was more than double that in 2001 (2200 km) and about nine times the length of waterways directly impacted by mining in 2001 (557 km) (ibid.). Contaminated water bodies include the Brokopondo hydropower lake, as well as rivers and creeks in the watersheds of the Marowijne, Lawa, Tapanahoni, Sara Creek, Suriname, Saramacca, Little Saramacca, Tibiti, Coppename, Coesewijne and Commewijne Rivers. The impact of sedimentation of these different watersheds varies as a result of differences in hydrological and geophysical conditions, as well as differences in the intensity and size of ASM activities in the various regions.

In aquatic systems, high loads of suspended and deposited fine sediment affect light penetration, temperature adjustment, electrolytes, bottom conditions, and retention of organic matter (NRCS, 1995). Such conditions, in turn, adversely affect stream fishes in different ways: they (1) kill fish outright, usually by clogging or damaging the gills, or reduce growth rate and thus tolerance to disease; (2) reduce the suitability of spawning habitat and hinder development of fish eggs, larvae, and juveniles; (3) modify the natural migration patterns of fish; (4) reduce the abundance of fish food by reducing light penetration and primary production, impede the feeding activities of invertebrates, and reduce the habitat of invertebrate prey; (5) affect the efficiency of hunting, particularly in the case of visual feeders; and (6) they expose fish to predators and physical disturbance through destruction of shelter and hiding places (Mol and Ouboter, 2004; Wantzen and Mol, 2013). Comparing a gold mining affected stream and a an undisturbed rainforest stream, Mol and Ouboter (2004) found that the stream affected by gold mining resulted in low species diversity, low proportion of young fishes, high proportion of mid-channel surface-feeding fishes and fishes adapted to low light, low proportion of visually orienting fishes and fishes that hide in leaf-litter banks and woody debris, and low relative biomass of food fishes.

Furthermore, due to the association of inorganic mercury with organic molecules within the sediment, turbidity is associated with a higher mercury load, and with facilitated transport of mercury to areas distant to ASM operations Legg et al., 2015).

The accumulated sediment and associated contaminants are expected to leave a legacy of environmental problems long after the causes of erosion are corrected (Wantzen and Mol, 2013). Human intervention could speed up this process, but would be hard to implement, particularly given the highly understaffed and underfunded nature of the responsible government agencies. Moreover, such measures would – again- only make sense if ASM miners will not return to previously mined locations.

4.5 Change of navigation channels in the rivers

Another effect of the presence of mining rafts, both the fully automated *skarljans* and the *pondos* with divers, is the formation of sand banks due to the dumping of tailings into the river (Figure 13). These sand banks change the navigation channels, making make it more difficult for boatmen to navigate the rivers and increasing the risk of accidents.

Figure 13. Two mining rafts (pondos), depositing their tailings in the river, this creating sand banks

4.6 Mercury

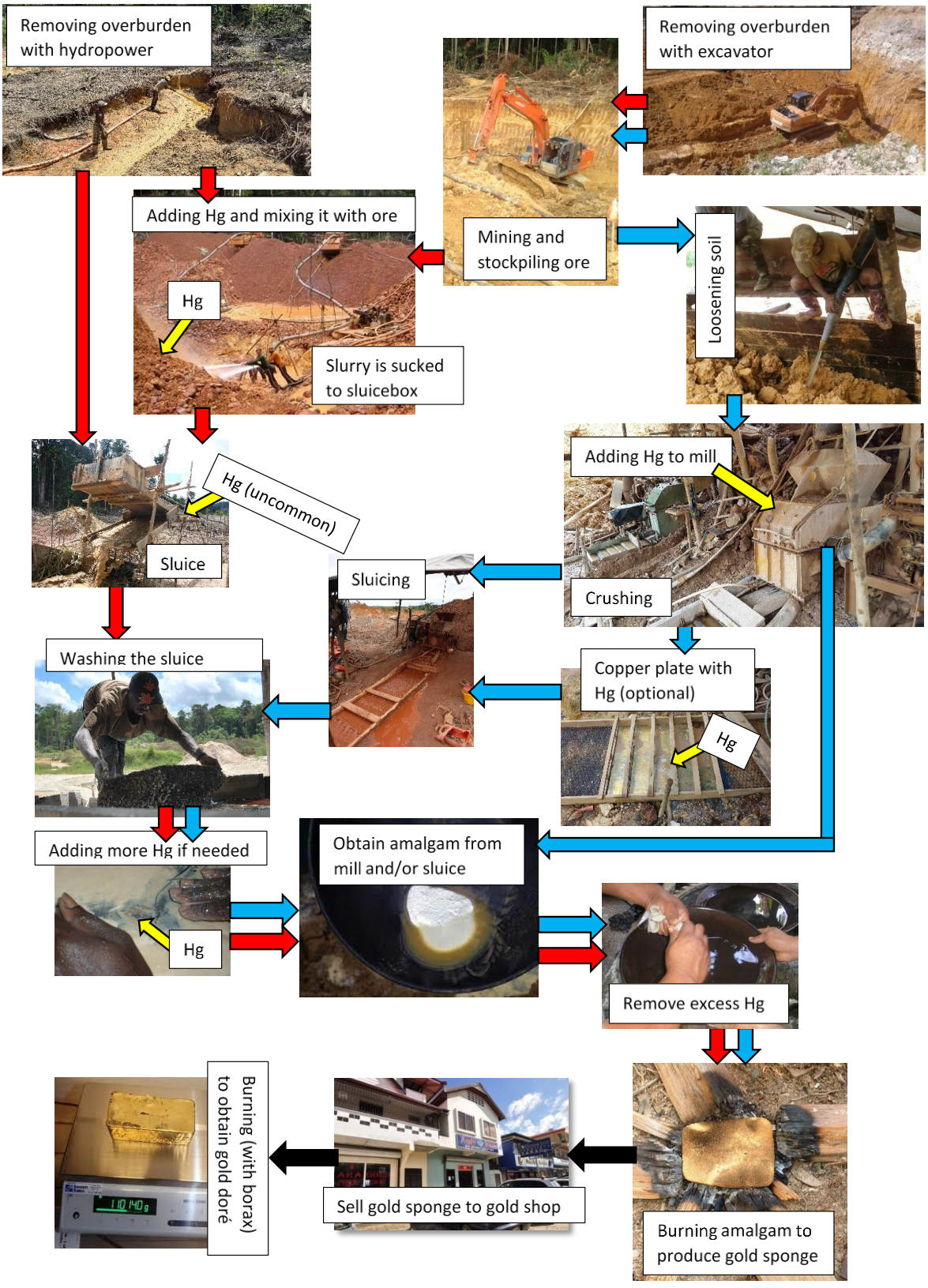
4.6.1 Mercury use

ASM is the largest source of anthropogenic mercury emissions and releases to the environment (~1600 tonnes/year), accounting for more than one third of mercury annually lost into the environment (UNEP 2013). Virtually all ASM operations in Suriname rely on gravity concentration and mercury amalgamation of sediments (Heemskerk and Duijves, 2014). As in most of the greater Amazon region, the most common ASGM processing methods involve sluicing (with or without excavator), some with the addition of crushing, using hammer mills, to further increase gold liberation and recovery. The usual production and mercury amalgamation methods are explained in Figure 13, and are described in further detail elsewhere (Heemskerk et al., 2016).

It is difficult to estimate how much mercury gold miners use and loose per Kg gold extracted because so many factors play a role in each individual processing case, including mining method, grain size (of the gold), characteristics of the ore, whether or not the place has been mined before, amount of recycling, and the personal experience and perceptions of the mine manager or boss. The impact of these factors has been described elsewhere (Heemskerk et al., 2016). It is important to realize that not all mercury used by ASM is lost into the environment, because gold miners recapture mercury in different stages of the processing cycle (Figure 14).

Worldwide, the mercury (Hg) to gold (Au) ratio used in ASM varies from roughly 1:1 to >20:1 in selected worst cases (Persaud and Telmer, 2015). Based on interviews with gold miners, Heemskerk et al. (2016) estimated the Hg:Au ratio for Suriname ASM at 3.3:1. That is, for every Kg of gold produced, an estimated 3.3 Kg of mercury is emitted into the natural environment. This estimate is in line with an earlier estimated Hg:Au ratio for the Guianas by Legg et al. (2015) of 3:1.

Figure 14. ASM processing cycle for sluicing systems (red arrows) and milling systems (blue arrows), with the places when mercury is added (yellow arrows)



4.6.2 Atmospheric contamination

Globally, artisanal and small-scale gold mining is the main source of anthropogenic mercury emissions to air. Mercury vapors are not only emitted into the air in the mining areas where gold miners burn the amalgam, but also in the gold shops (mostly in Paramaribo city), where the sponge gold produced by gold miners is burned again to remove residual mercury remaining in the sponge (often ~5%; Persaud and Veiga, 2015). A 2013 study on mercury emissions in Paramaribo noted that the collectors of surveyed gold shops were in very bad condition and that the fume hoods did not seem to function properly (Wip et al., 2013).

Measurements of atmospheric mercury have not been performed for Suriname mining areas. Such measurements may also not be useful because mercury vapors from burning amalgam are rapidly diluted. Existing measurements of mercury contents in the air have focused on the coastal area. Most consistent measures of atmospheric mercury in Suriname have been performed in Nieuw Nickerie, but because this site typically samples marine air from the Atlantic Ocean, these data are not relevant for assessing ASM impacts (Müller et al. 2012).

Atmospheric mercury also has been measured in Paramaribo, but less consistently. The Suriname physicist Ir. D. Wip found mercury emissions in Paramaribo (both maximum and average) to be comparable with those in world cities in Asia and North America (Wip et al., 2011). These levels posed no public health risks. Inside and in the close vicinity (<100m) of gold buying shops, however, he measured mercury concentration levels that surpassed the US National Institute for Occupational Safety and Health recommended exposure level of 50 µg/m3 inside, and the minimal risk level of 0.2 µg/m3 of the US Agency for Toxic Substances and Disease Registry outside (ibid.). More scientifically robust, longitudinal measurements of atmospheric mercury in Paramaribo must be performed to be able to draw definite conclusions.

4.6.3 Contamination in freshwater ecosystems: water, sediments and fish

Mercury enters the freshwater ecosystem both directly, with tailings from mining areas, and indirectly, when evaporated mercury is deposited with rainfall. In the aquatic ecosystem, traces of mercury can be found in water, sediments and aquatic biota. Measurements in Suriname **fresh water** bodies show that mercury levels are slightly higher than global background levels (Ouboter, 2015). Nevertheless, mercury content in fresh water is generally low, in part because elementary mercury poorly dissolves in water[27]. If mercury is found in water, it is most often present in, or connected to, sediment particles. Micro-organisms transfer mercury into methyl-mercury but also this form dissolves poorly in water, and rapidly enters the food chain where it is better dissolvable in fat tissue (Scheppers, pers. com. 01/01/17; see also Legg et al. 2015). Indeed, the highest mercury level measured in Suriname waters (1.11 µg/L at the south side of Brokopondo Reservoir) is still below the Environmental Protection Agency (EPA) drinking water standard of 2 µg/L (Ouboter et al. 2012). It can be concluded that filtered river water is not an important source of mercury and if consumed, metallic mercury will not enter the human body through the intestines.

For **river sediments**, available studies suggest that the sediments in virtually all Suriname rivers and streams, with the exception of northwestern Suriname, have mercury levels well above global background levels of 0.01-0.05 µg/g (Ouboter, 2015). Sediments in many locations approach or exceed the Canadian

[27] Dr. P. Scheepers, toxicologist Radbout University of Nijmegen, Netherlands. Pers. com. 01/03/17.

Interim Sediment Quality Guideline for Protection of Aquatic Life of 0.17 µg/g soil. High mercury levels were encountered in gold mining areas, upstream from gold mining areas (rainy season), in the mouth of the Marowijne River (eastern border river) and, surprisingly, in pristine areas of central, western and southern Suriname[28] – particularly in the Upper Coppename Basin (Ouboter, 2015). Research by Ouboter and colleagues explains the high mercury levels in sediments and fish in seemingly undisturbed streams by:

1. Atmospheric transportation of mercury from the gold mining areas to the southwest by the northeastern trade winds;
2. Wet deposition of atmospheric mercury, with the highest amounts polluting streams draining mountain ranges with high precipitation;
3. Mercury in pristine streams is freely available for methylation and bioaccumulation. In comparison, mercury in mining areas is to a large extent bound to fine sediment particles and therefore not freely available for bioaccumulation.
   (Ouboter et al., 2012)

Available data suggest that these high mercury levels found in Suriname riverine ecosystems are not natural but rather have an anthropogenic origin (ibid. 2012).

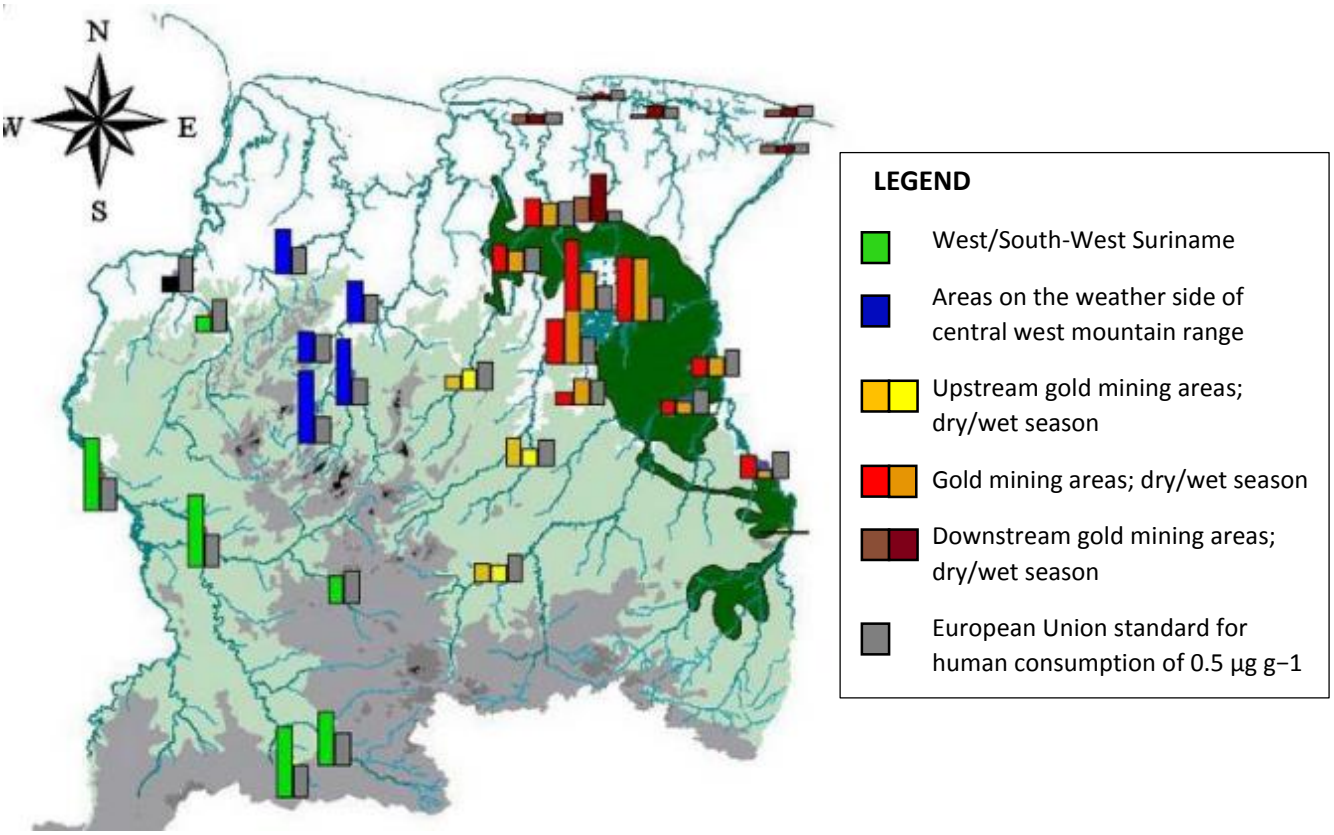
Aquatic ecosystems are a major site of mercury methylation and biomagnification (Legg et al. 2015). Methylated mercury moves up the food chain via micro-organisms to small fish, to larger fish, and eventually to people and fish-consuming mammals (e.g. river otters) and birds. Measurements of mercury in **fish** show elevated to high mercury levels in tissues of predatory fish in most gold mining localities, as well as in many other locations (Figure 15). Ouboter et al. (2012) measured:

> Extreme high levels […] in Brokopondo Reservoir where in some cases the levels in piranhas were six to seven times the norm for human consumption (on average two to three times). Downstream of the gold mining area, levels were usually much lower. Upstream of gold mining area, mercury values in piscivorous fish were generally below the norm, but in central and western Suriname levels were far above the norm.

As far as the researchers can ascertain, no measurements have been performed of mercury levels in Suriname's aquatic and terrestrial wildlife, birds, reptiles, amphibians and insects. Adverse effects of mercury ingestion on these different species have been recorded for other countries (Kessler, 2013).

[28] In these seemingly unaffected areas far from ASM areas, researchers measured average Hg levels in sediment of 0.20 µg g-1, with a maximum of 0.28 µg g-1

Figure 15. Average mercury levels found by Ouboter et al. (2012) in piscivorous fishes in different river systems in Suriname; Gray bars represent the European Union standard for human consumption



Source: Ouboter et al. 2012

4.6.4 Elevated mercury levels in people

Several studies have looked at mercury traces in the hair, urine and blood of possibly affected populations. Interestingly, few of these studies have focused on gold miners. Notwithstanding, in the early years of the present gold rush, De Kom et al. (1998) measured mercury content in blood and urine samples of Maroon gold miners and a control group of Maroon men. They found elevated mercury levels in the urine samples but not in the blood, suggesting exposure to an elemental or inorganic source of mercury through the inhalation of fumes[29]. Another study that was conducted around the same time found elevated levels of mercury contamination among both gold miners and community members from communities in the vicinity of gold mining areas (Pollack et al., 1998, cited in Ouboter, 2015).

[29] While urine samples can be used to measure total mercury (organic plus inorganic), results of urine testing are a better indicator of inorganic mercury than organic (methyl)mercury. On the other hand, elevated mercury in blood usually indicates exposure to organic mercury (such as from eating fish containing methyl-mercury) or recent exposure to a high level of elemental mercury vapor. For most people, an elevated blood mercury level is associated with eating fish and other seafood containing organic mercury (New York State Department of Health, 2016). Since gold miners do not typically eat a lot of fish, it is understandable that their blood samples did not differ from those of the control group.

Other studies mostly took place in possibly affected communities. In most Maroon communities that have been studied, researchers have found elevated mercury levels in hair samples[30]; above the EPA reference dose for hair mercury concentration of 1.0 µg/g but generally remaining below the WHO safety limit of 10 µg/g. Elevated mercury levels have been reported for the Matawai communities of Njoeng Jacobkondre and Poesoegroenoe[31] (Ouboter et al., 2007), the Matawai community of Kwakoegron (Peplow and Augustine, 2007; Hawkins et al., 2012), and the Indigenous community of Pikin Saron (Hawkins et al., 2012). As mentioned above, fish and sediments from the Brokopondo hydropower lake contain some of the highest mercury levels measured in Suriname. Nevertheless, researchers found that mercury levels in hair samples of inhabitants of Brownsweg, a Maroon community on the edge of the Brokopondo lake, generally remained well below the WHO safety limit (Ouboter and Landburg, 2010)[32]. This finding was explained by the limited reliance of villagers from the Brownsweg area on the lake for protein intake.

A 2017 study among pregnant women from Marowijne district (East Suriname) found that the majority of the participants had mercury levels in blood and urine below the reference level (HBM I), respectively 73.7% and 94.7 % (Quik, 2017). For hair the majority of the participants (60.5 %) had mercury levels between reference and action level (HBM[33] I and HBMII); two participants (2.6 %) had a mercury level above HBM II. No adverse birth outcomes, stillbirth, preterm deliveries or small for gestational age (SGA), were reported. Neither were there any defects reported in the newborns. The study recommends follow up of the women with high mercury levels in the hair because of their greater risk for adverse health effects and for adverse birth health outcomes.

At present, the Suriname Academic hospital with support from Tulane University (USA), and with funding from the American National Institute of Health, is executing a 5-year long project (started in 2015) on the health effects of mercury and other chemicals on large groups of people, including pregnant women and babies.

Alarmingly high levels of mercury have been measured in the Wayana Indigenous population along the Tapanahony and Lawa Rivers – in both Suriname and French Guiana communities. Already in 1997, French researchers found that 58 percent of the Indigenous population in four Wayana villages along the Lawa river had Hg levels above the World Health Organization (WHO) safety limit (10 µg/g) (Fréry et al. 2001). Dietary research in this group showed that all those over 1 year of age had an Hg intake greater than the WHO safety limit (200 µg MM Hg/week for a 60-kg male) (ibid.). Another study that was performed around

[30] Hair samples are particularly effective for measurement of longer-term average exposures. Mercury circulating into the body is incorporated into hair as it grows, and once there the concentration doesn't change. Concentrations in hair have been found to correlate well with concentrations in organs where mercury may accumulate, such as the brain and kidneys, particularly for methylmercury.

[31] Both along the Saramacca River, with the more upstream Poesoegroenoe displaying highest mercury values.

[32] Only 2 of 172 participants displayed Hg levels in hair above 10 µg/g.

[33] HBM stands for Human Biomonitoring. The HBM Commission defines two levels: HBM-I and HBM-II. The HBM-I-value represents the concentration of a substance in human biological material below which there is no risk for adverse health effects and, consequently, no need for action. At a concentration level higher than the HBM-I- and lower than the HBM-II-value the result should be verified by further measurements. If these measurements confirm the initial result a search for potential sources of exposure should be undertaken. The HBM-II-value represents the concentration of a substance in a human biological material above there is an increased risk for adverse health effects and, consequently, an acute need for exposure reduction measures and the provision of biomedical advice. The HBM-II-value should thus be regarded as an intervention or action level.

the same time among the French Guiana Wayana concluded that overall, 12% of the samples contained mercury levels in excess of 10 µg/g (Cordier et al. 1998). In some communities, however, up to 79% of the children had hair mercury levels that exceeded the WHO safety standard. Also the results of this study indicated that diet played a predominant role in total mercury burden. In Suriname Wayana communities, results of mercury measurements have been similarly worrisome. A 2008 analysis of hair samples from adults and children in the Wayana communities of Apetina and Kawamhakan found that 58% of the people who submitted hair samples had Hg levels above the World Health Organization safety limit, some even two to three times this limit (Peplow and Augustine, 2011). A follow-up study documented neurologic dysfunction consistent with mercury poisoning among the Wayana of Apetina (Peplow and Augustine, 2014).

In 2016, the Medical Mission (MZ, Suriname) in collaboration with the Radboud University Medical Centre (Netherlands) researched willingness to participate in bio-monitoring. They concluded that both:

> … villagers and gold miners would like to know their mercury body burden. They are prepared to provide body tissues and give their consent to collect such specimen from their children as well. For the success of such a program it is important to carefully give feedback on the lab results to all participants, together with information on possible solutions and adequate care, tailored to the situation of the participant (Radboud UMC and MZ, 2016: iv).

Support for a bio-monitoring program would be a useful activity within the GEF/UNDP project, as it may help raise awareness of adverse effects of mercury on human health.

4.6.5 Soils

Not much research has been conducted and published on ASM-induced contamination of terrestrial soils. In 2006, Arets et al. measured mercury in soil sediments at several sites within one mining area. Even though the values they recorded varied widely, they found that the highest mercury levels were encountered at the site of the sluicebox (Arets et al., 2007). Other studies, however, have not confirmed these findings.

In 2016, soil scientist Noordam and team analyzed soil samples from an abandoned ASM site within the concession of a large-scale gold mining firm. Samples were taken with a hand auger, on 1-2 m depths, on different locations (e.g. in the mining pit, in the tailing field, at various distances from the sluice box, and around the sluice box). Contrary to expectation, the team found hardly any traces of mercury in the samples (Noordam, soil scientist, pers. com. February 2017). Possible explanations for this finding are that given the huge size of some mining pits (figure 16) samples were not obtained from the most polluted locations; that due to repetitive re-mining most traces of mercury have been captured by the miners themselves; that the tailings with mercury (from mine sections with gold) are "diluted" with large quantities of tailings without mercury (mine sections without gold); or that ASM miners spill little mercury in the tailings.

Figure 16. The size and lay-out of mining operations make it difficult to obtain a good understanding of soil contamination

Especially for of milling systems, the latter seems a plausible explanation because the gold miners check their loss of mercury amalgam in the sluices behind the milling system (R. Finkie, mining instructor ADEK University, 09/03/17). In sluicing systems, most mercury (amalgam) will settle in the mats. While mercury is lost during burning, gold miners make an effort to capture all of it during the mining process (ibid.).

4.7 Wildlife

Virtually no research has been produced on the effect of ASM on wildlife populations and biodiversity. For Suriname, we are not aware of any study on this topic. Mercury contamination was discussed above. In addition, it is plausible that increased hunting pressure in previously isolated locations affects wildlife populations in the immediate surroundings of ASM areas. The overall impact of hunting on wildlife populations is probably small though, for various reasons.

- In the first place, gold miners typically do not travel long distances away from their camps to hunt at night. In many locations it is dangerous to walk around in the forest at night, because armed criminals may be hiding out in the forest or gold miners from neighboring camps may think the hunter is a robber. Nevertheless, when easy game crosses their way, gold miners will catch/shoot it as a welcome variation to their often rather monotonous diet (Figure 17). In addition, we have occasionally observed hunters who make a living selling bush meat to mining camps. These hunters are most often Maroons or Indigenous peoples.

- Secondly, the noise of mining equipment scares away most wildlife from the immediate surroundings of the mining camps. These animals will most likely retreat into the forest, away from the mining camps.
- Third, the forest landscape encompasses a huge area, and animals have many places to go outside of the neighborhood of the mining camps. Slightly increased hunting pressure in a few isolated pockets in the forest is not expected to significantly affect the wildlife population at large.

Better, scientifically founded insights into ASM impacts on wildlife populations would require a socio-ecological study combining wildlife surveys with interviews with gold miners about the consumption of bushmeat.

Figure 17. Bush meat in gold miners camps; forest turtles in the back of a pick-up truck (left) and a gold miner with an agouti (right)

4.8 Other pollution

In addition to mercury, soils may be contaminated with fuel due to leakages and sloppy handling. Fuel concentrations in the soil are low, so one may not find this during sampling. Only at the location where the motor was placed you would expect to find more fuel pollution, but also here the fuel mixes with soil particles and the concentration may be low. One also may find (broken) tools and machine parts in the soils of ASM areas (R. Finkie, mining instructor ADEK University, 09/03/17).

4.9 Projects aimed at reducing environmental impacts

Over the past two decades, several efforts aimed at reducing ASM-induced environmental impacts – particularly reducing mercury use- have been initiated by both Suriname and International organizations (Figure 18). These projects have primarily focused on retorts, alternative mining technologies, and awareness raising. Unfortunately, most projects have been poorly documented, applied minimal monitoring and evaluation have taken place, and did not publicize the findings or lessons learned. As a result, it is difficult to learn from these earlier experiences, or even to document what exactly has been done. An exception is the recent (2016-17) mercury awareness project executed by the Medical Mission

PHC and Radboud University Medical Center (UMC), which performed pre- and post-campaign surveys to measure impact of the pilot campaign. Below follows a brief overview from projects that could be traced.

4.8.1 Retorts

Most projects have focused on distributing retorts and motivating their use. In 1998, the Geology and Mines Department (GMD) in collaboration with the Pan American Health Organization (PAHO) introduced retorts in all known mining areas in Suriname. This model retort had a capacity of 2 kg and a burning time of 45 min. up (burning) and 45 min. down (cooling down), hence a total of 1½ hours. The extensive time required for burning the amalgam concerned miners because it made them vulnerable to robbery and assault. Another downside was that the retort worked with a gas burner, and hence required a gas bottle to be brought to the mining camp. At the time, infrastructure in the mining areas was not well-developed, and supplies had to be brought in on a tractor or on foot. Due to these two reasons, few if any gold miners adopted the retort (B. Paansa, Chief exploration and geology GMD, pers. com. 15/03/2017).

In a 2005/6 follow-up project by GMD/WWF-Guianas, different models of retorts were introduced to several pilot locations, including the community of Nieuw Koffiekamp. These models included retorts with a larger capacity, and retorts that also could be used on a wood fire. A larger model retort (as compared to the 1998 model) was demonstrated and left behind for the gold miners. The consultant was unable to locate records on the project results and the project was not formally evaluated. Nevertheless, a GMD staff member who talked to gold miners found that the long processing time (including time to cool down) remained a main concern. A long process to burn off the amalgam gives criminals an opportunity to contact others (e.g. in Paramaribo) and plan an armed robbery. According to Mr. Paansa, Chief exploration and geology at the GMD: “The fear for robberies is the only thing keeping people from using retorts” (pers. com. 15/03/2017). When the researchers visited the area in 2014, none of the interviewed miners remembered this workshop and none were using a retort.

In 2009, the GMD with support from WWF executed yet another retort project, in Brokopondo district (incl. Koffiekamp) and the Sella Creek mining area (Tapanahoni). A year later some of the retorts could be found back, but were not in use. Other retorts had been sold or melted for other uses (N. Emanuels, former WWF gold mining pollution abatement officer. pers. com. 06/03/17). In 2012-2013, the Commission OGS demonstrated the use of retorts in the Merian area and the Matawai region. Thirty retorts were handed over to the miners (G. Dompig, head OGS management team, pers.com. 26/05/2014). It is not known whether these retorts are still in use.

4.8.2 Hg-free mining technologies

Different national and international organizations have executed projects aimed at introducing new processing technologies. In 2005-6, the World Bank funded the US-based NGO **Artminers** to perform mercury awareness training and demonstrate **CleanGold**[34] sluices in Suriname. The Suriname firm Thera’s

[34] CleanGold sluices are magnetic sluices, that cause the magnetite (often present in the ore together with gold) to form small riffles, which subsequently capture the gold particles. CleanGold sluices have been particularly effective at capturing very fine gold. CleanGold sluices come in different sizes, from sluices that are easily carried around in a

Publications provided field support and guidance. In the Benzdorp area, the team held demonstrations for Brazilian migrant miners. In the Tapanahony area (Godolo village), the team performed mercury awareness training, demonstrated the working of the sluice on mine tailings, and distributed several CleanGold sluices. In 2006, the Artminers team returned to Suriname, this time to train women in the community of Godolo in use of the CleanGold sluices. The idea was that women would be able to use these sluices for manual processing in small creeks near their garden plots. In addition, another training was given to gold miners in the Godolo area. Next the team visited the Nana Resources concession at Benzdorp, where the CleanGold sluice was mounted behind a hammer mill operation (instead of the mercury-coated copper plate) and in a regular sluice. At the time of the field visit (2017), no-one in the Benzdorp area was using the CleanGold sluices. We do not know whether anyone still uses the CleanGold sluices elsewhere in Suriname today. One observation has been that these sluices are suitable for capturing the very fine gold particles and for manual workers (e.g. panners) but less practical in mechanized ASM operations with a large throughput of ore (Van der Kooye, director Thera's Publications, pers. com. 06/03/17). Thera's Publications still has several hundreds of CleanGold sluices stored in Paramaribo.

In 2011, WWF supported an ADEK University of Suriname project to test the working of a jig as an alternative ASM method, eliminating mercury. As part of this project, demonstrations were given to small-scale gold miners in the Brownsweg area (Road to Atjoni Km 10-11) and Nieuw Koffiekamp. The results of this project suggested that the jig is an effective concentration method, though small-scale gold miners were not enthusiast. They were not convinced that a jig could handle the volumes of ore they were processing (the demonstration model was small).

In its initial year (2011), the Commission OGS also ordered several equipment sets that would allow for mercury free mining. A recent evaluation of these systems has pointed out that their capacity (~2 tons/hr) is too small for present-day gold miners in Suriname (C. Healy, anthropologist and OGS consultant, pers. com.15/08/2014). More recently, the Commission OGS has acquired a complete lineup of machinery for mercury-free gravity concentration for small-scale gold miners. This plant has been mounted on a platform, and the idea is to bring it to the interior for demonstrations. While the mercury free technology is appealing, it may not be easily transferable to Suriname's small-scale gold miners. In the first place, at USD 300,000 the machinery is expensive. Secondly, operation of the plant requires the involvement of persons with a certain degree of technical education, which few gold miners possess (C. Healy, anthropologist and OGS consultant, pers. com.15/08/2014).

In 2011, the then newly established School of Mining and Mineral Processing (SMMP) in Suriname received a USD 244.440 grant from the Suriname Environmental and Mining Foundation (SEMiF) to develop a "Satellite field station for capacity building in the mining sector". The grant was used to construct a building at Snesi Kondre and buy equipment, including i-concentrators (i-con) and shaking tables. By the end of February 2012, the SMMP was supposed to start a 6-month bachelor level course on

small backpack (8"x8"), to larger CleanGold sluice inserts (23.5"x24") that can be used singly or in multiple arrays to create modifications to conventional alluvial and hard rock operations.

mercury-free gold mining but this never happened. The SMMP still exists in name but no activities are executed[35].

In 2015, the School of Geology and Mining Technology (SGMT)[36] at the University of Applied Sciences and Technology (UNASAT) in Suriname started offering a 6-month bachelor level course on mercury-free gold mining technologies for graduates of the secondary technical school NATIN and bachelor students of mining – much like the SMMP previously. The course teaches competencies to work Hg-free in exploration, concentration and purification phases of gold mining. Field training for students has taken place in Brokopondo district within OGS installed mining reserves (Km. 58 and Km. 68 of the Atjoni road) and in the Paamaka gold mining reserve near Snesi Kondre/Merian), which the OGS allocated to UNASAT. UNASAT/SGMT works with the i-concentrator (i-con) and a shaking table. Part of its equipment was obtained through a loan agreement with the SMMP. The school receives –partly in-kind- support from Newmont Suriname.

In addition, there have been private initiatives to reduce ASM impacts. For example, Nana Resources N.V. operates a mining plant in the Benzdorp general area, which only applies mercury in the final processing phase, in a closed environment and using a retort. Other gold operators at the Nana Resources concession (e.g. sub-letters) have been obliged to use a retort and tailing containment. Compliance with these requirements is controlled during regular inspections, and noncompliance may result in closure of the pit. Interviews with gold miners working at the Nana Resources concession suggested that the inspections incentivized some equipment owners to work cleaner (e.g. retort use), but it has been challenging to motivate miners to work in a closed circuit to reduce the spillage of mine tailings.

State mining firm N.V. Grassalco operates one of the first small-scale gravity concentration plants in Suriname that works completely mercury free. This plant, which is located at Maripaston, reprocesses the tailings that ASM miners left behind before Grassalco obtained the mining rights to the concession in 2011. The Grassalco plant uses a combination of milling and shaking tables. In the final concentration phase, borax is used to remove impurities from the gold. In 2016, Grassalco started a drilling program to determine the feasibility of primary ore mining at Maripaston.

As part of its Social Responsibility program, Newmont Suriname has funded efforts to develop cleaner ASM methods on and near its Merian concession. In 2016, two UNASAT/SGMT graduates were involved in the testing of an Hg-free mining plant (i-con) at Merian. The graduates also trained and guided one team of gold miners in a pilot project to promote Hg-free mining among ASGM. This mining team worked for one production cycle mercury-free with the i-con. The gold miners were enthusiast about the kind of fine gold that could be obtained using this equipment, but still lost money because they mined a poor deposit. The operator wanted to relocate the i-con to a more promising location but ultimately this never happened – in part due to legal constraints.

[35] The SMMP was initiated by Mr. G. Geerlings, and is now headed by Mr. Courtar from the Medial Bureau of the Ministry of Labor

[36] Initiator and director of the SGMT is Mr. G. Geerlings

In 2016, Newmont Suriname (then named Surgold) closed a Cooperation Agreement with the Paamaka Maroons, who claim traditional rights to part of the lands where Newmont's Merian mine is located. The cooperation agreement explicitly states that Newmont will "commit itself to promoting the use of more responsible small-scale gold mining techniques. This primarily concerns discontinuing the use of mercury, while at the same time improving gold recovery and reducing costs." In addition, Newmont will "provide technical advice to reduce the sediments load in water, allow for stream restoration and re-vegetation of areas that have been mined out." The Hg-free mining pilot project was the first step to realize these intentions, but since that project stalled there have not been new efforts at promoting responsible ASM techniques.

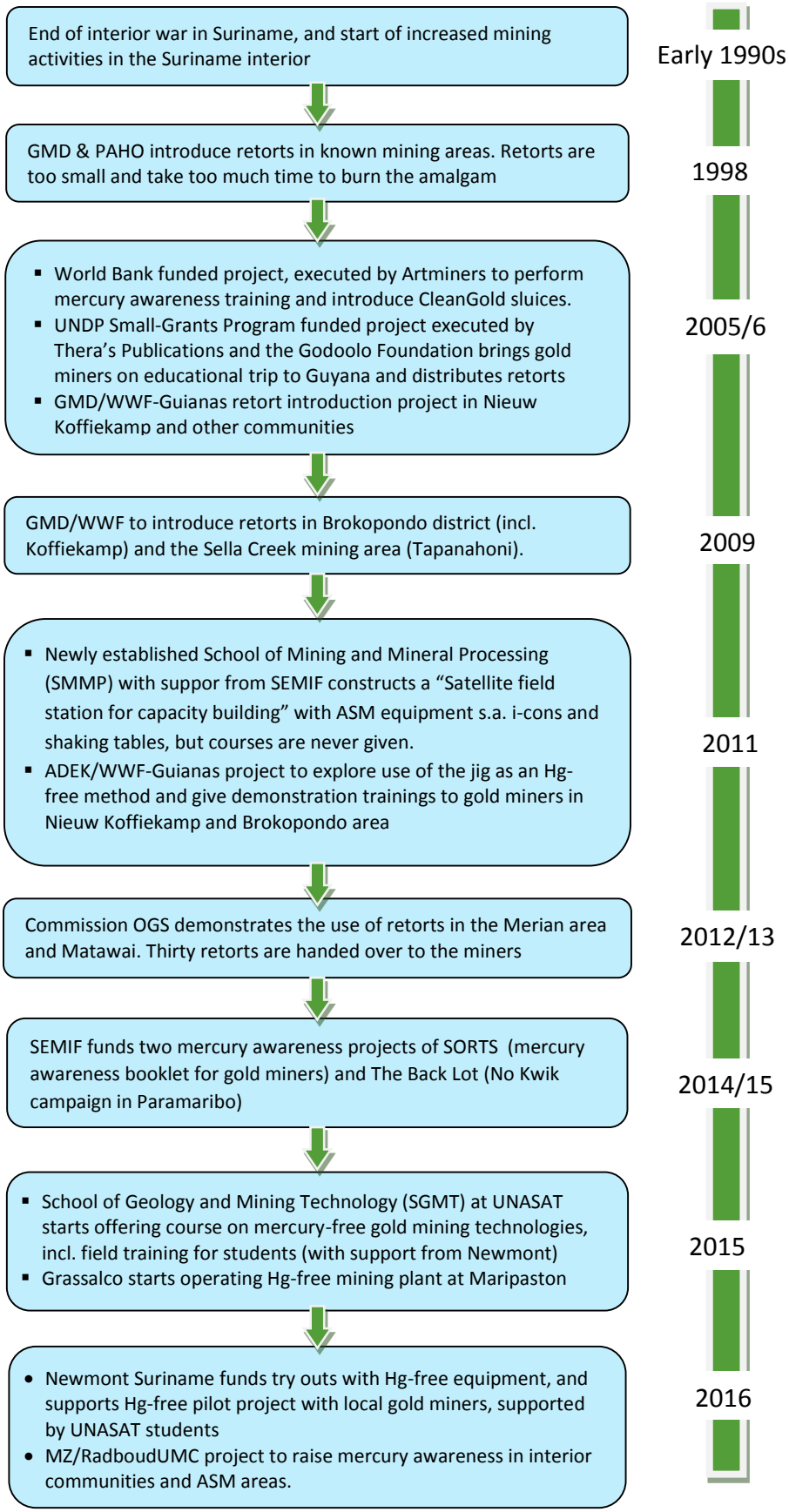
4.8.3 Awareness raising

In 2016, the Medical Mission-PHC Suriname in collaboration with the Dutch Radboud UMC designed and piloted a mercury awareness campaign in different ASM locations. On the basis of project evaluation, the institutions concluded that mercury knowledge in some areas had increased after the awareness campaign (meetings, posters, animation). Moreover, after the awareness campaign, community members were better able to specify their information needs (Radboud UMC and Medical Mission PHC, 2017). This project also investigated what community members and gold miners themselves can do to minimize mercury exposure, and assessed willingness to participate in bio-monitoring for mercury.

In alignment and simultaneous with the CleanGold sluices project, the UNDP/GEF Small-Grants Program funded a project to raise gold miners awareness of ASM impacts, executed by the Suriname communications firm Thera's Publications and the Godoolo Foundation. In addition to providing field and logistic support to Artminer, the Thera's Publications team brought a group of Suriname gold miners to Guyana to observe how to close tailing ponds, and how to improve the sluicing system (sluice angle, water velocity) to reduce gold and mercury loss. Also in the context of this project, retorts that had been obtained from WWF-Guianas were distributed. About 2-3 years ago these retorts were still in use (Van der Kooye, director Thera's publications, pers. com. 06/03/17).

In 2014/15, the Suriname Environmental and Mining Foundation (SEMIF) funded a mercury awareness project from the Foundation for Development of Radio and TV in Suriname (*Stichting voor Ontwikkeling Radio & TV in Suriname*-SORTS). SORTS published a booklet with advice for gold miners on more environmentally responsible mining. In the same period, SEMiF, the Suriname Conservation Foundation (SFC), UNDP-SGP and WWF-Guianas co-financed the "No Kwik" (No Mercury) campaign of foundation The Backlot. The aim of this campaign was to make people –mostly in Paramaribo- more aware of mercury contaminations. Its outputs include public awareness events, internet campaigns, lesson plans for middle and high school, and an informative website.

Figure 18. Chronology of efforts to introduce more environmentally responsible ASM



Lessons learned from previous projects include:

1) **ASM projects need continuity and longer-term planning**. Project implementation has been rather haphazard, narrow-focused and short-term. Few projects are part of a long-term vision with regard to where we want to go and how we wish to achieve that. As a result, projects starts from scratch rather than build on the results of earlier projects, and there is no follow-up.
2) **Monitoring and Evaluation (M&E) must be strengthened**. For past projects, M&E have typically not or poorly been performed, and achieved project results and outcomes are not publicly available. Again, the result is that new interventions cannot build further on the results of earlier projects.
3) **More collaboration and synchronization between donor organizations** in the establishment of a long-term vision and coordination of project interventions is likely to advance results. A nice example occurred in 2005/6, where different donor organizations simultaneously funded mutually supportive projects. The executing organizations worked together and undertook shared field trips, thus reducing expenses and increasing impact. Such examples are, however, rare and most projects have been executed in isolation from other interventions. The Mercury Free Partnership (see Section 3.1) could play an instrumental role in defining a long-term vision and coordinating related project interventions.
4) **Participation of gold miners in all project stages, from project design to final evaluation** elevates the chances that projects deliver the desired results. For example, if the broader vision is that all ASM miners must use retorts for burning of the amalgam, a first step should be to sit with different groups of gold miners and elicit their ideas on how this could be achieved. Next, a small team of gold miners could be hired to help design a retort that would be acceptable to the gold miners, (e.g. not too small, silent, cheap, ease of use & fabrication). This model must be piloted, monitored by gold miners, and –if necessary- re-designed. Such a participatory approach would require longer term planning (see 1).
5) **Technical problems require (largely) social solutions and multidisciplinary teams.** Many of the ASM-induced environmental impacts appear technical in nature; inefficient mining methods, spillage of mercury, low degree of retort use, and so forth. Technical solutions for these problems already exist though. Retorts are readily available in mining equipment stores and shaking tables and concentrators also can be purchased in Suriname. Yet even though many gold miners are aware that their current working methods produce environmental damage and occupational health risks, and know of the existence of retorts and alternative mining technologies[37], hardly any gold miners have embraced more responsible ASM methods. Project teams must be interdisciplinary and include social scientists in additional to technical experts, in order to ignite behavioral change in the ASM sector.
6) **Learning by doing.** Trying to change ASM behavior by talking to gold miners has not been very effective. Field demonstrations with an actual mining plant, and longer term field support appear to have been most efficient in getting gold miners to try out new (Hg-free) mining methods.

[37] E.g. Heemskerk and Duijves 2014

5. Health Impact Assessment

ASM working methods and working environment expose miners to a variety of health hazards and unhealthy conditions which often reinforce one another. The World Health Organization (WHO) categorizes ASM health hazards as chemical, biological, biomechanical, physical and psychosocial (WHO, 2016). In the following sections, we discuss the most prevalent health hazards and review access to health services in the Suriname ASM sector.

5.1 Chemical hazards

The most common chemical exposure in small-scale mining is the exposure to mercury. As described in chapter 4, elemental mercury is used in the mining process to form gold amalgam. Exposure to high concentrations of mercury vapor can cause permanent damage to the brain and the lungs. Prolonged exposure to much smaller amounts of mercury can lead to permanent damage to internal organs such as liver and kidney (RadboudUMC and MZ, 2017). A recent study of gold miner's knowledge, attitudes and practices with regard to mercury (Heemskerk and Duijves, 2014) showed that almost 98 percent of respondents used mercury in the mining process and 82 percent of gold miners in teams working with mercury, personally handled mercury and had skin contact. More than half of the surveyed miners indicated that they were concerned about contact with mercury primarily because of the adverse health effects.

Inorganic mercury, the kind that is used by gold miners, transforms into a highly toxic state called methyl-mercury and can be ingested by local area inhabitants through the consumption of fish. This form of mercury can easily be absorbed in the digestive tract and more easily gains entry into cells. As with inorganic mercury, once in the bloodstream, methyl-mercury will accumulate in the brain can cause damage to the central nervous system (Heemskerk and Duijves, 2014).

For Suriname there are, as far as we could confirm, no registered cases of persons with severe symptoms of mercury poisoning (Vreden, MD internal medicine and Infectious Diseases, Academic Hospital Paramaribo, pers. com. 28/03/17).

5.2 Biological hazards

The most common biological hazards affecting small-scale miners are waterborne and vector-borne diseases, sexually transmitted infections including HIV/AIDS, and tuberculosis (WHO, 2016). Furthermore, recent fieldwork suggests that ASM-related migration may be linked to cases of leprosy.

5.2.1 Waterborne diseases

For Suriname no data is available concerning waterborne diseases in mining areas such as typhoid fever, cholera, leptospirosis and hepatitis A. Risk factors for these type of diseases are a lack of, or inadequate drinking water and sanitation infrastructure. Creeks that are used for drinking water, bathing and defecating are sources of disease just like inadequate sanitation services. Due to the mobility of mining populations, mining camps are often temporary structures. Moreover, the camps and mining communities (*curetelas*) are typically located in remote areas without sewage systems. Toilets are most often pit latrines or when there is no toilet facility, miners use a creek or the forest.

The problems seem particularly severe in more established mining communities, because at these locations more people live close together and for a longer period of time. During a recent field visit to the Antonio do Brinco *curetela* a staff member from the Malaria Programme explained that some sewages are open and as a result of that people get stomach problems and diarrhea (pers. comm. Ms. Pereira de Paulo, March 19, 2017).

Another serious problem is domestic waste, again particularly in the *curetelas* that are inhabited by many (mobile) people for many years. In the absence of garbage collection, cans, plastics, bags and bottles are thrown either in the water or on piles behind the houses. The large number of stray dogs, often abandoned by mining camps that have moved on, adds to the unhygienic living conditions in the *curetelas*.

5.2.2 Vector-borne diseases

Vector-borne diseases such as dengue fever, zika fever, chikungunya, malaria and leishmaniasis are prevalent in Suriname. Depending on the disease, disease vectors are mosquitoes, ticks, flies, sandflies, fleas, triatomine bugs and some freshwater aquatic snails[38]. A representative of the Ministry of Health Malaria Program indicated that leishmaniasis is a problem nowadays but it is not documented for the miners. She adds that there is little to no outreach by the Dermatological Service to this target group (Ms. Hiwat, director Malaria Program, pers. com. March 8, 2017). Also during the field visit, different case of leishmaniasis were observed, and respondents indicated that the disease was becoming a problem. A fieldworker from the same program indicated that people buy their own injections to cure themselves from leishmaniasis, but the problem is that you need three injections, and many people take only one (pers. comm. Ms. Pereira de Paulo, March 19, 2017). A monitoring and evaluation manager from the Ministry of Health agrees that leishmaniasis is upcoming but that there are no studies available (Ms. Stijnberg, pers. com. March 8, 2017). Overall there are no studies executed and no specific data exists with regard to vector-borne diseases in mining areas in Suriname except from studies and data on malaria.

Although Maroon and Indigenous communities in the interior had become almost malaria-free since the last decade, small-scale mining areas continued to exist as untreated point sources of malaria transmission. Gold miners were minimally reached by the regular malaria campaigns because travel to the mining areas is logistically difficult and expensive, and the population consists largely of migrants who do not speak the local languages (Heemskerk and Duijves, 2016).

In 2009, the Suriname Ministry of Health (MoH) started the Global Fund funded “Looking for gold, finding malaria” program, which had as its main purpose to reduce the transmission of malaria in Suriname’s mining areas, and thereby prevent its relapse in interior villages. Main program activities included free testing and treatment of people with malaria symptoms in the small-scale gold mining areas; active case detection; an information and awareness campaign; and the free distribution of Long-Lasting Impregnated Nets. These activities are ongoing.

Recent data shows the success of the interventions; in 2015, the number of autochthonous malaria cases had dropped to 73, while another 300 positive malaria cases had been imported from other countries. In

[38] http://www.who.int/mediacentre/factsheets/fs387/en/

this same year, Suriname counted zero recorded deaths that could be attributed to malaria. On the other hand, a knowledge, attitudes and practices study conducted in 2013 showed that access to formal malaria prevention and treatment services in Suriname mining areas was suboptimal. The large distance to formal malaria treatment locations, coupled with the easy access to illicit malaria medication in Suriname, motivates self-medication. Less than one third of persons with (suspected) malaria followed the correct steps for malaria treatment the last time they fell ill (Heemskerk and Duijves, 2013).

Additional to testing for malaria the Malaria Program organizes health weeks at Antonio do Brinco. This started in October 2016 and has been organized twice now. During this health week, people can test for malaria, leishmaniasis, HIV, and high blood pressure, and can get health advice. Particularly men have participated during past health weeks. The organizer behind this event suggested that women may be more hesitant to test out of fear that the results will not be kept confidential (pers. comm. Ms. Pereira de Paulo, March 19, 2017).

5.2.3 HIV/AIDS

The living conditions and behavior of small scale miners living and working in the mining areas make these populations particularly vulnerable to HIV-infection. These conditions include the gender imbalance in mining areas; high prevalence of formal and opportunity-driven sex work; the large number of people without a steady partner nearby; frequent casual sexual relationships; inconsistent condom use; incorrect condom use; distorted risk perceptions; insufficient knowledge of HIV transmission; and high alcohol consumption (Heemskerk and Duijves, 2012b). Nevertheless, there is no evidence that HIV/AIDS rates in ASM areas are higher than those in the general population – largely because of a lack of data. A 2012 behavioral surveillance survey and seroprevalence study among 101 sex workers and 93 clients in small-scale gold mining areas in Suriname found only one CSW (1.0%) and none of the clients HIV+ (Heemskerk and Duijves, 2012a). This study highlights several topic areas in which more information and sensitization was urgently needed; knowledge of transmission, perception about own exposure, what to do after condom failure and where to go for HIV services.

Apart from MoH Malaria Program staff, there are no health workers systematically attending health needs in ASM areas, particularly at some distance from traditional communities. As a result, people in the gold mining areas have inadequate access to HIV prevention, testing, care, treatment and support services.

A 2012 mapping study on the accessibility and quality of HIV services in ASM areas identified various factors that obstruct the access of migrant mobile populations to HIV services (Heemskerk and Duijves, 2012b). These factors included: the distance between Paramaribo and ASM areas and the costs in time and money to see a doctor; unfamiliarity of HIV service providers with ASM areas; language barriers between health seekers and HIV service providers; and the fact that many people do not have medical insurance.

A more recent study suggests that, similar to the distribution of malaria, the Suriname-French Guiana border area is a “hot spot” for HIV infection, featuring high levels of HIV vulnerability and facing great challenges to control epidemics (Jaries et al., 2017). This retrospective cohort study among 121 recently diagnosed patients at the French Guiana -Suriname border suggests that the majority of HIV-patients are male (male-to-female ratio 0.8) and of foreign (not French or Suriname) origin (85%). Almost three-

quarters of identified HIV-patients were undocumented migrants (72%); increasing their vulnerability and reducing the chances of optimal treatment behavior (ibid.). Twenty-one percent of the patients followed during this study were living in Suriname.

5.3 Biomechanical and physical hazards

Biomechanical hazards such as heavy workloads, repetitive tasks, long working hours and unsafe equipment can lead to the development of musculoskeletal disorders, the most common of which are shoulder disorders, fatigue and lower back pain. Physical hazards form a broad category that includes vibration, loud noise, heat and humidity, and radiation, all of which are present in ASM (WHO, 2016).

Although no specific data on biomechanical and physical hazards with regard to Suriname's small-scale miners exist, we can assume that the above-described hazards are experienced by ASM miners in Suriname, with an increased risk for those mining in tunnels or under water. The listed types of hazards could possibly be addressed through improved mining engineering and protective equipment. However, this is not often executed, presumably because of a lack of organization and formalization. Fatal accidents that are reported by the Suriname media are most often the result of ATV accidents and the collapse of a sand hill, or may be attributed to escalated disagreements and quarrels. There is, however, no general record that keeps track of accidents, and over the years we have heard of many fatal accidents that were never reported to the police or recorded.

5.4 Other health issues

5.4.1 Alcohol and drugs use

The mobile and migratory nature of small-scale miners, coupled with the harsh and often lonely working and living conditions, create an enabling environment for drug and alcohol use (Heemskerk and Duijves, 2012). Drugs found in the mining areas include marihuana, cocaine, crack and hashes. (Police commander RBT at Antonio de Brinco, pers. com. 19/03/17). Observations and interviews in mining areas throughout Suriname suggest that marihuana is by far most common and particularly popular among Suriname gold miners. This drug is often planted locally.

A consulted Police Commissary with several decades of working experience in Suriname's ASM areas, the drugs problem in ASM areas is ever increasing, especially for cocaine (Com. Amier, Policy advisor region East, KPS, pers. com. 30/03/17). Cocaine is used in the form of blaka jonko (purified coke mixed with marihuana, is smoked), base (purified, heated and inhaled through the mouth) or raw cocaine (sniffing). The Police Commissary estimated that 1 out of every 20 to 25 persons in ASM (occasionally) uses some form of cocaine. When cocaine users become addicts they become a nuisance to their surroundings. The equipment owners do not want a junky on their team, and also the stores chase them away as they involve in petty theft. One mining experts suggested that hard drugs such as cocaine are more often used among people in spin-off activities such as commercial sex workers, as intoxicated gold miners pose a risk to themselves and others (Paansa, pers. com. March 15, 2017).

Furthermore, women working in the cabarets may use XTC. None of the respondents had seen or heard about injection drugs, and in the many years of research in ASM areas we never encountered evidence thereof. Also heroine does not appear to be used.

Alcohol is used daily and by virtually everyone, male and female alike; it is part of the sector. As compared to local gold miners, who are relatively more frequently observed using marihuana, migrant gold miners and mining service providers are more likely to use alcohol. A 2012 survey among CSW found that more than half of surveyed CSW reported that they drank more than six cans or bottles of alcohol in an evening. Besides, observations in and around the cabarets in the evening and early morning hours suggest that alcohol consumption of small-scale miners is considerable. Stakeholder interviews suggest that alcohol consumption occurs most frequently in weekends and at off days.

5.4.2 Access to health care

In Suriname primary health care is provided by three actors; the Regional Health Service, the Medical Mission Primary Health Care (MZ), and by general practitioners. In the interior the Medical Mission is the only primary health provider and its clinics are located in Maroon and Indigenous villages. Even though for many inhabitants of mining areas the MZ health posts are the nearest by location to obtain medical assistance, most often only local miners make use of this facility. Migrant miners in need of medical help and Suriname miners who are not in the area of an MZ clinic, go to Paramaribo or, when working near the Suriname –French Guiana border, French Guiana. In addition, inhabitants of ASM areas rely a lot of home remedies and Over-The-Counter (OTC) medication (pers. comm. Ms. Pereira de Paulo. March 19, 2017).

Urban organizations that offer health related services generally do not provide services in the interior with the exception of the MoH Malaria Program which is the only health program offering services in the mining areas, even in local and migrant's languages. The services provided by the Malaria Program target anyone in the mining areas, regardless of nationality or legal status.

5.5 Occupational safety and health regulations

Most workers in ASM operations do not abide by general occupational safety and health regulations. Although article 4.1 of the Mining Decree determines specifically that "all mining activities …….should take into account prevailing norms concerning safety and health of workers" workers are not protected by this stipulation. In general these regulations are not complied with nor enforced (NIMOS, 2003). Among the exceptions is Nana Resources NV, a middle-sized gold mining company. This company has a total of 90 employees; 10-15 with a permanent contract and others are contractors. Everyone falls under the accident (SOR) insurance and both employees and contractors receive health insurance through Nana Resources. In addition, **Personal Protective Equipment** (PPE) policies to protect the employees have been designed and activated per department (pers. comm. Mr. Doorson, HSEQ supervisor, March, 19, 2017. Gold miners on the concession have to work according to the **Nana** Environmental Management System (NEMS), though in practice these regulations are not followed to the letter.

6. Gap Analysis

6.1 Social Studies

While much has been written about some topics, other issues have remained minimally researched. The main gaps in socio-economic studies related to ASM include those below:

Trafficking in ASM areas. Reports on trafficking in persons in ASM areas are contrasting. On the one hand, the previous Minister of Justice and Police, and the annual US embassy Trafficking in Persons report, speak of a severe situation with many and growing cases of trafficking – particularly in the commercial sex business, including minors. Our own investigations and stakeholder interviews, on the other hand, suggest that there are incidental cases of trafficking in persons in the Suriname ASM areas. Yet according to our information, these cases are exceptions and the grand majority of CSW in ASM areas have come out of free will, and are free to come and go when they please. A systematic investigation of trafficking in persons in ASM areas, covering areas throughout the country, including CSW of different nationalities and backgrounds, and recording detailed accounts of CSW life choices, will help provide an evidence-based understanding of the trafficking in persons situation in Suriname ASM areas.

Armed robbery. We know that armed robbery of mining camps occurs, but how much, where and how has never been investigated. In order to get a better understanding of safety issues in ASM areas, it would be useful to perform a systematic survey or armed robberies in the past (3) years – based on interviews with equipment owners and concession title holders. Questions would include if the camp has ever been robbed, when was the last time, how often in the past year, how many criminals, how were they armed, has a police report been filed and so forth.

Money flows. We know little about where the money earned with ASM goes to. Observations suggest that not much is invested in the communities, and different efforts to collect money from ASM miners for community projects have been short-lived. It would be useful to better understand money flows in the sector (e.g. who gets what, spending patterns, debt systems) as well as options for sustainable community investments.

6.2 Environmental studies

With regard to the environmental impacts of mining, the main gaps are listed below:

Present impacts of historic bauxite mining. There are indications of many forms of contamination, but systematic, independent research has been minimal. In order to be able to start a high quality rehabilitation process after almost a century of bauxite mining in Suriname, we need to know, among others: the presence and levels of contaminants (esp. toxic materials) in red mud; exact location and property of landfills – incl. possible connection with aquifers; exact content of landfills – particularly with regard to toxic waste; extent and location of mercury contamination; location and extent of radioactive contamination; and impacts on surface and ground water.

Actual health and neurological effects of mercury in people in Suriname. Several studies have measured moderately to severely elevated Hg levels in people in different locations in Suriname. We have no data, however, about the actual health impacts of these mercury levels. Do children that display high Hg levels fare relatively worse in schools –all other variables kept equal? Have elevated Hg levels caused birth defects? And when, in what context and to whom can treatment be offered?

Gender differentiated environmental impacts of mining. There are many reasons to believe that the environmental impacts of mining do not affect women and men equally. For example, the sedimentation of creeks disproportionally affects women because women are relatively more often responsible for fetching water for drinking and other household uses. As another example, gold miners in the mining camps rarely eat river fish, but their families in forest communities - particularly in those communities that are more isolated- rely heavily on local river fish as an important source of protein. As a result, women may be more likely to be exposed to methyl-mercury through the consumption of fish. Furthermore, women bear the brunt of caring for the sick and disabled. If children or other household members fall ill due to drinking polluted water or as a result of mercury intake, this will disproportionally affect the productivity and work load of women. These gender effects have not systematically been measured.

Effect of ASM on wildlife populations. We do not know of any studies in Suriname or abroad about the impact of ASM on wildlife populations. Even though we suspect that this impact is small, a study to support this assumption is warranted. Any research on this issue must be interdisciplinary, featuring both interviews with gold miners and wildlife population counts at different distances from the mines.

Soil contamination as a result of gold mining. Little systematic research has been conducted on soil contamination at abandoned mine sites. A study of such kind should take into account the different mining methods used at different locations (e.g. milling versus sluicing) and ideally also obtain information about the mining context, e.g. the number of times a site has been mined and the amount of time that gold miners have been present at the site.

Systematic study on quantity of mercury used by gold miners. To date, our estimates of the amount of mercury used by gold miners are VERY rough, involving lots of assumptions. In order to obtain a better idea of the amount of mercury that is annually released in the natural environment we need more systematic estimates, ideally based on measurements in a sample of mining camps. Gold miners could be provided with a financial incentive to weigh the amount of mercury they add, recycle and loose during the mining cycle. A national estimate requires that we also perform a more systematic count of the number of mining production units.

6.3 Health issues

Very little research has been conducted on health issues in Suriname ASM areas. Apart from several studies on malaria (prevalence, bed net use, treatment behavior), two studies on HIV/AIDS, and occasional general observations, we know very little about health conditions among the inhabitants of ASM areas. There are a lot of areas where more systematic research is needed.

One of these areas is the **prevalence** of, and **treatment behavior** in relation to different diseases, including leishmaniasis, leprosy, chikungunya, and many common health problems such as flu.

In addition, it is important to better understand what kind of **(OTC) medications** are used by the inhabitants of ASM areas for what ailments.

Improved public health management also includes knowing when and where people seek **medical assistance**.

Finally, there is very little information about **occupational health and accidents** in the Suriname ASM sector. A systematic survey among ASM camps in different areas would be helpful to start understand the main risks, and possible areas of intervention.

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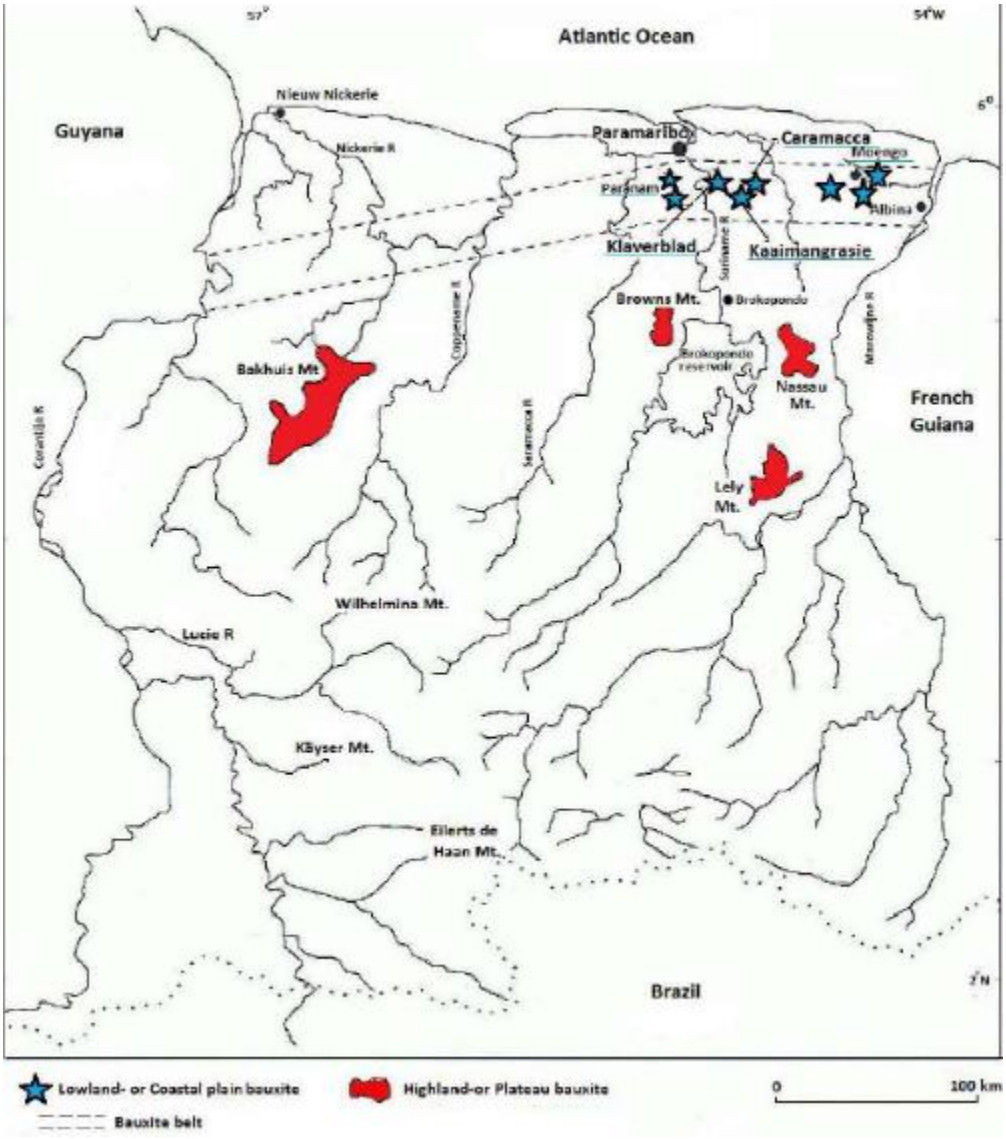
ANNEXES

Annex 1. Consulted stakeholders

Date	Name	Function	Affiliation/Location
Government			
28/03/17	Ms. J. Dragtenstein	Senior Superintendent, Chief	Trafficking in Persons, KPS
30/03/17	Chief of Police F. Amier	Policy advisor region East	Police Corps Suriname (KPS)
19/03/17	Chief of Police S. Sokarijo	Chief of Police, Eastern region	KPS, Antonio do Brinco mining area
03/03/17	Ms. A. Gemerts Ms. V. Sabajo Mr. R. Emanuels Mr. S. Mahesh Mr. A. Ramkhelawan	Geologist Geologist Mining engineer Environmental engineer Mining Engineer	Bauxite Institute Suriname (BIS)
15/03/17	Mr. B. Paansa	Chief exploration and geology	Geology and Mines Department (GMD)
08/03/17	Ms. H. Hiwat	Director	Malaria Program, Ministry of Health
08/03/17	Ms. D. Stijnberg	Monitoring and Evaluation Manager	Ministry of Health
19/03/17	Ms. C. Pereira de Paulo	Malaria supervisor	Malaria Program, Antonio do Brinco
28/03/17	Mr. S. Vreden	MD, Internal medicine and Infectious Diseases	Academic Hospital Paramaribo
Industry			
23/02/17	Ms. M. Riedewald	Community Relations Officer	Staatsolie
15/03/17	Ms. D. van Dijk	Institutional Relations Manager	Newmont Suriname
15/03/17	Mr. A. Nandlal Mr. R. Halfuid	 Director	Suralco
07/03/17	Ms. A. Lalta	Environmental Specialist	Grassalco N.V.
18/03/17	Mr. “Para”	Equipment owner	Antino
18/03/17	Ms. Bellarmina and spouse	Equipment owners	Antino
19/03/17	14 women, anonymous	Commercial Sex Workers	Antonio do Brinco, Peruano, Benzdorp
27/03/17	Mr. M.	Scalian shareholder and equipment owner	Saracreek/Brokoondo lake
26/03/17	Mr. J. Plein	Equipment owner and board member of Makamboa	Nieuw Koffiekamp
26/03/17	Mr. M. Asalobie	Equipment owner and traditional rights holder	Merian area
18/03/17	Mr. Delano	Mine coordinator/manager	Yellow Star Mining NV, Dehoy (Benzdorp general area)
25/03/17	Ms. Iolete	Bar/restaurant owner	Paramaribo North

18-19/03/17	Various	Nana Resources staff, ATV driver, show owners, other mining service providers	Benzdorp, Antino, Antonio do Brinco, Peruano
Academics			
	R. Finkie	Faculty of Mining	ADEK University, Department of Mining
01/03/17	P. Scheepers	Associate Professor Toxicology	Radboud University Nijmegen
NGOs			
	Ms. K. Schaefer	Executive Director and Founder	Artminers Institute for Sustainable Mining

Annex 2. Bauxite deposits and mines



Source: D.J. La Point, in World Bank, 2015