Mercury
Country Situation Report

Indonesia

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Acknowledgment

We take this opportunity to thank all those who were instrumental in compiling and contributing this report. This report presents updates on mercury situation in Indonesia. The report also recommends action steps by different stakeholders to protect the community from exposure to mercury.

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List of Abbreviation

ASGM	Artisanal and Small-scale Gold Mining
APRI	Asosiasi Petambang Rakyat Indonesia (Association of Indonesian Community Miners)
BPPT	Badan Pengkajian dan Penerapan Teknologi / Agency for Technology Assessment and Application
ESDM	Energi dan Sumber Daya Mineral
IPR	Izin Pertambangan Rakyat
IUP	Izin Usaha Pertambangan/Mining Lisence
KLHK	Kementerian Lingkungan Hidup dan Kehutanan (Ministry of Environment and Forestry)
MA	Mahkamah Agung
PESK	Pertambangan Emas Skala Kecil (ASGM)
Perpres	Peraturan President (Presidential Decree)
WPR	Wilayah Pertambangan Rakyat
WHO	World Health Organisation

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1. Introduction

In September 2017, Indonesia ratified the Minamata Convention on Mercury and became a party to the treaty.[1] The ratification has integrated into the national law through Law No. 11 year 2017.[2] Thus, Indonesia is committed to abiding by the legal obligations that bind the parties to the Minamata Convention on Mercury.

The Minamata Convention on mercury aims to protect human health and the environment from the emission and release of mercury from anthropogenic sources and mercury compounds.[3] In general, this convention combines measures in the form of obligations with voluntary actions. Some articles are completely voluntary, including provisions regarding contaminated sites (Article 12); health aspects (Article 16); research, development and monitoring (Article 19); and implementation plan (Article 20) (IPEN, 2013). Financial assistance to assist the government and other stakeholders in implementing this convention is likely to be prioritized for mandatory actions.

Due to the rampant use of mercury, although in March 2017, the President of Indonesia, Joko Widodo, already issued 7 instructions of President and prohibit the use of mercury in mining sector, mercury still traded widely and illegally in many ASGM sites of Indonesia.[4]

Miners and communities near gold processing centres, burning unit, and gold shops exposed to mercury vapour above dangerous level set by the WHO (Serikawa et al., 2011) (Bose-O'Reilly et al., 2017). A mercury inventory report identified that almost 60% of the mercury emission or approx. 307,125 kg Hg/year released to the air came from ASGM sector (Dewi & Ismawati, 2018).

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[1] United Nations Treaty Collection. Source: https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVII-17&chapter=27&clang=_en, accessed by 25 February 2018.

[2] Undang-undang No. 11 Tahun 2017 tentang Pengesahan Minamata Convention on Mercury (Konvensi Minamata mengenai Merkuri), LN No. 209 Tahun 2017, TLN No 6125.

[3] UNEP. (2017). The Minamata Convention on Mercury text. Source: http://www.mercuryconvention.org/Portals/11/documents/publications/MinamataConventiontextEn.pdf accessed by 25 February 2018.

[4] President Orders to Stop Mercury Use in Traditional Mining. https://en.tempo.co/read/854535/president-orders-to-stop-mercury-use-in-traditional-mining 10 March 2017, accessed by 20 February 2018.

A study in Aceh shows that smelters workers (burning unit) have more chronic neurological disturbances than non-smelter (64.3% vs. 30.6%). For acute neurological disturbances, smelters and non-smelters nearly the same (19.0% vs. 19.4%) (Sofia, Ibrahim, & Risqa, 2016). Based on the available data, another study revealed that between 18% to 23% of Indonesia artisanal miners suffered from Chronic Metallic Mercury Vapour Intoxication or CMMVI (Steckling et al., 2017).

IPEN's study in 25 countries showed that Indonesian women, have average total mercury concentration of 9.4 mg/l (Bell et al., 2017). Various studies shows elevated level of mercury in rice, fish, food chain, and the environment that affected communities' health (Sarah E. Rothenberg et al., 2017; Yudiantoro et al., 2017). An elevated level of blood pressures, neurological symptoms, renal system, etc. (Ekawanti & Krishnayanti, 2015) (Sari, Inoue, Matsumoto, & Yokota, 2016) (Foundation, 2015).

In 2017, ASGM practices -active and non-active- spread out in more than 1200 hotspots, located in 93 regencies in 30 out of 34 provinces of Indonesia. Indonesian small-scale miners association (APRI/*Asosiasi Petambang Rakyat Indonesia*) recently claimed that they have one million member of gold miners formally registered as APRI members and used mercury more than 3000 tonnes a year.[5]

As the follow up of ratification, the Indonesian government were preparing and conducting several consultation meetings to develop the National Implementation Plans and roadmap to eliminate and reduce mercury. BaliFokus and ICEL have been invited by the Ministry of Environment and Forestry to attend a couple of preliminary meetings and submitted recommendations for the roadmap.

This report will divided into three chapters. Chapter 1 will be consisted on nine sections and will introduce the background of the study (Section 1) followed status of regulations related to mercury and cinnabar (Section 2). The next section will describe the sources of mercury emissions and releases based on a mercury inventory assessment using UNEP's Toolkit for identification and quantification of mercury releases (Section 3). In this section, there will be a brief discussion about the major sectors that contributed to the Indonesian mercury emissions and releases.[6]

The section will be followed by mercury supply, availability, and trade and explore the cinnabar mining and processing into mercury in several locations in Indonesia including mercury as by-products from oil and gas sector (Section 4). The next

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[5] Personal communication with APRI leaders, 2017.

[6] UNEP Mercury Inventory Toolkit. https://www.unenvironment.org/explore-topics/chemicals-waste/what-we-do/mercury/mercury-inventory-toolkit accessed by 20 January 2018.

section will provide highlights of mercury-added products manufactured and sold in the Indonesian market including in e-commerce platform (Section 5).

The level of mercury pollution will be discussed in the next section (Section 6). This section will include a brief description of mercury pollution in national parks, protected forests and biodiversity-sensitive areas. The issues of mercury waste, mercury-contaminated sites, and mercury storage will be discussed the Section 7. The report will be address the level of human exposures to mercury reflected in some biomarkers stated in several recent studies in Section 8. In the last section of Chapter 1, the report will explain briefly about current projects related to mercury in Indonesia and establishment of mercury stakeholders including the committee to monitor and research on mercury (Section 9).

Chapter 2 will cover the project outcomes including several sections explaining how the project was conducted, communication with stakeholders, and relevant informations related to focal point of mercury and references.

Chapter 3 of this report will presents the recommendations submitted by BaliFokus to the Ministry of Environment and Forestry as the focal point of the Minamata Convention on mercury.

Fig. 1. Cinnabar mining in West Seram regency. Photo credit: Tommy Apriando/Mongabay

2. Regulations Related to Mercury and Cinnabar

Under Indonesian law, mercury is regulated under the category of Hazardous and Toxic Substances (Bahan Berbahaya dan Beracun or B3) that require permits to import and allowed to be used for restricted purposes. In Article 1, Government Regulation No. 74 year 2001, restricted use of hazardous substances defined as "hazardous substances that are restricted in use or application, importation and or its production (B3 yang dibatasi penggunaan, impor dan atau produksinya)".[7]

Further, in Article 7 and 8, for the exportation and the importation of hazardous substances with restricted use (mercury included in this category), exporter and or importers must send notifications to the destination country as well as transit country/countries.

As mandated by the Minamata Convention that party has to develop the National Implementation Plan to implement all the agreed provisions in the treaty, Indonesian government and stakeholders currently developing the National Implementation Plan.

The Indonesian Centre for Environmental Law (ICEL) identified several gaps in the mercury regulatory framework as following:

1. For export and import provisions, it is necessary to stipulate in the National Implementation Plan or in the Minister of Trade Regulation which regulates additional requirements regarding written approval and certification applied for mercury export and import activities.
2. For cinnabar mining, there must be a revision of Government Regulation No. 23 year 2010 and ESDM Regulation No. 25 year 2016, that cinnabar or mercury is no longer included in metal mineral commodities.
3. It is necessary to develop a sustainable remediation strategy by establishing a list of national priorities for the sites to be characterised, including former cinnabar mining sites, sustainable remediation and rehabilitation measures and the sources of funds.
4. There is no technical regulation regarding the classification and standard of handling, storage and the final treatment process for mercury as confiscated mercury or cinnabar ore. There is a need for socialisation to the police and district attorney apparatus for handling and storing mercury as seized items.

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[7] Indonesian Government Regulation No. 74 year 2001 on Hazardous and Toxic Toxic Substances Management - http://www.flevin.com/id/lgso/translations/JICA%20Mirror/english/32.PP%2074%20TAHUN%202001.eng.html accessed 5 August 2018.

Table 1 presents several relevant regulations regarding cinnabar ore and mercury.

Table 1. Several relevant regulations on cinnabar ore and mercury

Form of mercury	Sector	Relevant Regulations
Cinnabar ore	Mining	Law of the Republic of Indonesia No. 4 year 2009 on Mineral and Coal Mining, Chapter 23, Criminal Provisions, Article 158-165
	Import	Law of the Republic of Indonesia No. 4 year 2009 on Mineral and Coal Mining no prohibition to import cinnabar
	Export	Prohibited by the Minister of Trade Regulation on Export Provisions of Mining Products of Processing and Purification of Mining Products, Permendag No.1 year 2017, Article 3. Law of the Republic of Indonesia No. 4 year 2009 on Mineral and Coal Mining. As of 2014 the law mandated mineral producers to build mining processing/smelters so that the minerals exported in form of 99% processed raw metals.
	Supply/ procurement and trade	Not prohibition, but could be a subject of Law of the Republic of Indonesia No. 4 year 2009 on Mineral and Coal Mining and the Ministry of Trade Decree No. 75 year 2014
Elemental mercury	Production	Law of the Republic of Indonesia No. 4 year 2009 on Mineral and Coal Mining, no prohibition
	Packaging & labelling	Government Regulation *(Peraturan Pemerintah)* No. 74 year 2001, Articles 15 and 16; Ministry of Environment Regulation No. 03 year 2008 regarding Symbol and Label of Hazardous Substances; Regulation of the Minister of Industry of the Republic of Indonesia No. 23/M-IND/PER/4/2013 concerning Amendment to the Regulation of the Min. of Industry No. 87/M-IND/PER/9/2009 on Harmonisation System.
	Supply/ procurement, and trade	The Min. of Industry and Trade Regulation No. 254/MPP/Kep/7/2000 concerning concerning the Procedures for the importation & Circulations of Certain Hazardous Materials, Min. of Industry and Trade, classified mercury as B2 (Haz. Substance) in the Annex I; Prohibited by the Ministry of Trade Decree No. 75 year 2014, but allowed for limited use by the Government Regulation *(Peraturan Pemerintah)* No. 74 year 2001; The Ministry of Trade & Industry Decree No. 478/MPP/KEP/7/2003.
	Import	Prohibited by Environmental Act No. 32 year 2009 article Article 69; the Ministry of Trade Decree No. 75 year 2014; notifications from trade partners required by Government Regulation *(Peraturan Pemerintah)* No. 74 year 2001. Ministry of Environment Decree No. 2 year 2010 regarding the Use of Electronic System of Hazardous and Toxic Materials Registration in the Indonesia National Single Window (INSW) Framework.
	Export	No prohibition to export mercury but subject to Government Regulation *(Peraturan Pemerintah)* No. 74 year 2001. Ministry of Environment Decree No. 2 year 2010 regarding the Use of Electronic System of Hazardous and Toxic Materials Registration in the Indonesia National Single Window (INSW) Framework.
Mercury wastes	Storage	Environmental Ministerial Regulation Number 30/2009 regarding Norm, Standard, Guideline and Criteria for Local Goverment Policy on Storage and Collecting Facilites of Hazardous Waste

3. Mercury Inventory Assessment

The mercury inventory report identified five major sectors that contributed to Indonesian mercury emissions and releases as shown in Table 2 (Dewi & Ismawati, 2018).

Table 2. Major sources of mercury emissions and releases in Indonesia (2017)

No.	Major sources	kg of Hg/year	Percentage
1	Gold extraction with mercury amalgamation	244,125	69.7
2	Other materials production *5*8	16,946	4.8
3	Use and disposal of other products*7	16,238	4.6
4	Waste deposition *1	14,625	4.2
5	Coal combustion and other coal use	13,902	4.0

Note

**1: Waste is not an original source to mercury input to society. To avoid double counting of mercury inputs from waste and products in the graphs, only 10% of the mercury input to waste incineration, waste deposition and informal dumping is included in the chart for mercury inputs. These 10% represent approximately the mercury input to waste from materials which were not quantified individually in Inventory Level 1 of this Toolkit.*

**5: Includes production of cement and pulp and paper.*

**7: Includes thermometers, electrical switches and relays, light sources, batteries, polyurethane with Hg catalyst, paints and skin creams with Hg, blood pressure gauges and other manometers, lab chemicals, and other lab and medical uses.*

**8 To avoid double counting, fossil fuel mercury contributions to cement production was subtracted automatically in the TOTALS.*

Source: Dewi & Ismawati, 2018

Kania Dewi (2018) report stated that Indonesian small-scale gold miners used more mercury, between 20 to 60 gram, to obtain 1 gram of gold. As a comparison, miners in other ASGM countries in average used 5–10 g of mercury per gram gold produced) (Lee Bell, 2015; Telmer & Stapper, 2007). Most miners believed that the more they add mercury into the mixture, either in the ball-mills or during the panning, they will get more gold. In reality, that's not the case.

There are three methods or practices used by illegal gold miners to get the ore. The first method is by dredging rivers, mainly for alluvial deposit along the river. In some ASGM hotspots in Sumatra and Kalimantan, miners also using heavy equipment, i.e. excavator. The second method, uses a raft that contains a machine to suck sand and rocks in the river. Miners and communities called this method "dongpeng" - the term refers to a pump and generator set branded Dong Feng, made in China. This practices still can be found in several big rivers in Sumatra and Kalimantan. The third method is by making a hole the size of a human body or called a "pinhole" or "*lubang*", for primary rock deposit in the mountain areas.

The hole can be as deep as 100 meter, most of the time equipped with an air blower unit to supply air for miners who works inside the mining pit.

Mercury used directly in the alluvial mining sites to catch gold, by the side of the rivers or lakes. While for the primary rock, mercury usually added or used in the processing centres, not far away from the mining pit or in the nearby villages. Further, after the amalgam nugget formed, miners will burn it at the gold shops/ kiosks or in any burning unit in the village, at the backyard or in their kitchen.

As confirmed by other studies, most mercury used in ASGM hotspots are locally sourced or domestically produced in Seram Island, Maluku Province and West Kalimantan, and then distilled or processed in several places in Java (Bogor, Sukabumi, Bekasi, and Jombang) and sold in the local market cheaper compared to the imported mercury from Germany, Spain, etc. (Baiq Dewi Krisnayanti, 2018; Spiegel et al., 2018).

Fig. 2

Gunung Botak, Buru Island ASGM hotspot.

Photo credit: Mongabay

Fig. 3

Hundred years old nutmeg plantations destroyed by ASGM activities and acid drain water.

Photo credit: Mongabay

Fig. 4 Illegal gold mining in the middle of a river in Kalimantan.
Photo credit: Larry C.Price/Pulitzer Centre on Crisis Reporting.

Fig. 5 Mercury poured into the carpet on of a sluice box in a river in Kalimantan.
Photo credit: Larry C.Price/Pulitzer Centre on Crisis Reporting.

Fig. 6 A gold processing centre collectively owned by 4 families. The owner of the land rented the space and charged the rent based on the number of ball-mills.
Photo credit: Yuyun Ismawati/BaliFokus.

Fig. 7. The price of one kilogram of mercury in West Sumbawa in March 2018 was IDR 650,000 per bottle (approx. USD 47.30). Photo credit: Yuyun Ismawati/BaliFokus.

4. Mercury Supply, Availability, and Trade

In 2012, the USA prohibited the exportation of mercury, followed by the EU countries in 2013 (UNEP, 2017). In response to the declined supplies from overseas, in 2012, Indonesian miners started exploiting cinnabar ore, mined in West Seram Island, Maluku Province, and then processed in Sukabumi, West Java Province, and Jombang, East Java. BaliFokus staff went to West Seram Regency in February 2018 with a Japanese consultant to learn more about the situation of cinnabar mining that became the source of mercury supplies for Indonesian miners.

In Seram Island, cinnabar had been extracted since 2013 without permit or license. The government of Indonesia officially shut down of the cinnabar mining in Seram Island in 2016. The peak time of the cinnabar mining operation was between late 2014 and early 2015. Initially, miners from Java came to the island in order to research gold deposit, however they discovered high concentration of cinnabar instead of gold. Due to high demand of elemental mercury by ASGM sector and the mercury export bans in the US and Europe entered into force, cinnabar mining rush and processing in Indonesia had started in 2013.

Prior the cinnabar mining rush, about 10,000 inhabitants of Luhu Village were well known clove, nutmeg, and cocoa farmers and fisher folks. When they learned that their village is sitting above the high quality of cinnabar deposits (60%-69%), many farmers switched their professions to become miners. The community of Iha village also claimed the mining sites as their territory.

The community of Luhu followed the steps of Iha villagers to mine cinnabar. They are aware that the mineral deposits should benefit the broader populations. Later, Iha villagers followed Luhu villagers' policy and applied tax for the revenue from cinnabar ore trade. Within seven months, the chief of the village managed to collect IDR 100 million (approx. USD 7,000) and used the fund for the village development and social purposes.

The Head of the Village was aware about the harmful effect of mercury. The community of Luhu and Iha villages agreed not to process the ore in their villages and sell the cinnabar dusts to any buyers. Their decisions and activities were supported by the local military and police officers.

Fig. 8. Location of cinnabar mining site in West Seram Island, Maluku Province.
Map credit to Osamu Sakamoto/EXRI.

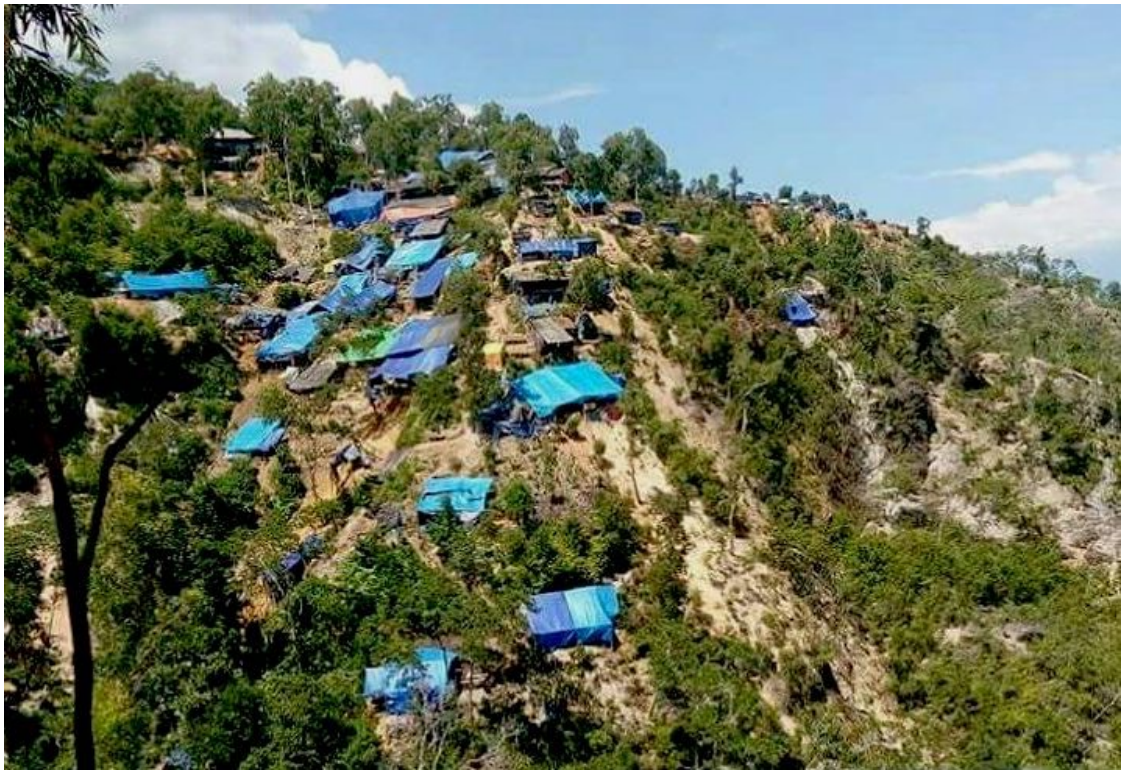

Fig. 9. Illegal cinnabar mining in Iha village, Huamual Sub-district, West Seram Regency.
Photo credit: Kumparan, 20 March 2017.

Buyers of cinnabar ore from Seram came from various cities in Indonesia, as well as from neighbouring countries, including buyers from China, UAE, and Singaporean buyers (Ismawati, Zaki, Buftheim, Septiono, & Arif, 2017).

Fig. 10. One of the boys who was forced by his parents to 'help' them in the mine site. Photo credit: Tio/BaliFokus, 2018.

Fig. 11. Communities, including children, of Luhu and Iha villages worked at the bottom of the cliff. Photo credit: Tio/BaliFokus, 2018.

Fig. 12. Women also participated in washing the cinnabar ore in a pool of water, in a naturally-shaped pond. Photo credit: Tio/BaliFokus, 2018.

Although the location of cinnabar mineral deposits is located in the cliff and risky, communities and miners still considered this challenge was worth to pursue. During the peak time, more than 3,000 people lived in the mining site (including miner's family). In addition, many merchants came to the mining site to sell meals and daily staffs for miners. Following the mining activity, prostitution was rampant, and it became social problem during the peak time.

Fig. 13. Male miners, wash the cinnabar ore in a 'smarter' way to prevent the losses of cinnabar dusts into the waterways. Photo credit: Tio/BaliFokus, 2018.

Fig. 14. A women miner sold her washed cinnabar to get some cash for her family.
Photo credit: Tio/BaliFokus, 2018

Fig. 15. Two middle-men preparing sacks of cinnabar dusts to be transfer to buyers.
Photo credit: Tio/BaliFokus, 2018

Fig. 16. Major Cinnabar Mine and Potential Destination of the Cinnabar extracted in Seram Island. Source: EXRI report Note: Legend: Blue spots are major cinnabar mines in Indonesia. Red spots are potential destination of cinnabar extracted in Seram Island.

Processing facilities are mainly located in Sukabumi Regency, Bekasi Regency in West Java Province and in Jombang Regency, and Surabaya City in East Java Province. Most processing facilities are also illegal, small-medium home-industry scale, and released mercury vapour and contaminated soil around the village. A survey conducted by the Ministry of Energy and Mineral Resources in 2017 revealed that one million miners in Indonesia used about 3500 tonnes of mercury to extract 60-100 metric tonnes of gold annually (Ismawati, Zaki, Septiono, & Buftheim, 2017).

Mercury sold in various packaging in social media including the phone numbers of the traders. All mercury traders do not have permit or license to sell mercury and violated the Indonesian law. However, only small number of mercury traders were confiscated and processed in court (Ismawati, 2018).

Fig. 17. Various packaging of mercury sold in Indonesia via social media, e-commerce platform and in ASGM hotspots. Photo credit: Yuyun Ismawati/BaliFokus

5. Mercury-added Products

Product prohibition occurs by "taking appropriate measures" to "not allow" the manufacture, import, or export of new mercury-containing products. However, the sale of existing stocks is still permitted by the treaty.

The products agreed to be phased-out and phase-down are listed in the Annex A Part I and Part II of treaty respectively. Parties advised to discourage the manufacture and distribution in commerce of new mercury-added products before the treaty enters into force unless they find that a risk and benefits analysis shows environmental or human health benefits (IPEN, 2013). These 'exceptional' products have to be reported to the Secretariat, which will make the information publicly available.

The Ministry of Environment and Forestry as the focal point of Minamata Convention on mercury is currently preparing the draft of government decree to eliminate and reduce mercury. Instead of developing a National Implementation Plan, the government of Indonesia is planning to develop a National Action Plan (NAP) to reduce and eliminate mercury as a national roadmap.

Separately, a NAP to eliminate mercury in ASGM sector is currently being developed by BCRC SEA with the support from GEF through a Minamata Initial Assessment project (2017-2018). The NAP of ASGM that is currently being developed is an updated NAP for period of implementation 2019-2023.

Batteries

For batteries with mercury, data from the Ministry of Industry only show one company in North Sumatera that used mercury as a supporting material for batteries production. There is no information about the amount they used but only in form of percentage (0.02% per production). The target is to reduce the mercury use to 50% by the end of 2018.

Lamps

For lamps with mercury, until 2017, there are four lamp manufacturers that are still using mercury as their production materials. The factories are located in East Java (Surabaya and Nganjuk), near Jakarta, and Bandung. In 2018, the industry used 163 kg Hg per year. The target is to reduce Hg use to 50% by 2020, from 163 kg in 2018 to 81.5 kg. According to ARPELINDO (*Asosiasi Industri Perlampuan Listrik Indonesia*), in 2017, there were about 70 millions pieces of fluorescent tube, about 180 millions unit of Compact Fluorescent Lamp (CFL), and 130 million unit of LED lamps sold in Indonesia.

Health care devices

In 2018, about 26.6% healthcare facilities in Indonesia do not use hg-based medical devices. This was partly a result of BaliFokus' advocacy works since 2012. Started in Bali with 10 hospitals to phase out medical devices containing Hg, followed by a pilot in 5 provinces done by the Ministry of Health, and in 2017, several hospitals have already phase-out some devices (Ismawati, Zaki, Gita, & Wahyudi, 2017).

For health-care devices containing mercury, the Minister of Health issued a Circular Letter titled Surat Edaran Menteri Kesehatan No. HK.02.02/V/0720/2018 concerning the the Validity of Circulation Permit and Medical Devices Containing Mercury (Penetapan Masa Berlaku Izin Edar dan Peredaran Alat Kesehatan yang Mengandung Merkuri) issued on 8 March 2018. The validity of the permit will be only until December 2018 and the list is also include dental amalgam.

Based on the data available at the Ministry of Health, currently there are 13,037 hg-based thermometer and 6,320 sphygmomanometer or in total 21,660 unit of medical devices containing mercury are being used in various Indonesian public health care facilities. The target is to withdraw and eliminate them 100% by 2020.

Dental amalgam

Indonesian dental association do not use amalgam anymore as of December 2015. However, currently, the Ministry of Health already identified 129 unused dental amalgam capsules in several public hospitals. Some of them were unused.

The Collegium of Dentistry has revised the curriculum and excluded amalgam fillings from dentistry practices. However, the removal of amalgam still included in the curriculum without highlighting the need to have safe removal protocol and apply relevant PPEs.

The Ministry of Health of Indonesia decided to include dental amalgam under Part-I of Annex A of the treaty, to be phase out by 2020. This decision is accommodated in the Ministry of Health Decree No. 57 year 2016 concerning the National Action Plan to control mercury impact on human health.

Table 3. Part II: Products subject to Article 4, paragraph 3

Mercury-added product	Indonesia
Dental amalgam	Included in the list in the circular issued by the Minister of Health (Menteri Kesehatan) No. HK.02.02/V/ 0720/2018 concerning the Validity of Circulation Permit and Medical Devices Containing Mercury issued by 8 March 2018

Table 4. Part I: Products subject to Article 4, paragraph 1

Mercury-added products	Date after which the manufacture, import or export of the product shall not be allowed (phase-out date)	Indonesia's plan
Batteries, except for button zinc silver oxide batteries with a mercury content < 2% and button zinc air batteries with a mercury content < 2%	2020	Reduced 50% by 2020, from 0.0202% to 0.0101%
Switches and relays, except very high accuracy capacitance and loss measurement bridges and high frequency radio frequency switches and relays in monitoring and control instruments with a maximum mercury content of 20 mg per bridge, switch or relay	2020	Not available
Compact fluorescent lamps (CFLs) for general lighting purposes that are ≤ 30 watts with a mercury content exceeding 5 mg per lamp burned	2020	Reduced 50% by 2020, from 163 kg in 2018 to 81.5 kg
Linear fluorescent lamps (LFLs) for general lighting purposes: (a) Triband phosphor < 60 watts with a mercury content exceeding 5 mg per lamp; (b) Halophosphate phosphor ≤ 40 watts with a mercury content exceeding 10 mg per lamp	2020	In 2018, the industry used 163 kg Hg per year. Target: reduced to 50% by 2020, from 163 kg in 2018 to 81.5 kg. According to ARPELINDO (Asosiasi IndustriPerlampuan Listrik Indonesia), in 2017, there were about 70 millions pieces of fluorescent tube, about 180 millions unit of Compact Fluorescent Lamp (CFL), and 130 million unit of LED lamps sold in Indonesia.
High pressure mercury vapour lamps (HPMV) for general lighting purposes	2020	Not available
Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL) for electronic displays: (a) short length (≤ 500 mm) with mercury content exceeding 3.5 mg per lamp (b) medium length (> 500 mm and ≤ 1 500 mm) with mercury content exceeding 5 mg per lamp (c) long length (> 1 500 mm) with mercury content exceeding 13 mg per lamp	2020	Not available
Cosmetics (with mercury content above 1ppm), including skin lightening soaps and creams, and not including eye area cosmetics where mercury is used as a preservative and no effective and safe substitute preservatives are available*	2020	Not available
Pesticides, biocides and topical antiseptics	2020	Not available

The following non-electronic measuring devices except non-electronic measuring devices installed in large-scale equipment or those used for high precision measurement, where no suitable mercury-free alternative is available: (a) barometers; (b) hygrometers; (c) manometers; (d) thermometers; (e) sphygmomanometers.	2020	Phase-out by 2020, Circular Letter of Minister of Health (Menteri Kesehatan) No. HK.02.02/V/0720/2018 concerning the Validity of Circulation Permit and Medical Devices Containing Mercury issued by 8 March 2018.
** The intention is not to cover cosmetics, soaps or creams with trace contaminants of mercury.*		

6. Mercury emissions and releases

Indonesia's coal-based capacity stands at 24.7 Giga Watt (GW) or 44% of the total capacity of 55.5 GW (2015). Within the period of 2006 to 2015, steam-based power plant's capacity has increased at an annual growth rate of 10.4%.

In 2016, data shows that Coal-Fired Power Plant (CFPP) consumed coal more than 5 times higher compared to the level of consumption in 2000 which resulting 5 times mercury releases (BCRC-SEA, 2017). Rate of mercury release is increasing from 2010 at average of 0.27 tonne per year compared to an average of 0.08 tonne/year during 2000 to 2010 as the consequences of rapid coal utilisation as part of national priority program.

Over 80% of Indonesia's coal reserves proves to be having a calorific value of under 6,100 kcal/kg, particularly, more than 41% of reserves is found to be coals under 5,100 kcal/kg in calorific value. It is noted that high-grade coals (high: 6,100-7,100 kcal/kg) and ultra-high-grade coals (very high: >7,100 kcal/kg) are limited, but coal deposits with a calorific value of over 7,100 kcal/kg are available around two hundred million tons.

No formal standards are available for defining low-grade coals. Accordingly, low-grade coals are defined as those having calorific value of around 5,100 kcal/kg or less. These coals can be counted and categorised into sub-bituminous coals and/or lignite. Low-grade coals are found abundantly in Kalimantan, South Sumatra, Jambi and Riau. Recently, the Indonesian government has been promoting the use of low-grade coals for various purposes.

Most major coal-user countries and region have adopted very tight emission standards for coal-based power plants. In Indonesia, the standard for PM, SO_2, and NO_2 is very low compared to other countries. Indonesia does not have yet a standard for mercury emission from coal-fired power plants and other coal burning facilities.

Table 5. Emission standards for coal-based power plants in coal-users' region/countries (in mg/Nm^3)						
Country/ region	PM	SO_2		NO_x		Mercury
		New plants	Existing plants	New plants	Existing plants	
EU	50 -100	200	400	200 (after 2015)	500 (till 2015)	0.03 (Germany)
USA	22.5	160 (after 2005)	160 (1997-2005)	117	117 (after 2005); 160 (1997-2005)	0.001 - 0.006
China	30	100	200; 400*	100	100 (2004-2011); 200 (before 2004)	0.03
India	100 (till 2003); 50 (2004-2016); 30	100	600 (<500 MW); 200 (>= 500MW)	100	600 (till 2003); 300 (2004-2016)	0.03
Indonesia	150 - 100	750	750	850	750	0.03
**SO2 standard of 400 mg/Nm^3 in four provinces of China with high sulphur coal*						
Source: World Resources Institute Asia. Environmental Science and Technology and BCRC SEA						

According to the Indonesian Government Regulation regarding Hazardous Waste Management No. 101 year 2014, the standard of mercury for Landfill Class-1 is 300 mg/kg, Class-2 between < 300 mg/kg and 750 mg/kg. If the hazardous waste containing mercury has concentration >260 ppm, waste operators have to send it to another country that have capacity and technology to treat and stabilise mercury so it will be safely dispose to the environment (Hidayat, 2012).

Mercury speciation in emission can be estimated using the IPOG software (Krishnakumar, Niksa, Sloss, Jozewicz, & Futsaeter, 2012). Forty-five CFPPs in Indonesia selected in a project lead by BCRC SEA and IEA Clean Coal Centre in 2017-2018 were calculated using this software. It was estimated that around 2.9 tonnes of mercury were emitted through air which consist of 81.72% in Hg^0 form and 18.28% in the form of Hg^{2+} (BCRC-SEA, 2017).

For reducing mercury emission, availability of technology is very important. BCRC SEA (2017) collected information from 93 units power plants out of 200 coal-fired power plants in Indonesia. From the returned questionnaires, they gathered the following informations:

- 72 units are using ESP;
- 9 units are using ESP, FGD & low NO_x burner;
- 3 units are using ESP, FGD, low NO_x burner, bag filter;
- 3 units using ESP, wet FGD;

- 1 unit using multi cyclone & low NO_x burner;
- 1 unit using bag filter only; and
- 4 units using ESP & cyclone de-duster.

The type of boiler that is more efficient is the super-critical boiler which is currently used by Cirebon. It is proposed that new power plants use the super-critical and ultra-super-critical. Moreover, for a higher efficiency of mercury removal,ESP + FGD are strongly recommended for new power plants.

From the field measurement made to the three coal-fired power plants, mercury released ranged between 0.0006 – 0.003 mg/Nm^3. These values will easily meet the European (Germany) standard at 0.03 mg/Nm^3. However, not all CFPP in Indonesia generate low mercury emission. BCRC SEA study (2017) suggested a new emission standard for mercury in Indonesia at 0.03 mg/Nm^3 (30 nanogram/ Nm3).

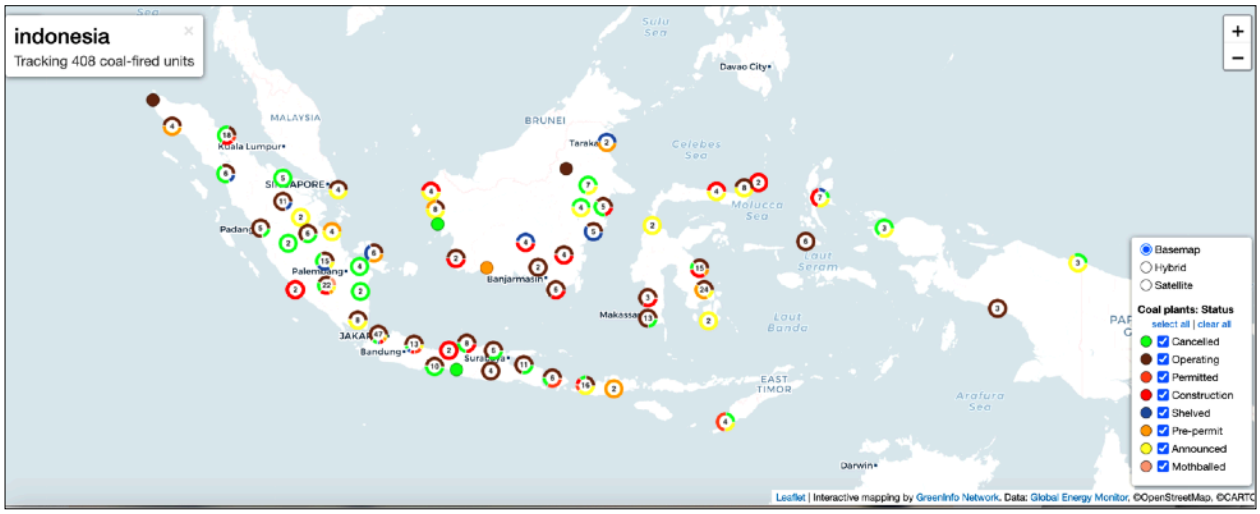

Fig. 18. Coal-fired power plants in Indonesia.
Source: https://endcoal.org/tracker/

Even though mercury concentration in emission for three coal-fired power plant samples of were ranging between 0.0006 – 0.003 mg/Nm^3, the high capacity of CFPPs will generate large volume of flue gas released. Looking at the data where mercury released from Suralaya, Cirebon and Indramayu are 9.15, 20.53 and 57.31 kg/year respectively. These figures came from only 3 plants out of 300 Indonesian. To have a more accurate and representable baseline, the Indonesian government need to collect more samples from more coal-fired power plants.

Aware of the upcoming regulation to address mercury emissions from their plants, the Indonesian coal-powered industries raised their concern and argued that the new regulation will result in higher tariff of energy generation to IDR 80-100 per

kWH. However, CSE research indicated that the impact would be far lower, IDR 40-70 per kWH (Bhati & Singh, 2017).

Pollution control equipment used in power plant can decrease emission if they used ESP, FGD and low NOx burner and optimise the co-benefits option (Sloss, 2008). New power plants should have the lowest emissions achieved so the power plants will be required to install the newer technologies such as the super-critical boiler (Bhati & Singh, 2017).

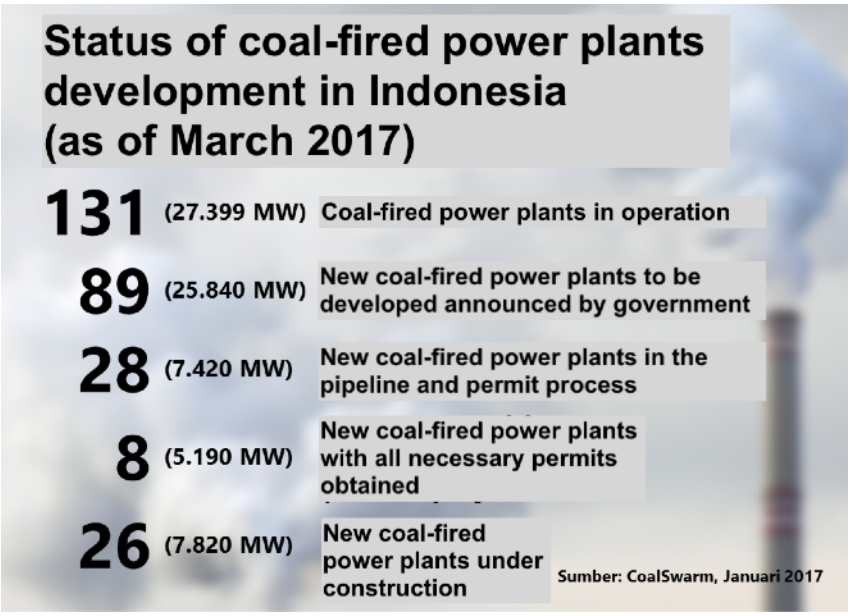

Fig. 19. Status of coal-fired power plants development in Indonesia.
Source: CoalSwarm, 2017

From the estimation of this study by year 2026 Indonesia may still contribute 7.7 tonnes (based on the UN Environment Toolkit) or 5.8 tonnes (based on IPOG) of mercury to the air from CFPP. To reduce the mercury emission, regulations will have to be developed to include technology interventions ESP, FGD and low NOx burner, Super Critical boilers, CEMS monitoring and emission load (BCRC-SEA, 2017).

However, researchers revealed that production and use of energy remains a major source of air pollution in Indonesia. More than 85 percent of the sulphur oxide and nitrogen oxide particles are released by the energy sector. At present, millions of tons of pollutants from the energy sector are released and cause premature death to reach an estimated 190 people per day in the country in 2013 (Greenpeace, 2016).

A recent study conducted by Greenpeace (2016) noted that there are coal power plant projects with a total additional capacity of 45,365 MW across Indonesia. There were 17,825 MW 'announced' projects, 17,930 MW 'pre-permit development' projects, 4,400 MW 'permitted' projects and 5,210 MW 'under

construction' projects. The total investment cost predicted about USD 58.5 billion or IDR 770 trillion.

The real cost of coal power production should include the internalisation of health cost and other types of externalities. Based on a Greenpeace's calculation based on Harvard University research, health impacts from 45,365 MW coal power plants will cost USD 26.7 billion or equal to IDR 351 trillion for every year of operation.

7. The Level of Mercury Pollutions

Mercury emissions and releases identified in the inventory report 2018 (Dewi & Ismawati, 2018) stated that the five major sources of mercury are:

1) gold extraction with mercury amalgamation;
2) other materials production;
3) use and disposal of other products containing mercury;
4) waste deposition; and
5) coal combustion and other coal use.

However, due to limited data can be obtained from relevant ministries, some information. i.e. mercury releases from oil and gas sector, are not available.

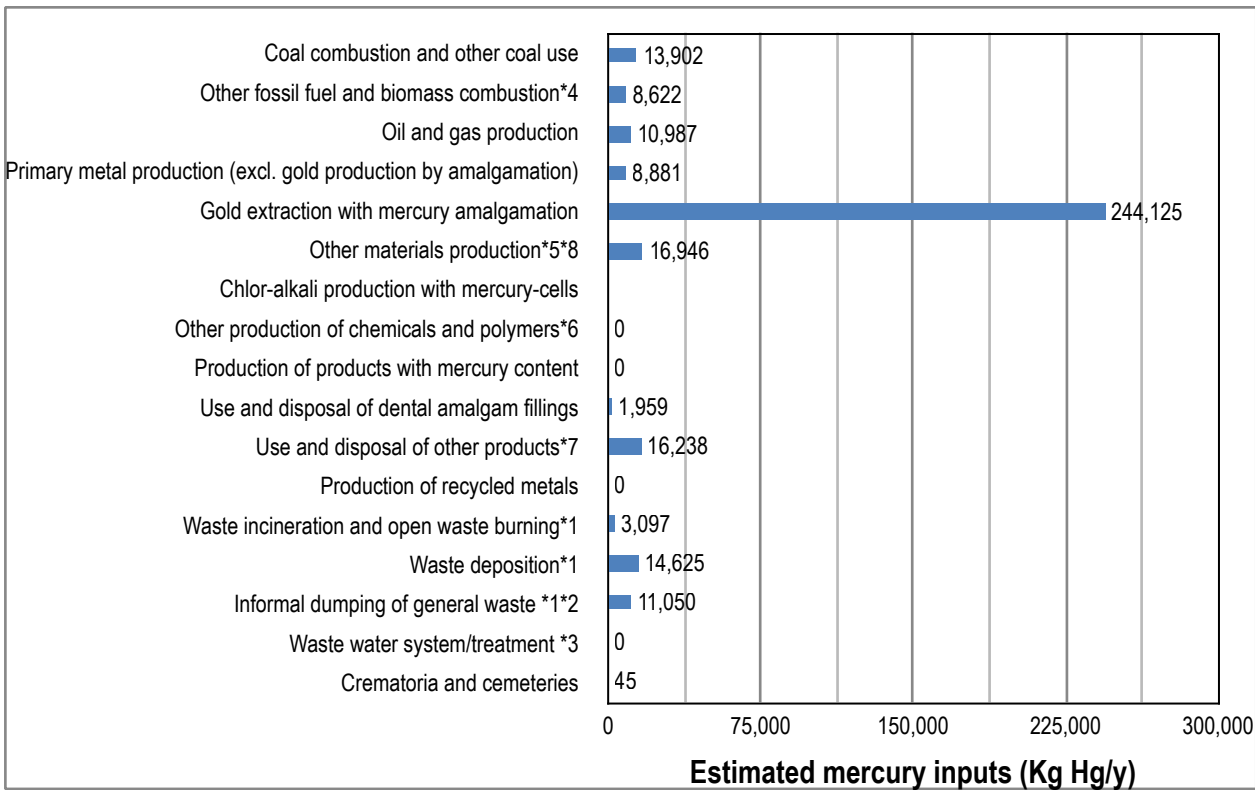

Fig. 20. Estimated mercury input per year based on sources (Dewi & Ismawati, 2018).

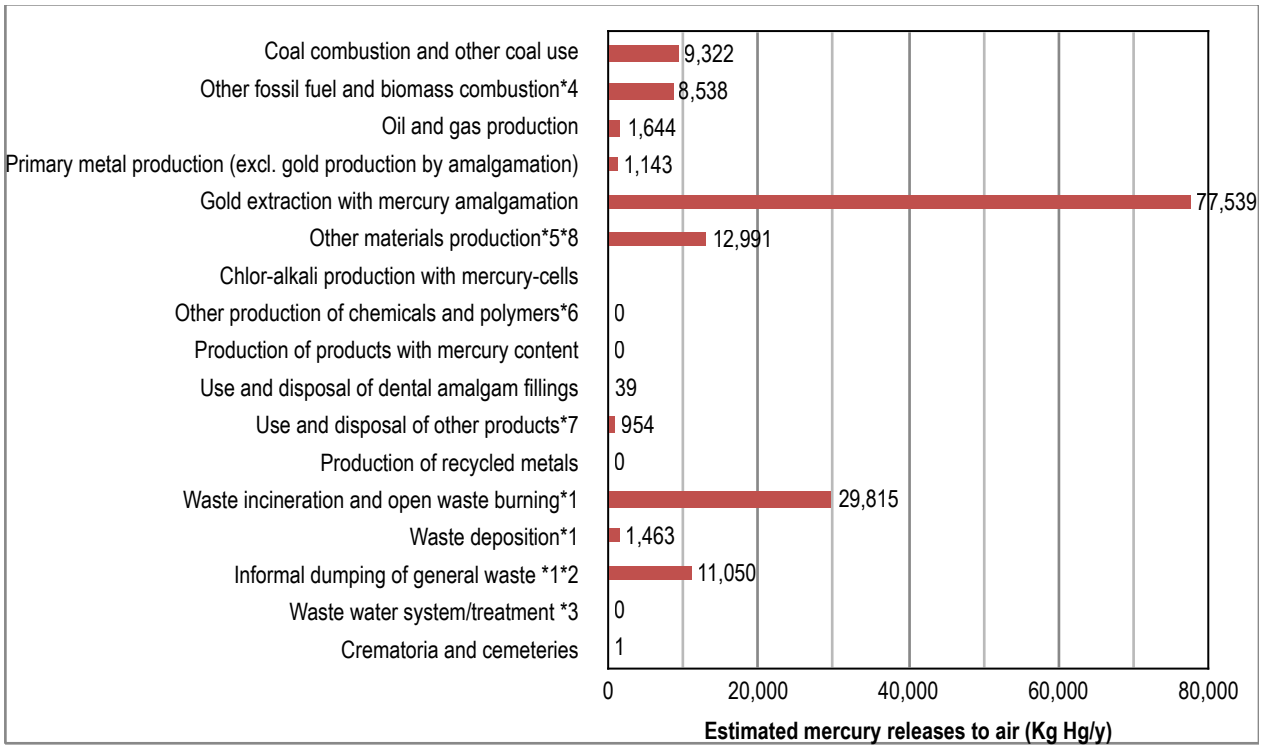

Fig. 21. Estimated mercury releases to the air based on sources (Dewi & Ismawati, 2018).

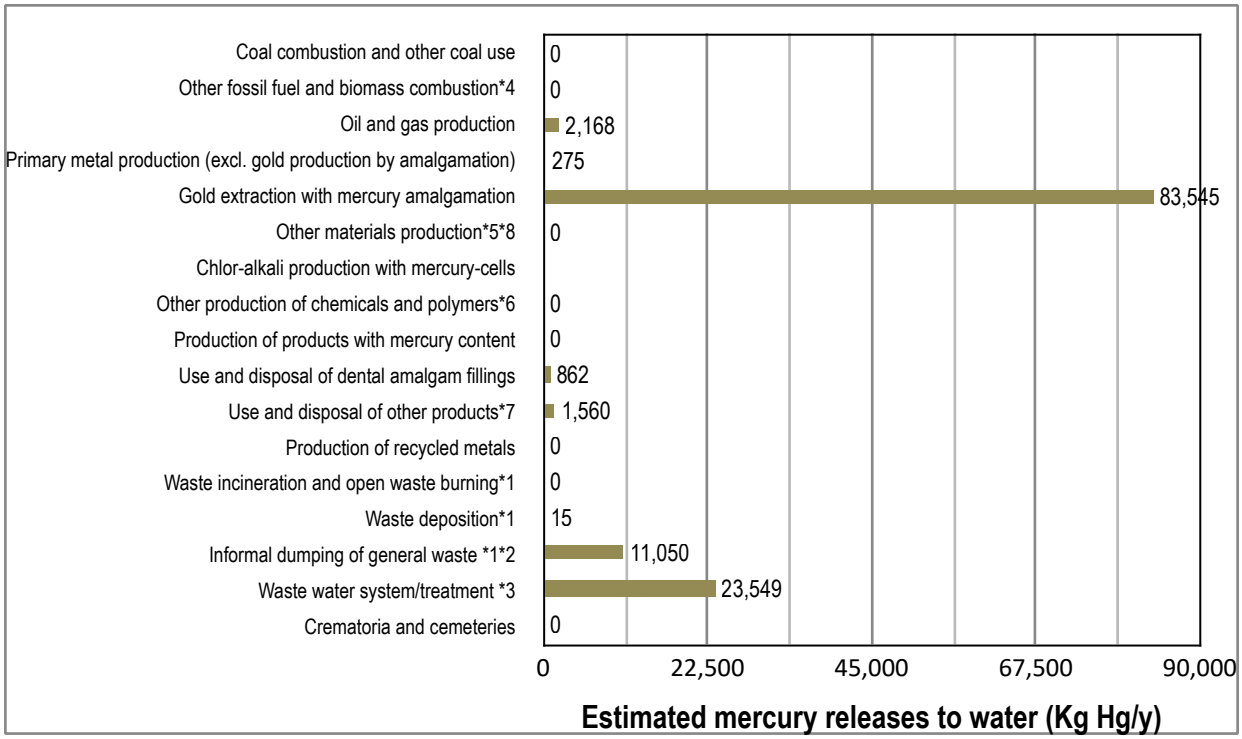

Fig. 22. Estimated mercury releases to water based on sources (Dewi & Ismawati, 2018).

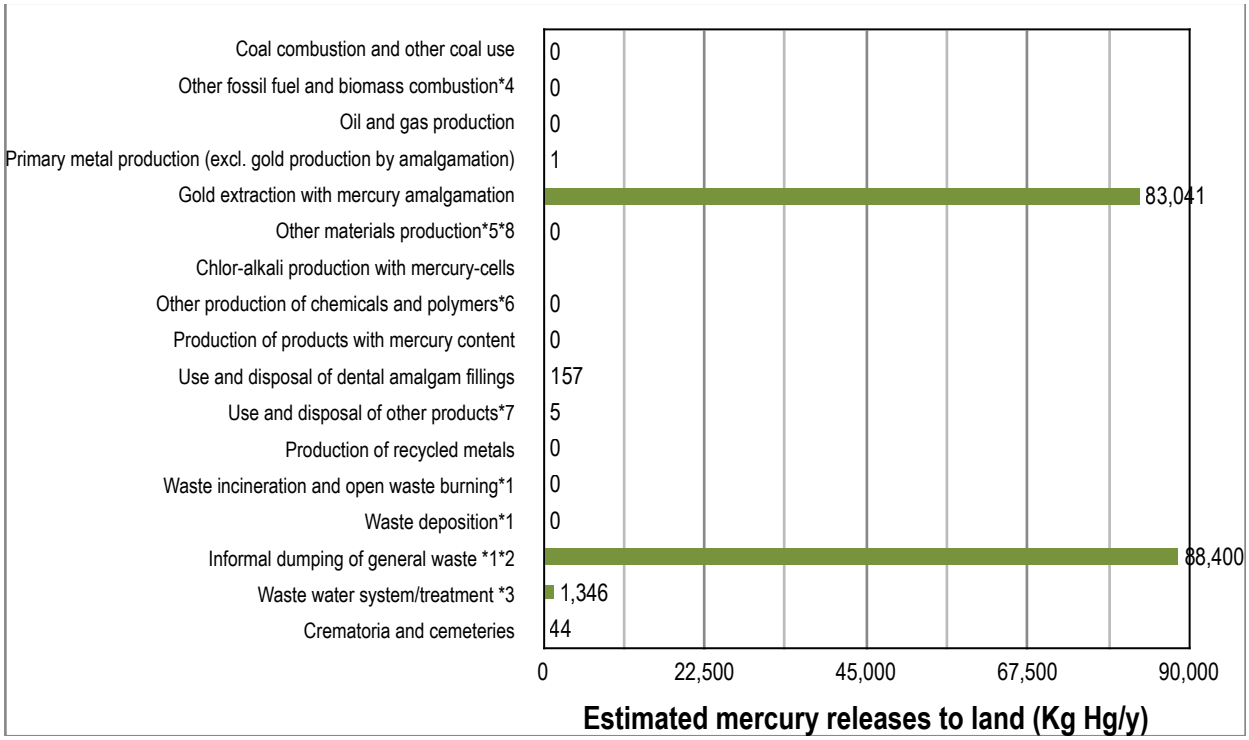

Fig. 23. Estimated mercury releases to land based on sources (Dewi & Ismawati, 2018).

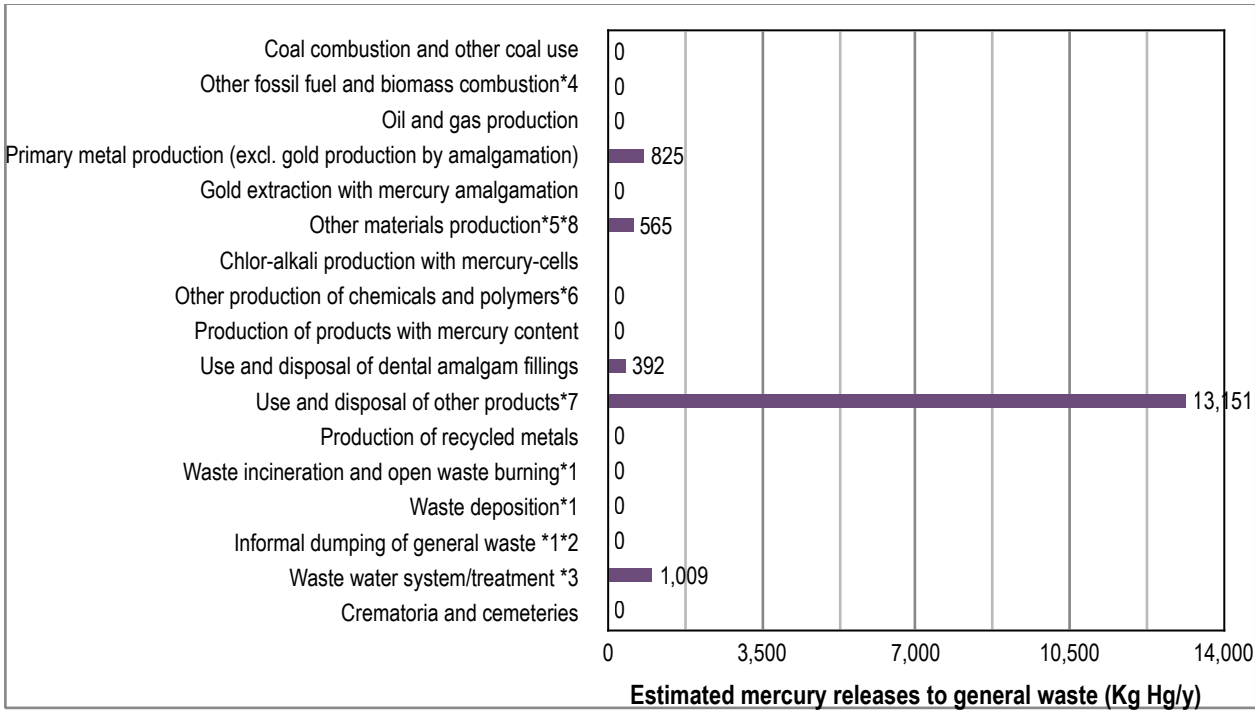

Fig. 24. Estimated mercury releases to general wastes based on sources (Dewi & Ismawati, 2018).

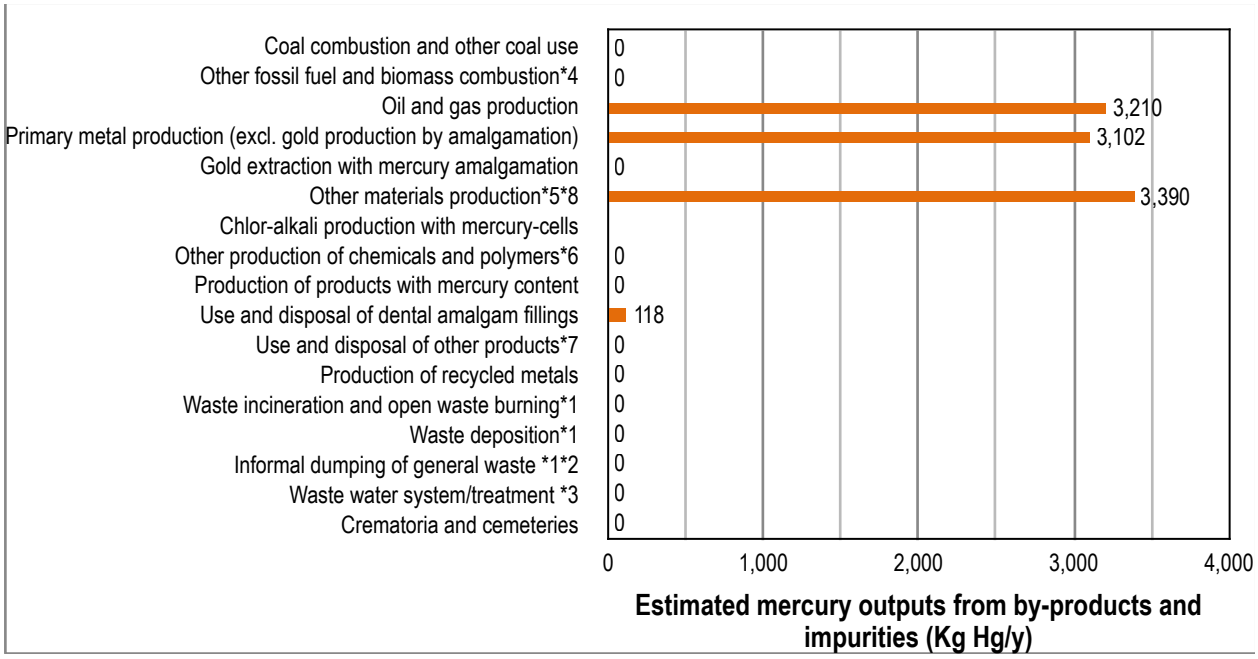

Fig. 25. Estimated mercury outputs from by-products and impurities (Dewi & Ismawati, 2018).

Several studies have shown an elevated mercury concentration in the last 5 years - period of 2013-2018 - in environmental matrices, food chain, and biomarkers collected mainly from ASGM hotspots.

A study in West Sumbawa showed that mercury used in ASGM in that area alone was about 1.25 ton per day. With the price of mercury per kg about 100 Euro, the mercury trade in West Sumbawa Regency was approx. 38,400 Euro/day or approx. IDR 630,000,000.

In Lombok, mercury in sediment from tailing was recorded 692 mg/kg (Baiq Dewi Krisnayanti, 2018). Another study in West Nusa Tenggara Province, showed that 61% of the miner's urine and 81% of the miner's hair content high mercury concentration within the alert and high levels (Baiq Dewi; Krisnayanti, Vassura, Asmara, Ekawanti, & Suheri, 2016)

In Maluku Province, Male et al. (2013) stated that a significant proportion of mercury in the tailings produced from Gunung Botak ASGM hotspot of Buru Island. The lowest concentration of total recoverable mercury in sediments from waste ponds in ball-mills processing centre was 682 mg/kg (Male, Reichelt-Brushett, Pocock, & Nanlohy, 2013). In comparison, the mercury concentrations in the mud of Minimata Bay, was ranging between 19 to 908 mg/kg (Fujiki & Tajima, 1992).

In Banyumas ASGM hotspot in Central Java, researcher found that mercury also found in papaya fruit between 0.238 to 4.361 ppm and in cacao fruit between 0.0184 to 2.448 ppm. Soil collected from Banyumas ASGM hotspot also showed concentration between 2.4 to 26.8 ppm while the reference level is 6.6 ppm (Octaviano, 2017).

In several ASGM hotspots, mercury also found in high concentration in rice, ranging from 15 ppb to 140 ppb. In comparison, the recommended safe level set by WHO is 30 ppb and the Indonesian allowable standard is 50 ppb (S. E. Rothenberg et al., 2017).

However, the percentage of methyl mercury of the Total mercury in rice from old ASGM hotspots (not too active) was lower compared to the new or active ASGM hotpots. In old ASGM hotspots, the Total mercury concentration in rice was higher compared to the new hotspots but the methyl mercury (MeHg) concentration in rice in the opposite: higher MeHg percentage found in new or active ASGM hotspots, while lower MeHg concentration found in old hotspot (Ismawati, Lelitasari, & Buftheim, 2015).

8. Mercury Waste, Mercury-contaminated Sites, and Mercury Storage

Based on data from the Directorate of Mineral and Coal Engineering and Environmental Ministry of Energy and Mineral Resources in 2017, the state losses due to ASGM using mercury with the assumption of ASGM production of 80 tons of gold per year was approximately Rp. 157 billion per year or about USD 11 million, excluding tax (BPHN, 2017).

Concerning the rehabilitation of mercury-contaminated land, the estimated recovery cost is IDR 12 million per metric tonnes soil or approximately USD 850 per tonnes. Another study identified the cost and duration of soil remediation are technique-dependent and site-specific. The costs are up to $500 per ton soil (or $1500 per m3 soil or $100 per m2 land, and might take time up to 15 years (Liu, Li, Song, & Guo, 2018).

With the large number and ASGM area that uses mercury all over Indonesia, the losses incurred are enormous for the restoration of the land. An effective in-situ remediation solutions need to be examined.

Currently, there is no mercury storage in Indonesia. Mercury wastes or waste containing mercury >260 ppm will be send abroad to another countries with proper mercury waste treatment facilities. There is no data regarding mercury wastes or waste containing mercury that publicly accessible.

9. The Level of Human Exposures to Mercury

In 2016, the Minister of Health Decree No. 57 year 2016 concerning the National Action plan to control mercury impact on human health issued. In this NAP on mercury and health, the Ministry of Health took the lead in coordinating and addressing mercury impact to human health, not only from ASGM sector but including manufacture sector, the health impact of energy generation facilities, etc. with a time frame from 2016-2020.

The main components of the NAP are capacity building, regulatory component, awareness raising, health services, and communication plans.

A study by Krisnayanti et.al. (2016) recorded the total mercury in hair sampled from miners, their families, and non-miners. The respondents are divided into three groups: respondents who are directly exposed, indirectly exposed and non-exposed communities in ASGM hotpots of West Sumbawa. The average of total mercury in directly-exposed respondents was 13 ppm in men, 16 ppm in women and 4.7 ppm in children below 13 years of age. The safe level according to WHO is 1 ppm.

The study also assess the level of intoxication using the Human Bio Monitoring method and concluded that 44% of participants suffered from chronic mercury intoxication (Baiq Dewi; Krisnayanti et al., 2016). As comparison, Steckling et.al. (2017), based on the available data, it was recorded that between 18% to 23% of Indonesian miners suffered from chronic metallic mercury vapour intoxication (Steckling et al., 2017).

10. Mercury in biodiversity sensitive areas

In Indonesia, ASGM activities are taking place in various areas, following mineral deposits history and new pieces of information. In the last twenty years, the alluvial gold deposits along several big rivers in Kalimantan and Sumatera already mined and depleted, leaving the mercury pollution in the middle of the river sediment and degraded river bank.

As the alluvial deposits depleted, in the last ten years, the artisanal miners started to explore gold deposits from the primary rocks sites in the mountains, inside the indigenous people's territory, and biodiversity-sensitive areas such as national parks, grand forest, protected forest, etc.

Fig. 26 Abandoned ASGM site along the Geumpang River, Pidie Regency, Aceh Province. Photo credit: WALHI Aceh

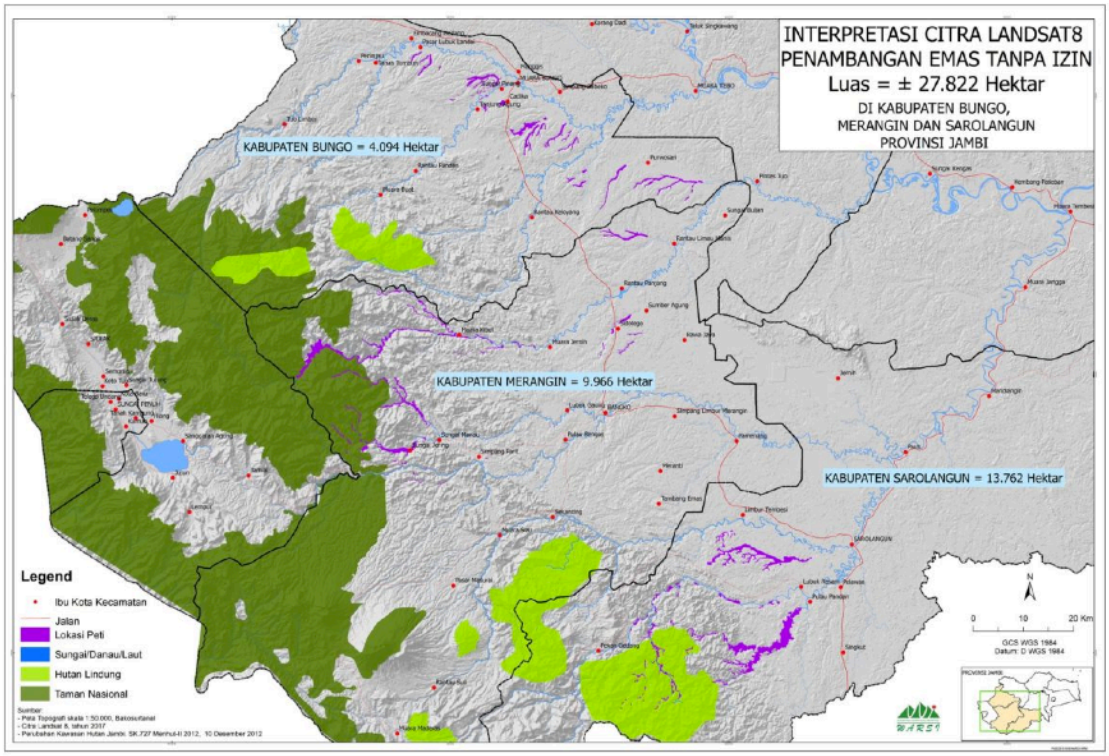

Fig. 27. Distribution map of ASGM activities in Jambi in purple. Photo credit: WARSI.

A local NGO in Jambi, WARSI Indonesia Conservation Community (KKI) noted that, based on the interpretation of Lansat Image 8, in 2017, land damage due to illegal gold mining occurred in three regencies in Jambi Province, namely Sarolangun, Merangin and Bungi Regencies (see Figure 24). The total damaged land was 27,822 hectares. The largest in Sarolangun Regency is 13,762 hectares, followed by Merangin 9,966 hectares and Bungo covering 4,094 hectares.

In 2016, WARSI identified the area cleared for illegal mining increased by more than 100 percent in the areas belong to Merangin and Sarolangun Regencies. It is estimated that half of the illegal mining area took place in paddy field which is a source of food for the local community.

Illegal gold mining occurred along river basins destroyed the river channel, widened the river created critical river bank, landslides, and erosion. Once the gold ore in alluvial deposits fall into the river body, the owner of the land along the river bank will not be able to claim it as their properties. Some of the land along the river banks are owned by some families for generations. This situation created tension and conflict between illegal miners and land owners.

In Jambi, there are several biodiversity sensitive areas with different degree of protection. The Kerinci Seblat National Park is located in Merangin Regency and Bukit Limau Protected Forests located in Sarolangun. Kerinci Seblat National Park is the largest national park on Sumatra island. Together with Bukit Barisan Selatan and Gunung Leuser National Parks, it forms a World Heritage Site, Tropical Rainforest Heritage of Sumatra. Since 2011 the UNESCO also lists this world heritage as World Heritage in Danger.

Kerinci Seblat National Park is home to less than 400 Sumatran tiger, Asian Golden Cat, Rafflesia Arnoldii and many exotic species.

NATIONAL PARKS IN SUMATRA	NATIONAL PARKS IN JAVA	NATIONAL PARKS IN BALI AND NUSA TENGGARA
1. Gunung Leuser	1. Ujung Kulon	1. Bali Barat
2. Siberut	2. Kepulauan Seribu	2. Gunung Rinjani
3. Kerinci Seblat	3. Gunung Halimun	3. Komodo
4. Bukit Tigapuluh	4. Gunung Gede Pangrango	4. Manupeu Tanah Daru
5. Bukit Duabelas	5. Karimunjawa	5. Laiwangi Wanggameti
6. Berbak	6. Bromo Tengger Semeru	6. Kelimutu
7. Sembilang	7. Meru Betiri	
8. Bukit Barisan Selatan	8. Baluran	
9. Way Kambas	9. Alas Purwo	
NATIONAL PARKS IN KALIMANTAN	**NATIONAL PARKS IN SULAWESI**	**NATIONAL PARKS IN MALUKU AND PAPUA**
1. Gunug Palung	1. Bunaken	1. Manusela
2. Danau Sentarung	2. Bogani Nani Wartabone	2. Teluk Cendrawasih
3. Betung Kerihun	3. Lore Lindu	3. Lorentz
4. Bukit Baka-Bukit Raya	4. Taka Bonerate	4. Wasur
5. Tanjung Puting	5. Rawa Aopa Watumohai	
6. Kutai	6. Wakatobi	
7. Kayan Mentarang		

Table 6. List of National Parks in Indonesia. Source: Ministry of Environment and Forestry.

Fig. 28. Asian Golden Cat *(Catopuma temminckii)*. Photo credit: Karen Stout - originally posted to Flickr as Asian Golden cat, CC BY-SA 2.0.

Fig. 29. Sumatran tiger *(Panthera tigris sondaica)* in the Kerinci Seblat National Park. Photo credit: https://tnkerinciseblat.or.id/

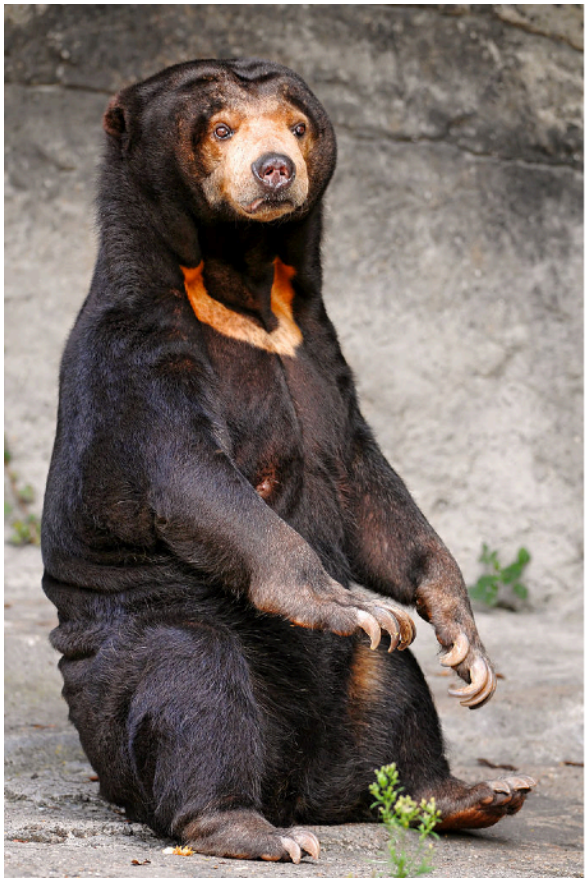

Fig. 30. Sun Bear *(Helarctos Ursus Malayanus)* in the Kerinci Seblat National Park. Photo credit: https://tnkerinciseblat.or.id/

Fig. 31. Corpse lily or stinking corpse lily *(Rafflesia arnoldii),* only found in the Kerinci Seblat National Park, is one of the Indonesian flowers. Photo credit: SofianRafflesia/CC BY-SA (https://creativecommons.org/licenses/by-sa/4.0)

Mercury-contaminated water supplies

In addition to ecosystem damaged, some regions started to have contaminated water supply and watershed areas (DAS/Daerah Aliran Sungai). Some State-owned Water Companies (Perusahaan Daerah Air Minum/PDAM) observed an increased level of mercury in the raw water supply sources. Jambi's Batanghari River, the longest river in Sumatera, already have high mercury concentration.

Central Kalimantan's rivers Barito, Kahayan, dan Kapuas already have had elevated mercury concentrations since more than ten years ago. Prospectors and illegal miners have panned for gold in the Kahayan river for centuries.[1] Following test drilling, a consortium of Canadian and Indonesian companies announced in 1997 that in-situ gold resources were at least 3.4 million ounces.[2] In 2002 a Canadian company with a background in community development programs proposed to develop artisanal mining in the headwaters of the Barito and Kahayan Rivers in Kalimantan, providing income for some 13,000 Dayak people at project maturity.[3]

A large number of informal prospectors are undertaking alluvial operations within the river system, and mining hard rock gold veins. Even those doing hard rock mining transport the ore to the rivers for processing. More than 2,000 illegal miners may converge on a site when there is a reported gold find. In Indonesia as a whole, nearly 180 tonnes of mercury are released to the environment annually.[4]

Tewah River within Barito River watershed recorded total mercury 5,519 micro grams per litre. Maximum limit of mercury concentration quality standards in Indonesia is 2.0 micro grams per litre.

While in the watershed (DAS) Kahayan , high mercury concentration between 2,966 to 4,687 micro gram per litre was found in Bawan, Tanjung Sanggalang, Tumbang Rungan, Kahayan Bridge, Jabiren, and Pulang Pisau.

The condition is most severe is in the Kapuas River with pollution levels reached 7.029 micro grams per litre or more than three times the quality standard limits. Polluted areas along this river are Mentangai, Kuala Kapuas, Pulau Tilu, Timpah, Masaran, and Masaran Hulu.

11. Current Projects and Mercury Stakeholders

11.1. Current Projects

In 2017-2018 there are several mercury-related projects implemented with the funding support from various donors, lead by several ministries and government agencies.

Table 6 below shows the list of current projects related to mercury in Indonesia.

Table 6. Current projects related to mercury in Indonesia 2017-2018

Project Title	Lead agency	Donor
Scoping and preparatory of UNDP GOLD project	UNDP, Min. of Environment and Forestry, BPPT	GEF
Pilot plants to process gold without mercury	Min. of Environment and Forestry and BPPT	Min. of Environment and Forestry
Mapping of 8 ASGM hotspots in Indonesia	Min. of Environment and Forestry, ITB (consultant), Brawijaya University (consultant)	Min. of Environment and Forestry
Development of guidance document and regulation to withdraw mercury-containing devices in health-care facilities	Ministry of Health	Ministry of Health
Scoping study for mitigation of mercury emissions from coal-fired power plants	Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources, Clean Coal Centre (consultant), Arcadis (consultant), BCRC-SEA	US Department of State
Rehabilitation and remediation of mercury-contaminated site - pilot plan	Min. of Environment and Forestry, ITB (consultant)	Min. of Environment and Forestry
Rehabilitation of Gunung Botak ASGM tailing, Buru Island, Maluku	Min. of Environment and Forestry	Min. of Environment and Forestry
Scoping project for rehabilitation of contaminated and degraded mining sites	MIRECO (Consultant), Min. of Environment and Forestry	South Korean government
Mercury waste treatment feasibility study	Nomura Kohsan-Delloitte, Min. of Environment and Forestry	Japan government
Reduction of mercury availability in Indonesia market and storage	Min. of Environment and Forestry, BRI, Nexus3, IPEN, CRPG	US Department of State
Mercury supply and trade in SEA countries survey (Indonesia, Singapore, Philippines)	EXRI (consultant), Min. of Environment and Forestry	Japan government

11.2. Mercury stakeholders

Mercury stakeholders in Indonesia are mainly representatives of relevant ministries, national government agencies, several local and provincial governments, research centres and academia, professional associations, and NGOs.

Figure 33 below shows mercury stakeholders in Indonesia.

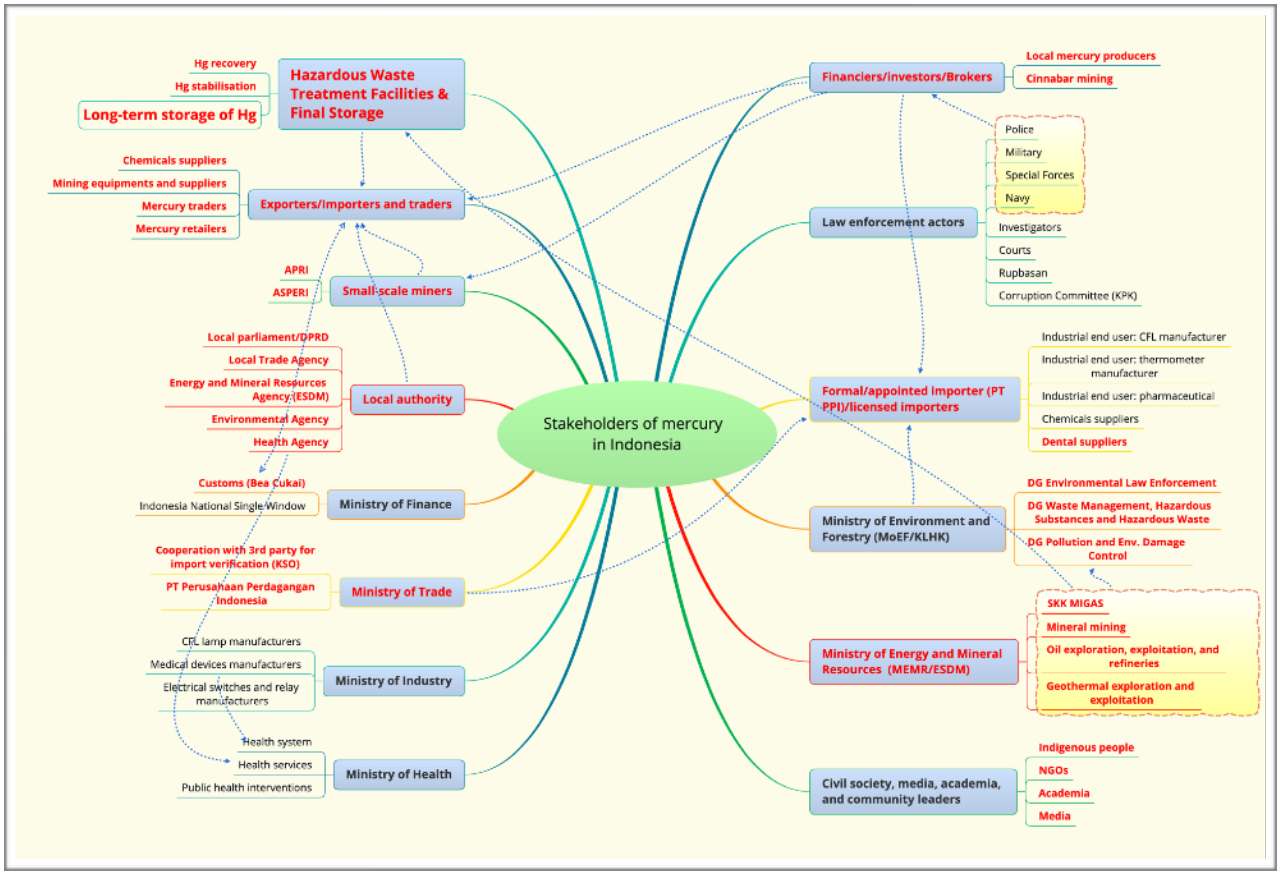

Fig. 32. Mercury stakeholders in Indonesia.

Indonesia ratified the Minamata Convention in September 2017. After the ratification, and the development of National Action Plan to reduce and eliminate mercury in all sectors, despite various project to address mercury already implemented by the Indonesian government and partial stakeholders involvement, there are several agenda items that still need to be elaborated and push further.

Below are some points that need a better and faster response from the national agencies to accelerate the process of phase-out, reduce mercury consumption and releases to the environment, and protect human health.

- Technical guidance to withdraw mercury-containing devices from health-care facilities need to be complemented by temporary mercury storage facilities.
- There is a need to review the status or classification of confiscated cinnabar, confiscated mercury, mercury-containing devices from health-care facilities, and CFL lamps, whether they will be classified as mercury wastes, or as products.
- For legal and court purposes, the decision of the court should not order the custody of the evidence to destroy the confiscated mercury. New terminology should be introduced to treat or stabilise confiscated metallic mercury into a state that will no longer serve its original purpose.
- Cinnabar mining should be prohibited by the Ministry of Energy and Mineral Resources. No new permit (Ijin Usaha Pertambangan/Mining License) should be given to any companies.
- Ministry of Environment and Forestry should calculate the degraded land due to ASGM practices and start conducting a study to characterise mercury-contaminated sites.
- ASGM practices and mining license for community group or small-scale miners should be limited to the designated community mining areas.
- Activities to give added value of gold as jewelleries should be introduce in ASGM hotspots and exit strategies need to be discussed and planned with local governments.
- Biomonitoring of human biomarkers, such as blood, hair, and urine, need to be conducted every two years.
- Encourage more laboratories in Indonesia to have mercury and methyl mercury analysers.
- Respondents or communities with high mercury biomarkers have to be monitored and advise to avoid mercury sources and food potentially contaminated by mercury.
- Local governments and provincial governments with ASGM hotspots have to develop Local Action Plans to reduce and eliminate mercury.
- Technical assistance and funding mechanism to support local governments and provincial governments should be allocated by the Indonesian government.

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Annex 1 List of Indonesian lamp manufacturer companies (members of ARPELINDO)

No.	Company	Website	Brand	Address	Contact details
1	Citra Hannochs Niagantara	www.hannochs.com	Hannochs, Arashi, Winova, Mitsui	Jl. Kejaksaan No.5 D, Petisah Tengah, Kec. Medan Petisah, Kota Medan, Sumatera Utara 20112	Tel : (061) 4519100 Fax : (061) 4518506/05
2	Honoris Industry	www.hori-lighting.com www.honorisindustry.com	Hori	Foresta Business Loft 5 No. 18 BSD City, tangerang - Banten Jl. Raya Sukabumi KM. 2, Ciawi - Bogor 16720 Gading Mediterania Residence Jl. Boulevard Bukit Gading Raya RK / 003 / C, Kelapa Gading - Jakarta Utara 14240 Green Central City, Commercial Area Lt. 6 Jl. Gajah Mada No. 188 - Jakarta 11120	(021) 3457777 (0251) 8240-322
3	Tjipto Langgeng Abadi	www.focuselectric.com	Focus, Badalex, Million, Hatanaka, Mgm	Jl. Gatot Subroto (d/h Surowongso) No. 121 Gedang, Sidoarjo - Jawa Timur	(031) 8917432
4	Pancaran Indonesia	-	Cahaya, Pancaran, Baris, Haomen, Szmr.	Jl. R.E. Martadinata Kompl. Mahkota Ancol Blok C No. 25-26, Jakarta Utara Jl. Pangeran Jayakarta Komplek 26 No. B-14 Jakarta Pusat 10730	(021) 6491955 (021) 64701691
5	Artolite Indah Mediatama	www.artolite.co.id	Artolite	Jl. Raya Jakarta Bogor KM. 34,5 Gg. Nangka Cimanggis, Depok 16453	Tel : 021 8774 2572 / 73 Fax : 021 874 1188 WA : 08568764888 / 0811140690
6	Golden Batam Raya	www.visalux.co.id	Visalux, Amasco, Citylamp	Komp. Citra Buana Centre Blok L No. 01 Kamp. Pelita Kec. Lubuk Baja - Batam	Tel : (0778) 8454036 Fax : (0778) 454049
7	Shukaku Indonesia	www.shukaku.co.id	Shukaku	Jl. Bandengan Selatan No. 43 Blok A No. 29-30 Kompleks Puri Delta Mas Jakarta Utara 14450	Tel : (021) 6669 2888 Fax : (021) 6669 6789
8	Chint Indonesia	v.chint-indonesia.	CHNT	Kompleks Prima Center Blok C9/10 Jl. Pesing Poglar Pool PPD No.11 Jakarta Barat 11710 - Indonesia	Tel : (021) 5436 3000 Fax : (021) 5436 7378 WA : 08211153300
9	Gunawan Elektrindo	visicomled.com	Visicom	Jl. Elang Laut Boulevard Blok B2 No. 31-35 Pantai Indah Kapuk - Jakarta Utara 14470	Tel : (021) 29219111 / 29218977 Fax : (021) 29219124 / 29219123 0812 1611 1977
10	Jaya Ceo Energi	www.jwbersama.com	Jishan, Chikara	Gading Kirana Uatara F10 No.3-5 Kelapa Gading Jakarta Utara 14240 Jl. Pulo Buaran Blok M1 Pulo Gadung Jakarta	Tel : (021) 45877268 Fax : (021) 45877269 Tel : (021) 4582 2633 Fax : (021) 4582 3060
11	Emperor Light Indonesia	www.emperor-light-indonesia.com	Emperor Light	Jalan Industri Selatan 5, Blok FF-1L Kawasan Industri Jababeka II Cikarang Selatan - Bekasi 17530	0812 8566 8629 / 0812 8582 7958
12	Holz International Technology	www.holzled.com	HOLZ	Sentra Industri Terpadu PIK Elang Laut Blok G No.2 Jakarta Utara 14450	(021) 2921 5000

No.	Company	Website	Brand	Address	Contact details
29	Dian Satelite Unggul	www.nikolux.com www.dynalux-id.com	Nikolux, Dynalux	Jl. Gading Pantai V/6-8 Surabaya - Indonesia	Tel : (031) 3812667, 3821402 Fax : (031) 3818594
30	Aierdane Indonesia	www.aierdane.com	Aierdane	Ruko Garden Boulevard Blok C2 No 11 Cengkareng - Jakarta Barat (seberang Apartemen Citypark)	Tel : (021) 2944 0964 Fax : (021) 6314 105
31	Sumber Klik Sejahtera	www.stark-indonesia.com www.klik-it.co.id/index.php	StarkLed	Jl, Sultan Iskandar Muda No 100B-C, Kebayoran Lama - Jakarta Selatan 12240	Tel : (021) 29419697 Tel : (021) 4244482 Fax : 4244385 0851 02999 763
32	Feilo Sylvania SDN BHD-Malaysia	www.sylvania-lighting.com	Sylvania	The CEO Building Level 12, Jl. T.B Simatupang No.18C Cilandak Jakarta Selatan 12430	Tel : (021) 30497341 Fax : (021) 30497342
33	Ecogreen Clean Teknologi	www.ecogreen.id	ECT	Rukan Sentra Niaga Blok RSN 2 No.050 Grand Galaxy, Jaka Setia, Bekasi Selatan 17147	(021) 8273 5121
34	Trimitra Karya Sukses	-	Zorlien	Jl. Pangeran Jayakarta Komplek Sentral 129 Blok B 29 Jakarta Pusat	-
35	Krisna Karya Teknik LED	www.instagram.com/luxmenn_led	Luxmenn Greenlight	Jl. Pluit Sakti Raya No.28 Blok C-18 Jakarta 14440	Tel : (021) 6626690 Fax : (021) 6626691
36	Prima medan Lestari	-	FUJILIGHT	Jl. Asia No. 34 (D-H 12) Medan 20214	Tel : (061) 7368524 Fax : (061) 6642251
37	Surya Citra Teknik Cemerlang	www.lightplusled.com	LIGHT+	Jl. Raya Narogong Pangkalan 1B RT.001/RW.006, Bantar Gebang Kota Bekasi - Jawa Barat	Tel : (021) 8262 7380 Fax : (021) 8263 4261
38	Asian Lighting Design (Piment Rouge Lighting)	pimentrougelighting.com	PIMENT ROUGE	Jl. Pengubengan Kauh No.99Z Kerobokan Kelod, Kec. Kuta Utara Kab. Badung, Bali 80361	Tel : (0361) 8476118 Fax : 0361) 8476120
39	Valensi Cahaya Persada	valexfolifix.com	Valex Folifix	Gd. TBIC No.10.1, Puspiptek, Jl. Raya Puspiptek - Gunung Sindur, Bogor 16340	Tel : 021-7560562 ext.6653/6654
40	YLI Industry Indonesia	www.yli-ind.com.my	YLI	Pergudangan Central Cakung Blok J3-26,Jl Raya Cakung Clincing KM3, Jakarta 14140	Tel: (021) 2244 8227 Fax: (021) 2244 8237
41	Kharisma Sinarlindo Persada	www.powerledindonesia.com	POWERLED	Gedung Harco Glodok, Lantai 06 Blok A-BN No.11 Jl. Hayam Wuruk No. 2-5, Mangga Besar, Jakarta Barat 11180	Tel : (021) 6220 3857 / 2252 7844 0877 80012762
42	Robin Litten Indonesia	-	REPRO	JL. Gajah Raya Ruko Mutiara Gama No. 28 - Semarang 50156	Tel : (024) 76413138
43	CARSURIN (LSPro)	www.lspro.carsurin.com	-	Soho Capital, 28th Floor, Jl. Letjen S. Parman Kav. 28 Grogol Petamburan, Jakarta Barat 11470, Indonesia	Tel : 021 5022 6868 Fax : 021 5017 1799
44	LIGMAN Indonesia	www.ligman.com	Ligman	Jl. Raya Pos Pengumben No. 11 Srengseng, 11630 Jakarta Barat	Tel : 08787 719 1488
45	HK Electric	www.hkelectric.com	-	Panglima Polim Raya No. 89 Sebelah Hotel Amaris 2 Panglima Polim, Melawai, Jakarta 12160	Tel : (021) 7220448 HP : 0812 81749399
47	Sarana Karya Solusindo	www.bandell-lighting.com	Bandell	Puri Surya Jaya J1-29, Gedangan Sidoarjo, Jawa Timur	Tel : (031) 8012950 Fax : (031) 8012953

No.	Company	Website	Brand	Address	Contact details
14	Kingled Indonesia	www.kingledindonesia.com	Kingled	Mediterania Gajah Mada Residence TUD 05 Jl. Gajah Mada No. 174 Jakarta 11130	Tel : (021) 63875085 Fax : (021) 63875086
15	Omni Lumins Cemerlang	omnilumins.com	Omni Lumins	Ruko The Central 88 / The LINQ Kemayoran Unit G829 Jl. Trembesi Raya Blok D3 Jakarta 14410	(021) 2260 7897
16	Sinar Angkasa Rungkut	www.chiyoda-lighting.com	Chiyoda	Jl. Rungkut Industri I No.8 - Surabaya 60293	Tel : 031 8438883, 8411582 Fax : 031 8432461, 8438847
17	Solarens Ledindo	solarens.co.id	Solarens	Kawasan Industri De Primaterra Block B2 No.3B, Jl. Sapan - Gedebage Bandung 40297 - Indonesia	Tel : (022) 87301403 Fax : (022) 87528436
18	Kensign Jaya Mandiri	www.kensign.co.id	KenSign	Jl. Pesing Poglar Ex Pool PPD no. 11 Kompl. Pergudangan Prima Center I Blok I-16-17 Kel. Kedaung Kali Angke, Kec. Cengkareng Jakarta Barat 11710	(021) 29518976-78
19	Sinko Prima Alloy	elitech.id	Elitech	Pergudangan Osowilangon Permai Blok E8 Jl. Osowilangon No. 61 Surabaya - 60191	(031) 7482816 / 7492882 / 7482835
20	Signify Commercial Indonesia	www.signify.com	Signify	Philips Building, Jl. Buncit Raya Kav. 99-100 Jakarta Selatan 12510	(021) 80860400
21	Panasonic Gobel Life Solutions Manufacturing Indonesia	www.panasonic.com/id	Panasonic	Kawasan Pasuruan Industrial Estate Rembang (PIER), Jl. Rembang Industri Raya No.47 – Rembang Pasuruan 67152 - Jawa Timur - Indonesia	Tel : (0343) 740230 WA : 0811 1660 770
22	Saka Agung Karya Abadi	www.saka-lighting.com	Saka	Jl. Raya Lingkar Timur No.9 Kel. Kebonsari Kec. Candi Sidoarjo - Jawa Timur	Tel : (031) 896 6888 / 895 2255 Fax : (031) 895 2255 WA : 0812 3244 0070
23	Karya Energi Semesta	www.karyaenergisemesta.com	Letsa, Senergo, ETS, FSE	Komplek Pergudangan Biz-Park A2 Tambak Sawah, Waru - Sidoarjo 61256	Tel : (031) 8686281, 8686282 Fax : (031) 8666219 WA : 085733471019
24	Sinarmonas Industries	www.sinarmonas.com www.general-lighting.co.id	General Lighting Sinarmonas	Rukan Artha Gading Niaga Blok D No.7 Kelapa Gading Jakarta Utara 14240	Tel : (021) 4585 0660 Fax : (021) 4585 0661
25	Ningbo Global Lamp Global International Industries	www.shinyokuindonesia.com	Shinyoku	Komplek Agung Sedayu Harco Mangga Dua Blok L No.3 Jakarta Pusat 10730 Jl. Gunung Sahari Raya Komplek Rukan Mangga Dua Square Blok B – No. 1 Jakarta Utara – 14420	Tel : (021) 6220 0222 Fax : (021) 6220 0111
26	Himel Indonesia	www.himel.com	-	Ventura Building 8th floor, Jl. R. A Kartini Kav. 26, Cilandak, Jakarta 12430, Indonesia	Tel : (021) 7511110 ext. 2123 Fax : (021) 7504537 0811953019
27	Indikom Semesta Sampoerna	-	Nikita	Jl. Jelupang Raya No.99, Jelupang, Kec. Serpong Utara, Kota Tangerang Selatan, Banten Komp. Perkantoran Bali View Points Blok C-33 Jl. Cirendeu Raya, Ciputat Timur Tangerang Selatan 15419	(021) 22235551 (021) 22741344
28	Sumber Digital Media	-	AAA Tanaka	Jl. Mangga Dua Raya, Komp. Agung Sedayu Blok J-4, Jakarta Pusat 10730	Tel : (021) 6286289, 92836637 08161983733

Annex 2. List of ASGM hotspots inside national parks/biodiversity sensitive areas

No.	Province	ASGM sites	Regency/City	National Park/ Conservation area	Sources
1	Aceh		Aceh Barat Daya	Leuser National Park	https://www.mongabay.co.id/2017/10/28/tambang-emas-ilegal-bertebaran-di-aceh-bagaimana-dampaknya-terhadap-lingkungan/
2				Protected area (hutan lindung) Alue Tringgadeng	
3	North Sumatera	Madina	Mandailing Natal	Batang Gadis National Park	https://www.mongabay.co.id/2014/08/19/berburu-emas-di-batang-gadis/
4	Jambi	Merangin	Jambi	Kerinci-Seblat National Park	https://www.mongabay.co.id/2018/11/20/tambang-emas-ilegal-korban-jiwa-berjatuhan-hutan-jambi-pun-merana/
5		Sarolangun	Jambi	Hutan Lindung Bukit Limau	
6	Riau			Tesso Nilo National Park	http://ksdae.menlhk.go.id/topnews/990/tim-gabungan-balai-tn-tesso-nilo-berhasil-temukan-tambang-emas-ilegal-di-dalam-kawasan-.html
7	Banten	Cisitu	Lebak	Gunung Halimun-Salak National Park	https://aceh.antaranews.com/nasional/berita/1277955/wagub-banten-26-lokasi-tambang-emas-ilegal-di-tnghs-sudah-ditutup?utm_source=antaranews&utm_medium=nasional&utm_campaign=antaranews
8	West Nusa Tenggara	Belo, Jereweh	West Sumbawa	Belo	https://www.talikanews.com/2020/02/17/dlhk-ntb-bantah-penambangan-emas-wna-di-hutan-lindung-kesbangpol-ksb-aneh/
9		Lamunga	West Sumbawa	Lamunga	https://www.antaranews.com/berita/364946/penambangan-liar-di-sumbawa-barat-makin-marak
10		Elang Dodo	Sumbawa Regency	Elang Dodo forestry	https://media.neliti.com/media/publications/44092-ID-sengketa-usaha-pertambangan-di-wilayah-hutan-elang-dodo-kabupaten-sumbawa.pdf
11		Sekotong	West Lombok		https://bengkulu.antaranews.com/berita/85671/penambang-liar-terpapar-merkuri-di-lombok-barat
12	East Java	Tumpang Pitu	Banyuwangi	Meru Betiri National Park	
13			Jember	Resort Pemangkuan Hutan (RPH) Grintingan Bagian Kesatuan Pemangkuan Hutan (BKPH) Wuluhan	https://kumparan.com/jatim-now-admin/aparat-gabungan-gerebek-tambang-emas-liar-di-jember-1537441375149348494/full
14	North Maluku	Miaf	Halmahera Timur	Aketajawe Lolobata National Park (TNAL)	http://ksdae.menlhk.go.id/berita/853/penjagaan-peti-miaf,-polhut-bertemu-suku-togutil.html

No.	Province	ASGM sites	Regency/City	National Park/ Conservation area	Sources
15	Central Sulawesi	Poboya	Palu	Paneki Poboya Grand Forest	http://intanhamid22.blogspot.kr/2014/02/tahura-dijarah-penambang.html
16		Dongi-dongi	Donggala	Lore Lindu National Park	https://mediaindonesia.com/read/detail/285357-walhi-heran-tambang-emas-ilegal-dongi-dongi-aktif-lagi
17		Poso	Poso		https://rimbakita.com/taman-nasional-lore-lindu/
18	North Sulawesi		Bolaang Mongondow	Bogani Nani Wartabone National Park	https://www.mongabay.co.id/2020/05/01/di-tengah-pandemi-kasus-tambang-emas-ilegal-di-tn-bogani-nani-wartabone-dilimpahkan-ke-kejaksaan/
19	Southeast Sulawesi (Sulawesi Tenggara)	Bombana	Bombana	Rawa Aopa Watumohai National Park	https://tnrawku.wordpress.com/2012/03/10/kawasan-konservasi-vs-tambang/#more-62
20	North Sulawesi/ Gorontalo		Pohuwato	Bogani Nani Wartabone National Park	(http://www.mongabay.co.id/2013/03/28/ada-7-000-an-penambang-rakyat-di-tn-bogani-nani-wartabone/
21	South Kalimantan		Banjar	Grand Forest Sultan Adam (Tahura)	http://tataruangpertanahan.com/kliping-548-penambangan-emas-ilegal-ada-di-areal-konservasi.html
22	Central Kalimantan		Kalimantan Bun	Tanjung Puting National Park	http://www.pikiran-rakyat.com/node/270790
23	West Kalimantan			Bukit Baka Bukit Raya National Park	https://www.mongabay.co.id/2012/08/27/tambang-emas-ilegal-di-taman-nasional-bukit-baka/
24	Papua Barat			Teluk Cendrawasih	https://kabar24.bisnis.com/read/20180212/15/737676/tambang-emas-wondama-ancam-taman-nasional

Bibliography

<121823-ESM-MiniGridsandtheArrivaloftheMainGridFINALhhav-Indonesia-PUBLIC.pdf>.

BCRC-SEA. (2017). Mercury Emissions From Coal-Fired Power Plants In Indonesia. Retrieved from Jakarta:

Bell, L., Johnson, S., Regan, K., DiGangi, J., Federico, J., & Samanek, J. (2017). *Mercury In Women Of Child-Bearing Age In 25 Countries*. Retrieved from https://ipen.org/sites/default/files/documents/updateNov14_mercury-women-report-v1_6.pdf

Bhati, P., & Singh, M. (2017). Regulating Emissions of Coal-Based Power Sector: Proceedings and Recommendations of roundtable. Retrieved from New Delhi, MIndia:

Bose-O'Reilly, S., Bernaudat, L., Siebert, U., Roider, G., Nowak, D., & Drasch, G. (2017). Signs and symptoms of mercury-exposed gold miners. *International Journal of Occupational Medicine and Environmental Health*. doi:10.13075/ijomeh.1896.00715

BPHN. (2017). Naskah Akademik RUU Pengesahan Minamata Convention on Mercury. Hasil Penyelarasan. Jakarta

Dewi, K., & Ismawati, Y. (2018). Mercury Emission Inventory in Indonesia 2017. Retrieved from Denpasar, Bali:

Ekawanti, A., & Krishnayanti, B. D. (2015). Effect of Mercury Exposure on Renal Function and Hematological Parameters among Artisanal and Small-scale Gold Miners at Sekotong, West Lombok, Indonesia. *Journal of Health & Pollution, 5*(9).

Foundation, B. (2015). Preliminary Report On Suspected Mercury Poisoning In 3 ASGM Hotspots Of Indonesia: Case Reports Bombana-Southeast Sulawesi, Sekotong-West Lombok, And Cisitu-Lebak. Retrieved from

Fujiki, M., & Tajima, S. (1992). The Pollution of Minamata Bay by Mercury. *Water Science and Technology, 25*(11), 133-140. doi:https://doi.org/10.2166/wst.1992.0284

Greenpeace. (2016). The High Cost of Coal Power: Internalizing Health Impacts and Cost from Coal-Fired Power Plants in Indonesia. Retrieved from Jakarta:

Hidayat, S. (2012). Assessment of Options for Managing the Excess Mercury Supply and Costing Components of Mercury Storage in Indonesia. Retrieved from Jakarta:

IPEN. (2013). *Guide to the New Mercury Treaty*. San Francisco: International POPs Elimination Network Heavy-metals Working Group.

Ismawati, Y. (2018). Illegal and illicit mercury trade in Indonesia. Retrieved from Jakarta:

Ismawati, Y., Lelitasari, & Buftheim, S. (2015). *Gold production in rural areas of Bogor Regency and its hidden hazards implication*. Paper presented at the The 5th Environmental Technology and Management Conference (ETMC-2015), Bandung.

Ismawati, Y., Zaki, K., Buftheim, S., Septiono, M. A., & Arif, A. S. (2017). *Mercury Trade and Supply in Indonesia*. Retrieved from Denpasar:

Ismawati, Y., Zaki, K., Gita, A., & Wahyudi, T. (2017). Indoor Air Mercury Monitoring in Ten Hospitals in Denpasar City, Bali, Indonesia. Retrieved from

Ismawati, Y., Zaki, K., Septiono, M. A., & Buftheim, S. (2017). *Mercury Trade and Supply in Indonesia*. Retrieved from Denpasar:

Krishnakumar, B., Niksa, S., Sloss, L., Jozewicz, W., & Futsaeter, G. (2012). Process Optimization Guidance (POG and iPOG) for Mercury Emissions Control. *Energy & Fuels, 26*(8), 4624-4634. doi: 10.1021/ef2018397

Krisnayanti, B. D. (2018). ASGM status in West Nusa Tenggara Province, Indonesia. *Journal of Degraded and Mining Lands Management, 5*(2), 1077-1084. doi:10.15243/jdmlm.2018.052.1077

Krisnayanti, B. D., Vassura, I., Asmara, M. D., Ekawanti, A., & Suheri, H. (2016). Analysis of Artisanal Small-scale Gold Mining Sector in West Sumbawa Regency, Indonesia. *Journal Health and Pollution, 12*, 26-33.

Lee Bell, J. D., Jack Weinberg. (2015). An NGO Introduction to Mercury Pollution & the Minamata Convention: IPEN.

Liu, L., Li, W., Song, W., & Guo, M. (2018). Remediation techniques for heavy metal-contaminated soils: Principles and applicability. *Sci Total Environ, 633*, 206-219. doi:10.1016/j.scitotenv.2018.03.161

Male, Y. T., Reichelt-Brushett, A. J., Pocock, M., & Nanlohy, A. (2013). Recent mercury contamination from artisanal gold mining on Buru Island, Indonesia--potential future risks to environmental health and food safety. *Mar Pollut Bull, 77*(1-2), 428-433. doi:10.1016/j.marpolbul.2013.09.011

Octaviano, H. A. (2017). Mercury Elimination In Artisanal And Small Scale Gold Mining: Progress And Barriers In Implementing National Action Plan To Eliminate Mercury In Indonesia (Case Study: Banyumas Regency). (Master in Environmental Management). Massey University, New Zealand,

Rothenberg, S. E., Yin, R., Hurley, J. P., Krabbenhoft, D. P., Ismawati, Y., Hong, C., & Donohue, A. (2017). Stable Mercury Isotopes in Polished Rice (Oryza sativa L.) and Hair from Rice Consumers. *Environmental Science & Technology, 51*(11), 6480-6488. doi:10.1021/acs.est.7b01039

Rothenberg, S. E., Yin, R., Hurley, J. P., Krabbenhoft, D. P., Ismawati, Y., Hong, C., & Donohue, A. (2017). Stable Mercury Isotopes in Polished Rice (Oryza sativa L.) and Hair from Rice Consumers. *Environ Sci Technol, 51*(11), 6480-6488. doi:10.1021/acs.est.7b01039

Sari, M. M., Inoue, T., Matsumoto, Y., & Yokota, K. (2016). Measuring total mercury due to small-scale gold mining activities to determine community vulnerability in Cihonje, Central Java, Indonesia. *73*(2), 437-444. doi:10.2166/wst.2015.503

Serikawa, Y., Kawakami, T., Cyio, B., Nur, I., Elvince, R., & Inoue, T. (2011). Emission and Dispersion of Gaseous Mercury from Artisanal Small-scale Gold Mining Plants in Palu City, Central Sulawesi, Indonesia. *Journal of Environmental Sciences, 24*(4), 269-274.

Sloss, L. (2008). *Economics of mercury control*: International Energy Agency Clean Coal Centre.

Sofia, S., Ibrahim, T., & Risqa, M. (2016, 2017). Neurological Status Disturbances Caused by Mercury Exposures from Artisanal Gold Mining Area in West Aceh, Aceh Province. Paper presented at the 1st Public Health International Conference (PHICo 2016), Jakarta.

Spiegel, S. J., Agrawal, S., Mikha, D., Vitamerry, K., Le Billon, P., Veiga, M., . . . Paul, B. (2018). Phasing Out Mercury? Ecological Economics and Indonesia's Small-Scale Gold Mining Sector. *Ecological Economics, 144*, 1-11. doi:10.1016/j.ecolecon.2017.07.025

Steckling, N., Tobollik, M., Plass, D., Hornberg, C., Ericson, B., Fuller, R., & Bose-O'Reilly, S. (2017). Global Burden of Disease of Mercury Used in Artisanal Small-Scale Gold Mining. *Ann Glob Health, 83*(2), 234-247. doi:10.1016/j.aogh.2016.12.005

Telmer, K., & Stapper, D. (2007). Evaluating and Monitoring Small Scale Gold Mining and Mercury Use: Building a Knowledge-base with Satellite Imagery and Field Work. Retrieved from

UNEP. (2017). Global mercury supply, trade and demand. Geneva, Switzerland: UN Environment.

Yudiantoro, D. F., Nurcholis, M., Sayudi, D. S., Abdurrachman, M., Haty, I. P., Pambudi, W., & Subroborini, A. (2017). Mercury Distribution in the Processing of Jatiroto Gold Mine Wonogiri Central Java Indonesia. *IOP Conference Series: Earth and Environmental Science*. doi:10.1088/1755-1315/71/1/012023/meta