ACTION COALITION CLIMATE CHANGE, ACCC

STATUS & EXTENT OF MERCURY USE BY THE ARTISANAL & SMALL-SCALE GOLD MINERS IN SELECTED GOLD-MINING SITES OF MUBENDE AND BUSIA DISTRICTS OF UGANDA

A BASELINE SURVEY REPORT

A Publication of Action Coalition on Climate Change (ACCC) with support from Open Society Institute for East Africa (OSIEA)

June, 2018
Researchers

**Mr. Nimpamya Enock** – Director, Research & Administration at ACCC (Lead Researcher)

**Mr. Ssenyonjo Julius** – Member of the Uganda Association for Impact Assessors (UAIA), and Environment & Social Safeguards Specialist

Research Support Team

**Mrs. Kiconco Milliam**, Senior Lecturer of Gender and Natural Resource Governance at Kyambogo, and Makerere Universities

**Ms. Shallon Kacucu**, Research Assistant at ACCC

Editor

**Anne Nakafero**, Environmentalist at National Environment Management Authority (NEMA)

**Citation:**

ACCC, 2018: Status and Extent of Mercury–use by artisanal and small–scale gold miners in selected gold–mining sites of Mubende and Busia districts, Uganda. Research Paper No. 1, 2018, Kampala, Uganda

© ACCC, 2018

Any reproduction in full or in part must mention the title and credit the above–mentioned publisher as the copyright owner.
## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Acronyms</td>
<td>E</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>F</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>G</td>
</tr>
<tr>
<td><strong>CHAPTER I</strong></td>
<td></td>
</tr>
<tr>
<td>1.0 Background</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Justification</td>
<td>3</td>
</tr>
<tr>
<td>1.2 Overall Objective</td>
<td>3</td>
</tr>
<tr>
<td>1.3 Specific Objectives</td>
<td>3</td>
</tr>
<tr>
<td>1.4 Scope of the Study</td>
<td>4</td>
</tr>
<tr>
<td>1.5 What the study did not cover</td>
<td>4</td>
</tr>
<tr>
<td><strong>CHAPTER II</strong></td>
<td></td>
</tr>
<tr>
<td>2.0 Study Area</td>
<td>5</td>
</tr>
<tr>
<td>2.1 Mubende District</td>
<td>5</td>
</tr>
<tr>
<td>2.2 Methods and Materials</td>
<td>8</td>
</tr>
<tr>
<td>2.3 Data Analysis Methods</td>
<td>10</td>
</tr>
<tr>
<td><strong>CHAPTER III</strong></td>
<td></td>
</tr>
<tr>
<td>3.0 Analysis of Existing Legislative Framework in View of Mercury Use &amp; Asgm Sub–Sector</td>
<td>11</td>
</tr>
<tr>
<td>3.1 National Legislation</td>
<td>11</td>
</tr>
<tr>
<td>3.2 The Minamata Convention on Mercury</td>
<td>12</td>
</tr>
<tr>
<td><strong>CHAPTER IV</strong></td>
<td></td>
</tr>
<tr>
<td>4.0 Analysis and Presentation of Results</td>
<td>14</td>
</tr>
<tr>
<td>4.1 Participation And Sample Size</td>
<td>14</td>
</tr>
<tr>
<td>4.2 Findings on Respondents’ Demographic Information</td>
<td>14</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.2.1 Findings on Gender of Respondents</td>
<td>15</td>
</tr>
<tr>
<td>4.2.3 Findings on Education Levels of the respondents</td>
<td>17</td>
</tr>
<tr>
<td>4.3 Findings on the Status and Extent of Mercury–Use by the Artisanal Gold Miners in Mubende and Busia Goldmining Sites</td>
<td>18</td>
</tr>
<tr>
<td>4.3.1 Findings on the Number of Artisanal Miners Using Mercury in the process of gold mining in Busia and Mubende gold mining sites</td>
<td>18</td>
</tr>
<tr>
<td>4.3.2 Sources of Mercury used by the miners</td>
<td>19</td>
</tr>
<tr>
<td>4.3.3 Quantity of Mercury Used Per Week</td>
<td>20</td>
</tr>
<tr>
<td>4.4 Findings on Artisanal Miners’ Perceptions and Knowledge on the use of Mercury in the Gold Mining Processes</td>
<td>24</td>
</tr>
<tr>
<td>4.4.1 Concern About the way Mercury is Used</td>
<td>24</td>
</tr>
<tr>
<td>4.4.2 Knowledge of Environmental and Health Effects of Mercury</td>
<td>25</td>
</tr>
<tr>
<td>4.4.3 Factors influencing use of mercury by the miners in Busia and Mubende gold–mining sites</td>
<td>28</td>
</tr>
<tr>
<td>4.5 Findings on the Storage and Disposal Practices Adopted by the Artisanal Miners in the Management of Mercury in Mubende and Busia Gold Mining Sites</td>
<td>30</td>
</tr>
<tr>
<td>4.5.1 Storage of Mercury by the artisanal gold miners in Mubende and Busia mining sites</td>
<td>30</td>
</tr>
<tr>
<td>4.5.2 Existing Management Practices of Used Mercury Bottles</td>
<td>32</td>
</tr>
<tr>
<td><strong>CHAPTER V</strong></td>
<td></td>
</tr>
<tr>
<td>5.0 Dangers of Mercury to Human Health and Environment</td>
<td>35</td>
</tr>
<tr>
<td>5.1 Existing Opportunities</td>
<td>36</td>
</tr>
<tr>
<td>5.2 Mercury–Free–Technologies</td>
<td>37</td>
</tr>
<tr>
<td>Recommendations</td>
<td>42</td>
</tr>
<tr>
<td>Conclusion</td>
<td>45</td>
</tr>
<tr>
<td>References</td>
<td>46</td>
</tr>
<tr>
<td><strong>APPENDIX I</strong>: UNIDO Technical Guidelines on Mercury Management in Artisanal and Small–Scale Gold Mining</td>
<td>48</td>
</tr>
</tbody>
</table>
# List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCC</td>
<td>Action Coalition on Climate Change</td>
</tr>
<tr>
<td>ASMG</td>
<td>Artisanal and Small Scale Gold Mining</td>
</tr>
<tr>
<td>CSO</td>
<td>Civil Society Organization</td>
</tr>
<tr>
<td>EHS</td>
<td>Environment Health and Safety</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>ESIA</td>
<td>Environmental and Social Impact Assessment</td>
</tr>
<tr>
<td>MDLG</td>
<td>Mubende District Local Government</td>
</tr>
<tr>
<td>MEMD</td>
<td>Ministry of Energy and Mineral Development</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Environment Management Authority</td>
</tr>
<tr>
<td>OSIEA</td>
<td>Open Society Institute for East Africa</td>
</tr>
<tr>
<td>UBOS</td>
<td>Uganda Bureau of Statistics</td>
</tr>
<tr>
<td>UGX</td>
<td>Uganda Shilling</td>
</tr>
<tr>
<td>UNBS</td>
<td>Uganda National Bureau of Standards</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Program</td>
</tr>
<tr>
<td>UNIDO</td>
<td>United Nations Industrial Development Organization</td>
</tr>
<tr>
<td>WGI</td>
<td>Water Governance Institute</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
Acknowledgement

Action Coalition on Climate Change (ACCC), appreciates the contributions and commitment of its staff members in making this study a success. ACCC staff will remain part of the anticipated solution to the problems encountered by the Artisanal Small Scale Gold miners (ASGM). This is especially so with their use of mercury in gold mining. ACCC management is grateful to Mr. Nimpamya Enock. His coordination effort towards data collection, compilation and drafting of this report is commendable. The Board of Directors hereby acknowledges the team spirit of the entire technocratic membership of ACCC.

The Miners of Mubende and Busia together with their leaders are hereby appreciated for their cooperation with study facilitators. This report is, largely, out of their input into the entire process of the study. ACCC is grateful to them for their contribution in terms of information given on the different components and aspects of the study.

ACCC further appreciates the invaluable contributions of the various personalities and agencies. Great personalities include; Hon. Peter Lokeris, the Minister of State for Minerals. He gave valuable information about the subject at hand. He further recommended the research team to the technocratic staff in the Mines Department of the line Ministry. Professor Muwanga of Geology Department, Makerere University is also applauded for useful information given. For her input in editing the report draft, Anne Nakafero of NEMA is also applauded. ACCC further appreciates Julius Ssenyonjo for his role in the administration of research tools and data analysis.

ACCC is grateful to the heads of technical departments of Environment, Community Development and Probation and welfare of Busia and Mubende for their time and knowledge shared during the research period. Their views greatly enriched this report.

Lastly, special thanks go to the Foundation Open Society Institute (FOSI) and the Open Society Institute for East Africa (OSIEA) for the financial support. ACCC has been able to bring to light the plight of artisanal gold miners because of this financial support.

We at ACCC look forward to continued and cordial working relationship with all the stakeholders in the implementation of the various programme areas.
Executive Summary

Mercury is a liquid metal used in artisanal and small-scale gold mining to extract gold from rock and sediment. Mercury is toxic and wreaks havoc on miners’ health and the environment. Mercury in gold mining is of growing international concern. In Uganda, artisanal and small-scale gold mining is one of the emerging forms of environmental degradation. This is, especially, the case in gold-mining districts and their downstream areas where water and soil from the mining areas get carried over to.

Available reports from previous studies indicate that the excavation of large volumes of alluvial materials and their deposition into the fragile ecosystems, particularly, wetlands has affected the hydrological value of those ecosystems. The quality of water in the different mining sites in Uganda has been affected by mercury pollution (Nabaasa, 2016: MDLG, 2013). The Minamata Convention on Mercury, to which Uganda is a signatory, is anchored on the need to protect human health and the environment from the anthropogenic emissions and releases of mercury and mercury compounds. The convention has not yet changed much in Uganda’s Gold-mining industry with respect to mercury use. Concerned with the looming problem of Mercury use in the ASGM sub-sector and with financial support from Foundation Open Society Institute (FOSI) and Open Society Initiative for Eastern Africa (OSIEA), ACCC undertook the study to investigate the status, extent, impact and attitudes towards mercury use in the artisanal gold mining industry in Mubende and Busia. The study commenced in February 2018. Its major objective was to ensure that all undertakings in Uganda’s ASGM industry conform to the Minamata Convention and Uganda’s Vision 2040. The latter’s major focus is concerned with ensuring a healthy, literate and well-informed society for improved livelihoods and environmental sustainability.

Key Findings

All the sampled respondents (n=204:100%) were using mercury in the different activities of gold extraction, and were using bare-hands without any protective gears contrary to international guidelines (UNIDO) on mercury use.

Majority (n=118: 58%) of the sampled artisanal gold miners were using an average of 1–50gms of mercury per person/week. This translates into 2,800gms per miner/year. This finding is in line with that of COWI (2016), which observed that, although there are no recent estimates on the use of mercury for ASGM in Uganda, if the
average mercury consumption per miner from Busia and Mubende gold-mining sites is applied, the resulting mercury consumption may be estimated at 33–48 tonnes/year. Case control studies have shown that chronic exposure via inhalation, even at low concentrations in the range of 0.7–42 μg/m² could lead to tremors, impaired cognitive skills and sleep disturbances.

In terms of exposure, the findings indicated that 90 (44%) respondents had spent between 1 to 4 years using mercury. The rest of the 114 (56%) respondents had spent between 5 to 29 years using mercury in the artisanal gold mining business. It was noted that the majority of the mining category using the chemical were female. The supply chain of Mercury in Mubende and Busia is comprised of; Foreign Traders of Indian, and Chinese origin. These bring in and sell mercury to the ASGMs through local mercury traders. It was established that Local Traders who sell mercury to the ASGMs are in most cases gold buyers; interestingly, it was found out that some Hospital and Laboratory officers smuggle and illegally sell mercury meant for hospital and laboratory operations to middle men who then deliver it to the ASGMs. In the study areas (Mubende and Busia), Mercury is typically distributed in 100gm plastic bottles. Each bottle is sold at UGX 2,000 per gram as revealed by the sampled respondents. This figure translates to USD ($) 0.6, that is, 3,500 UGX at the current exchange rate (June, 2018). The plastic bottles are small, unlabeled and in some cases the bottles have labels of other products other than mercury. This perhaps is meant to disguise the identity of the bottle content.

In terms of perceptions and knowledge on the use of mercury, majority of the respondents (n=140, 69%) were not concerned about the current state of mercury use in their areas of operation. The lack of concern about the current state of mercury–use was attributed to absence of awareness programs on the dangers and effects of mercury among the artisanal gold–miners. This was revealed by 100% of the respondents in Mubende, and 61% in Busia. The foregoing notwithstanding, majority of the respondents (n=118, 58%) expressed fears regarding the health and environmental implications of mercury use in gold extraction. Particularly, the fear of getting cancer, becoming infertile and impotent was laudable. Respondents further expressed concern over the possibility of mercury polluting food and water resources. Thus, it was observed by the research team, that all the sampled gold – mining sites, are located within or a few meters away from domestic water sources and agricultural gardens. This is contrary to international guidelines on mercury–use, which state that no amalgamation washing and sluicing using
mercury shall be done along or close to rivers, streams or any other water sources.
This is also in line with WGI’s (2017) finding, which established that indeed water bodies were located a few kilometers from mining sites.

Pregnant women and children below the age of sixteen years old were present at almost all the mining sites visited. This is contrary to UNIDO standards and Guidelines on protection of pregnant women and children from mercury pollution. It was further discovered that most of the miners store mercury in closed containers (n=118, 40%). These containers are either kept at home (n=109, 37%) or at the site (n=57, 20%). Keeping mercury at home is also contrary to the UNIDO’s requirement that Mercury should NOT be stored in domestic residences, and, should not be accessible to children. In terms of management of mercury waste and used mercury bottles, majority of the sampled miners were using open dumping at the gold–mining sites. This was represented by n=103 (35%), followed by those who manage it through burying (28%) and those who dump on the roads (10%). The practice of open dumping of wastes contravenes the Uganda National Environment waste management regulations, 1998. The practice is also contrary to Article 39 of the Constitution of the Republic of Uganda, which calls for a clean and healthy environment for the enjoyment of all Ugandans.

**Conclusion**

The study presented a number of interesting findings on artisanal and small–scale gold miners’ perceptions, knowledge, and levels of exposure on the use of mercury. This has provided a bird’s eye view into what characterizes the use of mercury in Mubende and Busia gold–mining sites. This also informed the recommendations provided in this report with the aim of contributing towards improved public health through strategies that can lead to minimization of mercury–use in the ASGM sub–sector and the chemical’s eventual elimination among ASGMs. If recommendations on mercury–free–technologies as suggested in this report are adopted, it is believed the gesture will go a long way in promoting the protection of human health and environmental in Uganda and beyond.
Recommendations

Based on the above findings, ACCC recommends the following action points:

a. Since government of Uganda passed the Mining Policy in 2001, the Mining Act in 2003, and Mining Regulations in 2004; the current Mineral Policies and Legislation need to provide sufficient opportunities for the formalization of artisanal gold–mining in Uganda.

b. Artisanal mining sites need to have formal structures that regulate their activities. There is, thus, urgent need to duly legalize and formalize the ASGM sector by government and designate specific sites for gold mining.

c. There is urgent need to conduct trainings and awareness programs on mercury use, storage, and management among the artisanal and small–scale gold miners in Mubende, Busia, and other artisanal gold mining sites in Uganda.

d. There is a need for government of Uganda through MEMD, MOH, NEMA and UNBS to develop a Policy, Legislation and Regulations on Mercury–Use and where feasible, eliminate mercury use in artisanal and small–scale gold mining, as per the Minamata Convention.

e. There is a need by government to identify and promote alternative mercury–free technologies that increase (or, at least, maintain) income for miners, and are better for health and the environment protection. Such methods may include; the use of gravity methods, panning and direct smelting (borax) among others.

f. There is a need to centralize management of mercury waste among the ASGMs by establishing waste management systems, especially, for contaminated waste water, used mercury bottles, and tailings. This system should be developed in such a way that is affordable and accessible for the ASGMs. This system has been adopted and worked well in other jurisdictions such as Ecuador and Mongolia among others.

g. There is urgent need to examine the level of concentration of mercury in the bodies of miners, existing water sources, and agricultural soils in the gold mining sites of Mubende and Busia. The laboratory testing is critical in coming up with a proper and lasting solution in lieu of public health and environmental quality protection.
This section presents the background to the study, justification, the overall objective and specific objectives, and scope of the study.

1.0 Background

Artisanal mining is increasing in operation in many parts of the world. There are approximately more than 30 million active artisanal miners in the more than 55 countries (Charles et al., 2013). In Uganda, the artisanal small-scale gold-mining industry employs more than the oil and gas sector will ever employ. By 2015, the sector was employing an estimated 400,000 Ugandans. Another 1.5 million people are indirectly benefiting from the artisanal and small-scale mining activities.

According to UNEP (2012), Artisanal Small Scale Gold Mining (ASGM) is the single largest demand for mercury in the world. Elemental mercury destined for use in ASGM is largely uncontrolled and unregulated in Uganda. ASGM use mercury in gold amalgamation. Men, women and children use their bare hands and feet in washing crushed rocks mixed with mercury to get gold. Globally, ASGM miners used an estimated 1400 tones of mercury in 2011. In Uganda, the ASGM sector contributes an estimated annual mercury input to society of 18,495 kg/y of which 12136 kg/y is released in the air, 3333 kg/y is released in water, and 3027 kg/y is released on land (NEMA, 2017).

Mercury (Hg) is a powerful neurotoxin that is harmful to people. It is mostly dangerous to the developing fetuses, and young children. Once emitted, mercury can travel great distances through the atmosphere, causing global contamination of ecosystems, fish, birds, mammals and the human food chain. Worldwide, consumption of mercury–contaminated seafood puts billions of people at risk of mercury poisoning. This poisoning affects brain and nervous system development and function. Local exposures in mining communities that use mercury can be even more acute. ASGMs use mercury to bring gold particles in sediments or crushed ore into an “amalgam,” a soft mixture of roughly 50% mercury and 50%

---

1 For more information about contribution of the ASGM sub-sector to Uganda’s economy, visit: www.oilinuganda.org. Tuesday, 26th July, 2016

gold (UNEP, 2012). To recover gold from the amalgam, it is heated to evaporate the mercury, leaving the gold behind. Mercury is released into air, water, and soil in several of the steps of this process.

Studies done indicate that mercury vapors in the air around amalgam burning sites can be alarmingly high and almost always exceed the WHO limit for public exposure of 1,000 nanogram/cubic meter. This risks the health of workers and those in the communities surrounding the processing centers. Exposure to levels of mercury vapors above 1,200,000 nanogram/cubic meter can be fatal (UNEP, 2012). Given the health and environmental effects associated with Mercury use; in 2009, the UNEP Governing Council agreed to establish an Intergovernmental Negotiating Committee (INC). This committee was mandated to prepare a legally binding international agreement and beginning the process resulting in the “Minamata Convention on Mercury.” The objective of the Minamata Convention on mercury is meant to protect human health and the environment from the adverse effects of mercury. In the convention, it was agreed to:

a. Ban new mercury mines;
b. Phase out the existing mercury mines;
c. Phase out and phase down of mercury use in a number of products and processes;
d. Put in place control measures on emissions to air and leases to land and water; and
e. Regulation of the informal sector of artisanal and small–scale gold mining;
f. The convention also addresses the interim storage of mercury and its disposal once it becomes waste, sites contaminated with mercury as well as mercury related health issues.

The aspects of knowledge, perceptions, and levels of exposure to mercury by the ASGMs and of people who live in close proximity to artisanal gold–mining sites are not known nor appreciated. The potential health risks of exposure to mercury (Hg) are also unknown. Mercury exposure adds to the environmental burden of disease in Uganda. This added burden is likely to minimize the achievements of the Sustainable Development Goals as well as the objectives of the Minamata Convention. Thus, the primary objective of this study was to establish the status and extent of mercury use. The study also delved into the sources, knowledge and perceptions of artisanal miners on the environmental and health impacts
of using mercury. The findings were to act as a basis for the recommendation of alternative technologies and practices that are appropriate for a sustainable gold mining industry in Uganda. In this case, Busia and Mubende Artisanal Small Scale Gold mining communities are considered a sizable sample, hence, representative enough for the entire artisanal mining and mercury user fraternity.

1.1 Justification

Millions of miners, infants, children, women of child-bearing age (potentially pregnant) and breast-feeding women work or live in ASGM communities. All are at risk of mercury exposure. ASGMs often burn amalgam in front of children and in residential areas. In Uganda, the mining sites are close to farmlands and water sources. The water sources in such sites account for 99% of water requirements for domestic use. This puts the health of the miners and surrounding communities at a great health risk (Nabaasa, 2016). To effectively deal with the problem, there is urgent need to fully understand perceptions of artisanal gold miners on the use of mercury, knowledge of health and environmental effects associated with mercury use, the quantities and levels of exposure to mercury as well as storage and disposal practices used by the miners to manage mercury.

1.2 Overall Objective

The study aimed at assessing ASMGs’ knowledge, perceptions and exposure to Mercury toxicity as a way of contributing to national and international agenda of eliminating the use of mercury by artisanal and small-scale gold-miners;

1.3 Specific Objectives

The specific objectives of the study included;

a. Establishing the sources, status and extent of mercury use by the artisanal gold miners in Mubende and Busia gold-mining sites.

b. Finding out the artisanal miners’ perceptions and knowledge on the use of mercury in the gold mining processes.

c. Evaluating the storage and disposal practices adopted by the artisanal miners in the management of mercury in Mubende and Busia.

---

1.4 Scope of the Study

The study focused on mercury use by the artisanal small–scale gold miners in Busia and Mubende gold mining sites. The study also focused on the sources and quantities of mercury used by the ASGMs in the study area and their perceptions on the use of mercury.

The study used four (4) case study gold mining sites; two selected from Mubende district and another two sites selected from Busia District. The selection of the sites was based on the criterion big number of miners. Whether those miners are organized either in formal or informal groups and associations was another important criterion.

Therefore, two out of the four artisanal small–scale gold miners associations in each of the two districts were selected making a total of four case study sites. These included; (i) Kayonza Miners Association in Kitumbi village, Mubende district; (ii) Lugongwe Miners Group in Lujinji Village, Mubende District; (iii) Busia United Small scale Miners Association; (iv) and Tira Landlords Miners Association, Busia District. The study, particularly, the field survey was undertaken from 13th–28th March, 2018 while the desk research review and analysis occurred months before the field survey.

1.5 What the study did not cover

The study did not focus on conducting laboratory tests and analysis of the quality of water and soil samples. This was because it would be too early to conduct soil and water sample tests since the primary focus of the study was to establish artisanal miners’ knowledge, perceptions, and sources of mercury used in gold mining/processing. Thus, it is after this stage that water and soil samples would be tested to further establish the ASGMs and surrounding communities’ level of exposure to mercury contamination and associated environmental and health damage.

In addition, the study did not do a detailed discussion of the national and international institutional and legislative framework on mercury. This was because of the fact that this being a baseline survey, it was not a compliance or audit activity. The study of this nature can only make reference and inferences to the existing laws and policies as opposed to doing an in–depth discussion of the law. Therefore, the section on legislative framework that appears in this report is an analysis of the existing legislation discussed in general terms and its implication on mercury use by the artisanal gold miners.
This section describes the study area and the materials and methods used to carry out the study.

### 2.0 Study Area

The study was carried out in two districts of Mubende and Busia. In total four gold-mining sites; two from each of the two districts were purposively selected.

**Figure 1: Map of Mubende District Showing the Study Area**

![Map of Mubende District](image)

*Source: Adopted from Mubende District Development Plan, 2011/2012*

### 2.1 Mubende District

Mubende district where Kayonza and Lugongwe gold mining sites are located is divided into three counties of Buwekula, Kasambya and Kassanda. The district constitutes of 18 sub-counties and one Town Council and over 90 parishes. There are more than 770 villages. Both Kayonza and Lugongwe gold mining villages are located in Kitumbi Subcounty of Kassanda County.
According to the National Housing and Population Census (2014), Mubende is the 6th most populated district of Uganda with a total population of 688,819. The population growth between 2002 and 2014 is 4.06%. Probably, this is due to the gold rush in the district. Kitumbi sub-county has a total population of 58,367 people (UBOS, 2014).

A mixture of hard rock and alluvial soils characterizes the District land area. The district has a total area of 758Km² land under wetlands. Of the wetland coverage, 25km² is already converted into alternative land use. The permanent wetlands cover 171.7km² while the seasonal wetlands cover 586.4km² and of these, the papyrus swamps cover approximately 159.5Km².

Residents use unprotected wells and streams to get water for domestic use and for watering animals. Many of these water sources are located either within the gold-mining sites or a few meters away from the mines. A number of boreholes are also present in the gold mining area. However, the boreholes are not routinely maintained and a good number of them are thus broken down. The mining practice is characterized by deforestation and modifications of the physical and hydrological systems. This is mainly done through construction of reservoirs or through silt accumulation in rivers (Akagi and Naganuma 2000).

**Busia District**

Busia District is located in the South-Eastern part of the Republic of Uganda, north of Lake Victoria and west of the Republic of Kenya. It is 196km from Kampala the capital city of the Republic of Uganda. The District lies approximately between longitudes 33°05’ East and 34°01’ East, and latitude 00°10’North and 00°35’ North and it covers a total surface area of 743 sq. km.

Land area is 648.95 sq. Km while open water and swamps cover about 36.88 sq. Km (Busia District, 2015). Busia United Small Scale Mining site and Tira Landlords gold-mining sites are located in Tira Village, Sikuda sub-county of Samia-Bugwe North in Busia District. The district has 10 sub-counties, 58 parishes and 609 villages. The District is dominated by undulating plain topography with an altitude of about 1128 meters above sea level at Nebolola Hills in Lumino Sub-county. There are also low-lying areas, predominantly valleys with altitude of about 1,000 meters above sea level. The most significant is River Malaba valley to the north and River Lumboka to the west. The landscape is comprised of a mixture of hard rock (70%) and alluvial soils comprising 30% of the soil type, especially, in Tira village. Tira Village lies along 0° 31’ 0» North and 34° 5’ 60» East.
According to Busia District Environment Action Plan (DEAP, 2001) quoted from the DPP4, 2015; pollution of water is one of the most serious environmental issues in the District. This is attributed to poor waste disposal and management, poor sanitation, washing and bathing in the water sources, and from artisanal gold mining activities.

**Figure 2: Map of Busia District Showing the Study Area**

![Map of Busia District Showing the Study Area](image)

*Source: Adopted from Mponimpa, 2005*

**In terms of climatic conditions,** the District receives an annual rainfall of 1514mm to about 1940mm towards the lake varies. The rainfall pattern is bimodal, with the first rainy season (short rains) extending from March to May and a longer rainy season extending from August to November. This climatological characteristic facilitates the easy flow of the poorly managed mercury waste and other pollutants to distant areas within and outside the district.
2.2 Methods and Materials

2.2.1 Sampling Frame
The sampling frame incorporated a number of stakeholders. These included Town council leaders, local leaders, local community residents, and the miners. Purposive and random sampling methods were used to select a suitable representative sample size. A total of 4 artisanal mining sites were purposively selected out of the 8 known artisanal small–scale gold–mining associations in Mubende and Busia districts. Lists of members were then obtained from the association leaders. Random sampling was conducted using $n = N/(1+\phi^2 N)$. This was aimed at selecting the number of respondents per group/association. For Kayonza Miners’ Association that had a total of 100 registered members, the sample size was 80. Lugongwe Miners Association with 50 members, the sample size was 44. Tira Landlords Association with 41 members, the sample size was 36. Busia Artisanal Small–Scale Gold Miners’ Association with 50 members, the sample size was 44. Overall, a total sample of 204 respondents was selected.

2.2.2 Materials
A number of materials were used to aid in effective data collection. Among the key materials that were used were Gloves; Safety boots; Nose Masks; Note books, pens; Cameras; and GPS.

2.2.3 Field Methods
The study used a number of methods. These included:

a. **Focus Group Discussions (FGDs) and Meetings**
FGDs and Meetings were conducted with all selected persons and agencies that included; National Environment Management Authority (NEMA), Uganda National Bureau of Standards (UNBS), Ministry of Energy and Mineral Development (MEMD). Others included officials from Mines’ office of the Ministry of Energy and Mineral Development, Makerere University’s Department of Geology and the District Local Government Leaders.

The aim of this was to get insights about the guiding policy and administrative framework regarding mercury–use, artisanal gold mining, and government’s general plans on alternative mercury–free technologies in the ASMG sub–sector.
b. Semi–Structured Questionnaire

Semi–Structured questionnaires were administered to obtain first hand information from the sampled artisanal gold–miners and community members. This was in line with the core objectives of the study. For example, extent of miners’ – use of mercury, estimated quantities of mercury used by miners per week, storage, and disposal methods of mercury among other variables – were all considered for evaluation.

Source: Taken by ACCC Research Team at Entebbe on 19th March 2018

Picture 1: Meeting with the State Minister of Mineral Development in Uganda

Picture 2&3: The Research Team administering questionnaires at the sampled sites

Source: Taken by ACCC Research Team at Tira mining site, Busai; March 2018
c. **Guided Interviews**

Guided interviews were administered to gather information about miners’ governance and organizational structures. The available awareness programs, sources & quantities of mercury traded in the sampled. The key informants included Leaders of artisanal gold miners, Town Clerks, and Environment and Community Development Officers in Busia and Mubende districts.

![Pictures 4 & 5: Interviews with District Environment Officers, leaders of ASGMs in Mubende and Busia Districts](source: Taken by ACCC Research Team)

---

**d. Observation and Photography**

Observation and photography were used to provide evidence of mercury–use and existing disposal methods of the used Mercury bottles.

---

### 2.2.5 Secondary Data

This involved collection of a wide variety of information from various sources. These sources included Uganda National Environment Authority (NEMA) Library, Makerere University Main Library, Publications and Websites.

---

### 2.3 Data Analysis Methods

The collected data was analyzed quantitatively using descriptive statistical methods. The statistical methods applied involved frequency tables, percentages, pie charts, and bar graphs using Gen–stat soft ware package. One–way Analysis of Variance (ANOVA) was used to test the overall levels of significance and difference between the means of the variables at different sample areas.
CHAPTER

3.0 Analysis of Existing Legislative Framework in View of Mercury Use & Asgm Sub–Sector

This section presents summarized information on both national and international legal framework concerning mercury use in the ASGM sub–sector as analyzed by the study team.

3.1 National Legislation

Uganda has a number of laws and policies such as the Mining Act (2003), Mining Policy, as well as the Constitution. It is suffice to note that ASGM sector has mostly remained informal and not well regulated. Location Licenses 5 for Artisanal and Small–Scale Mining provided for under the Mining Regulations, 2004 are obtainable at an application fee of 500,000 UGX (equivalent of USD 143). There is also a payable annual renewal fee of 250,000 UGX (equivalent of USD 71). This seems little money but given the fact that majority of Ugandans live on less than a dollar a day, these fees are high to many artisanal miners. In a study conducted by COWI (2016), it was established that there are only 50 Location Licenses in Uganda and that there is a high degree of informality of the sector. It is, however, important to note that the mining legislation in Uganda is under review and it is anticipated that such anomalies may be addressed.

It is obvious that environmental and health impacts of mercury are well documented in a number of national and international studies and reports. However, the current environment and health sector legislations in Uganda do not address the issue of mercury. The existing Public Health Act Cap 281 has been overtaken by events. It was enacted in 1935. It needs to be revised in order to capture new issues that have emerged since its enactment. The reigning environment legislation, particularly, the National Environment Bill,6 which at the time of this study was before Parliament of Uganda for review does not address the issue

5 A Location License requires a licensee who has license expenditure below 10 million UGX, equivalent to USD 3,000, an amount that constraints the license holder from any type of significant investment in mining and processing equipment (COWI, 2016).

6 The Draft National Environment Bill, 2017 seeks to repeal and replace the National Environment Act, Cap 153 (1995). The Review process began in 2009 and was still on–going by the time of this study (March, 2018).
of mercury use in the ASGM sector. Articles 24 and 39 of the Constitution of the Republic of Uganda, 1995 (As Amended) provide the overriding framework as far as a right to life and a right to a clean and healthy environment are concerned. The provisions under these articles are, however, too general in nature and are subject to misinterpretation. It is, therefore, hoped that the issue of Mercury will be addressed in the draft national environment Bill before it is passed into law. If done, this will be in compliance with the requirements of the Minamata Convention to which Uganda is a signatory.

3.2 The Minamata Convention on Mercury

Uganda is a signatory to the Minamata Convention on Mercury. The most significant issue in the Minamata Convention is captured under Article 5(3). It mandates signatory parties to take measures aimed at restricting the use of mercury or mercury compounds in gold mining. This restriction is with reference to the processes that include the production of sodium/potassium methylate/ethylate compounds used variously in the production of biodiesel, pharmaceuticals, food ingredients, crop protection products and other applications. The Minamata Convention requires parties to take measures that include the phasing out of mercury use as fast as possible within a period of 10 years of coming into force of the Convention. It also caters for reduction in emissions and releases in terms of per unit production by 50 per cent by 2020. It was further agreed in the convention that the following should be done:

a. Ban new mercury mines;
b. Phase out the existing ones;
c. Phase out and phase down of mercury use in a number of products and processes;
d. Put in place control measures on emissions to air and leases to land and water; and
e. Regulation of the informal sector of artisanal and small-scale gold mining

In Uganda, the looming poverty levels, and low cost of mercury over other gold amalgamation methods is a motivator to the easy access of the chemical by the artisanal miners in disregard of the contents of the Minamata Convention.

7 For more information about conventions and regulation about mercury, visit:www.mercuryconvention.org
Successful implementation of the convention by the Ugandan government will depend on the firm stand in phasing out mercury use in any gold mining site within the country’s jurisdiction.

The elimination framework will also highly depend on;

1. The regulatory approach taken;
2. The time and nature of research taken in establishing cost–effective strategies and alternatives that can replace the low cost and easy–to – use mercury among many artisanal gold miners and;
3. Clear understanding of the sources and dynamics of illegal mercury traders and dealers in Uganda and subsequent responses to the vice.

The period of phasing out use of mercury in the existing ASGM mining sites needs to be ample. If the period is shortened or done in a rash before or without preparing the ASGMs in addition to finding alternative livelihoods for them, the following setbacks are likely to occur:

- Miners are likely to find other new sites and continue with the activity using mercury to make ends meet as already observed in Mubende district where miners were evicted in 2017 through a presidential directive, but by March, 2018, the miners had already acquired new sites and extensively using mercury in gold extraction activities;

- Exacerbation of unemployment levels, bitterness and most likely crime rate, especially, among the miners and their families who consider artisanal gold mining the only source of livelihood. The district leaders including members of parliament concur that artisanal gold-mining, especially, in Mubende has since 2003 helped create employment to community members within and outside the districts. This has in, turn, reduced crime rate. Gold mining activity has acted as a source of hope to many illiterate people who would, otherwise, find it hard securing formal employment.
This section presents the results of the study concerning the demographic information of the respondents, status and extent of mercury use by artisanal gold miners in the sampled mining sites. It also tackles Miners’ perceptions and knowledge of mercury use, factors that influence the use of mercury by the gold miners, the existing storage and disposal practices of mercury waste (and used mercury bottles) in Mubende and Busia gold–mining sites.

### 4.0 Analysis and Presentation of Results

#### 4.1 Participation And Sample Size

- 204 questionnaire responses were received from the 204 questionnaires administered across 4 gold–mining sites in the 2 districts under study.

- The overall response rate of the total number of questionnaires administered was 100%. This was a very good response rate for a survey of this kind.

<table>
<thead>
<tr>
<th>No</th>
<th>District</th>
<th>ASGM Associations/Villages</th>
<th>Number of questionnaires administered</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mubende</td>
<td>Kayonza</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lugongwe</td>
<td>44</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Busia</td>
<td>Busia United</td>
<td>44</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tira Landlords &amp; Miners Assoc.</td>
<td>36</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: Primary Data; March 2018*

#### 4.2 Findings on Respondents’ Demographic Information

The findings on demographic information of respondents involved Gender, Age Group and Level of Education.
4.2.1 Findings on Gender of Respondents

Findings show that there were more males involved in artisanal small scale gold mining compared to females as indicated in table 2 below:

Table 2: Findings on Gender of Respondents

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage (%)</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>146</td>
<td>72</td>
<td>146</td>
</tr>
<tr>
<td>Female</td>
<td>58</td>
<td>28</td>
<td>204</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Source: Primary Data; March 2018

Table 2 shows that, 146 (72%) of the respondents were males while 58 (28%) were females. The findings conformed to those by the Uganda Bureau of Statistics (2014) where males were also found to constitute the majority of the population in both formal and informal employment sectors of Uganda. The female counterparts were few and they are believed to be more disadvantaged than their male counterparts.

Figure 3: Graphic illustration of the Percentage Distribution of Respondents’ Gender

Source: Primary data; March, 2018
It is generally believed that women are more disadvantaged than men. Statistics in Uganda highlight several inequalities between men and women. For example, 23.1% of households are headed by women; men earn over 30% more than women; 76% of adult males and 61% of adult females are literate; women hold 24.7% of seats in Parliament; and only 7% of women own land (UBOS 2014). Although national statistics fail to provide a comprehensive picture of gender disparities in terms of vulnerability, access, control, decision-making and poverty, women and children are more prone to environmental catastrophes and are, generally, subjected to lower level and more risky activities of the socio-economic development value chain of many sectors in Uganda.

4.2.2 Findings on the Age Group of Respondents

The respondents considered for the study included those in the age groups; 18–35; 35–45; 45–60 and over 60 years of age. Findings are indicated in figure 4. The figure shows that most of the respondents were youth in the age category of 18–35 years that make up 70% of the total respondents followed by members in the age group 35–45 years old represented by 23%, and those in the age group 45–60 years old represented by 7% while age group 61 and above did not register any number of respondents.

This implies that most of the people engaged in artisanal small scale gold mining are youth. According to the Uganda Constitution (1995), the term “youth” is defined as those persons or individuals between 18 and 35 years of age. A youthful population seems to be more active, adaptive to change, energetic and more

Figure 4: Graphic illustration of the Percentage Distribution of Respondents’ Age groups

Source: Primary Data; March, 2018
responsive to development than the aging one, especially, in the labor-intensive activities of gold mining that require more energy. The finding that majority of the respondents were youth concurs with the fact that majority of the Ugandan population is youthful.

4.2.3 Findings on Education Levels of the respondents

No formal schooling, Primary, secondary, tertiary, and university were the education levels considered and the findings indicated that most of the respondents did not go through formal schooling followed by those who stopped at primary level of education as indicated in table 3. The low education levels suggest that unlike large-scale mining operations, small-scale mining, potentially, offers greater job opportunities for both literate and illiterate people in Mubende and Busia districts of Uganda.

Table 3: Education Levels of the respondents

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage (%)</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No formal schooling</td>
<td>94</td>
<td>46</td>
<td>94</td>
</tr>
<tr>
<td>Primary</td>
<td>93</td>
<td>45</td>
<td>187</td>
</tr>
<tr>
<td>Secondary</td>
<td>13</td>
<td>6</td>
<td>200</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>University</td>
<td>4</td>
<td>3</td>
<td>204</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>204</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Primary Data; March 2018

Table 3 shows that majority of the respondents had no formal education (46%), 45% had primary, while 6% had secondary level. Only 3% of the respondents had attained university education. Since the education levels of most respondents were low and given the fact that most people in the study area were found speaking Local languages, the research team carried out the research in local languages and respondents were comfortable while responding to questions.

It is good that a considerable number of respondents have gone through the elementary levels of formal education, this is a possible entry point for establishing community trainings and awareness programs/campaigns among the artisanal gold miners on mercury and its health and environmental effects. It also paves way for the introduction of alternative ways of processing gold using more sustainable
methods other than mercury in Busia and Mubende gold mining communities and by extension, other gold mining areas that are not covered in this study.

### 4.3 Findings on the Status and Extent of Mercury–Use by the Artisanal Gold Miners in Mubende and Busia Goldmining Sites

In generating findings on the status and extent of mercury use, the research team began by requesting respondents to indicate whether they use mercury in their daily operations for gold mining, the number of years they have spent in artisanal small scale gold mining activities, the quantity of mercury used per week, and the different sources of mercury used in Mubende and Busia Districts where the study was undertaken.

#### 4.3.1 Findings on the Number of Artisanal Miners Using Mercury in the process of gold mining in Busia and Mubende gold mining sites

All the sampled respondents (n=204:100%) were using mercury in the different stages of gold–processing/mining in both Mubende and Busia gold–mining sites. It was, however, observed that none of the miners was using Gloves during the process of gold amalgamation. Extracting minerals using mercury with bare hands is contrary to the UNIDO guidelines on mercury–use, which requires that Gloves should always be worn to reduce exposure to mercury by the small–scale and artisanal mineral miners.

**Picture 6: Gold amalgamation using mercury in Tira gold-mining site, Busia District**

Source: Taken by ACCC Research Team at Tira gold mining site on 14th March, 2018
4.3.2 Sources of Mercury used by the miners

Information on sources of mercury used by the ASGMs was generated through focus group discussions (FGDs) with the miners; interviews with key informants; and desk review of documents.

In Mubende District, both the miners and district leaders revealed that mercury used by the artisanal miners in the district is acquired from;

a. Indian Traders who bring in and sell mercury to the artisanal miners through local mercury dealers in Mubende. This finding is in line with that of COWI (2016), which established that the suppliers of mercury in Mubende gold-mining sites are gold buyers – of Indian origin – who, in some instances, trade mercury in exchange for gold.

b. Chinese Traders – who like the Indian Traders–, sell the mercury to the ASGMs through local traders in Mubende. Indeed, a report by COWI (2016) reveals that Some Chinese companies in Uganda smuggle mercury by concealing small stocks in cavities of imported mining equipment, which they then sell to the artisanal and small scale gold miners in Uganda.

c. Hospital and Laboratory officers who smuggle and illegally sell mercury meant for hospital and laboratory operations to middle men who then deliver it to the ASGMs.

In Busia, Miners enumerated the sources of mercury to include; Busia Town Council, Kampala city and from their association leaders. Therefore, In view of the information obtained, mercury supply in Mubende and Busia is comprised of;

- Foreign Traders of Indian and Chinese origin that bring in and sell mercury to other mercury traders.
- Local Traders who sell mercury to the ASGMs. Most of the local traders are gold buyers who also engage in mercury supply to the ASGMs.
- Hospital and Laboratory officers who smuggle and illegally sell mercury meant for hospital and laboratory operations to middle men who then deliver it to the ASGMs.

It was found out that mercury is typically distributed in 100gm plastic bottles selling at UGX 2,000 per gram as revealed by the sampled respondents in Mubende and Busia gold-mining sites. This translates to USD ($) 0.6 considering an exchange
rate of 3,500 UGX. As COWI (2016) observes, this study also established through observation that mercury in Mubende and Busia gold mining sites is transported and sold in small un–labeled plastic bottles, and in bottles of other products other than mercury.

4.3.3 Quantity of Mercury Used Per Week

Information on the quantity of mercury used by the miners is important in understanding the extent of mercury use by the miners in gold mining sites. The study findings in Busia and Mubende as presented in table 4 indicate that the majority (58%) of the sampled artisanal gold miners use an average of 1–50gms of mercury per person/week. This translates into an estimated 2,800gms per miner/year. This finding is in line with that of COWI (2016), which observed that, although there are no recent estimates on the use of mercury for ASGM in Uganda, if the average mercury consumption per miner from Busia and Mubende gold mining sites is applied, the resulting mercury consumption may be estimated at 33–48 tonnes/year. The finding is also in line with UNEP’s (2012) finding, which indicates that an estimated 1400 tones of mercury are used every year by ASGM miners globally.

It should be noted that for every gramme of gold produced, artisanal gold miners release about two grammes of mercury into the environment. Cumulatively, the world’s 10 – to 15–million artisanal gold miners release about 1, 000 tonnes of mercury into the environment each year, which accounts for 35% of synthetic mercury pollution (Hinton, 2011). Case control studies have shown that chronic

![Picture 7: A miner in Tira gold-mining site holding a plastic bottle containing mercury](source:Taken by ACCC Research Team at Tira gold mining site on 14th March, 2018)
exposure via inhalation – even at low concentrations in the range of 0.7–42 µg/m³ could lead to tremors, impaired cognitive skills and sleep disturbances.

**Table 4: Estimated Quantity of Mercury used by Miners per week**

<table>
<thead>
<tr>
<th>Quantity (gms)</th>
<th>Responses</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 50</td>
<td>118</td>
<td>58</td>
</tr>
<tr>
<td>51–100</td>
<td>44</td>
<td>22</td>
</tr>
<tr>
<td>101–150</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>151–200</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>201–250</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>251–300</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>over 300</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>204</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Source: Primary Data; March, 2018**

Table 4 shows that 58% of the respondents use between 1 and 50gms of mercury per week, followed by those who use between 51 to 100gms (22%), over 300gms (10%), 101 to 150gms (9%), and 151 to 200gms (1%). See figure 5 for graphic presentation.

**Fig. 5: Graphic illustration of the quantity of mercury used by miners per week in the sampled gold mining sites of Mubende and Busia**

**Source: Primary Data; March, 2018**
4.3.4 Number of Years using Mercury as an Artisanal Gold Miner

The number of years spent using mercury in gold–mining is a key denominator in evaluating the level of exposure and extent of mercury use by the artisanal gold miners. Findings show that majority of the sampled miners had spent between 1 to 4 years using mercury (44%) followed by those who had spent between 5 to 9 years represented by 30% of the respondents.

Table 5: Number of Years worked as Artisanal Gold Miner & using Mercury

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage (%)</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 4 yrs</td>
<td>90</td>
<td>44</td>
<td>90</td>
</tr>
<tr>
<td>5 – 9 yrs</td>
<td>61</td>
<td>30</td>
<td>151</td>
</tr>
<tr>
<td>10 – 14 yrs</td>
<td>21</td>
<td>10</td>
<td>172</td>
</tr>
<tr>
<td>15 – 19 yrs</td>
<td>10</td>
<td>5</td>
<td>182</td>
</tr>
<tr>
<td>20 – 24 yrs</td>
<td>14</td>
<td>7</td>
<td>196</td>
</tr>
<tr>
<td>25 – 29 yrs</td>
<td>8</td>
<td>4</td>
<td>204</td>
</tr>
<tr>
<td>30 –34 yrs</td>
<td>0</td>
<td>0</td>
<td>204</td>
</tr>
<tr>
<td>35 – 39 yrs</td>
<td>0</td>
<td>0</td>
<td>204</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>204</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Primary Data; March, 2018

In terms of exposure, findings indicate that save for the 90 respondents who had spent between 1 to 4 years using mercury (44%), the rest of the respondents (n=114) represented by 58% had spent between 5 to 29 years using mercury in the artisanal gold mining business. It is important to note that out of the total number of miners who had spent 5 to 29 years using mercury, 41% were female an indication that although findings in section 3.1 it is shown that majority of the sampled respondents were males (72%), women in the sampled sites have stayed longer in the artisanal mining business and are relegated, mostly, to those stages of gold–mining where mercury is intensively used (such as gold amalgamation).
as opposed to men – indeed, one of the men in Lugongwe gold-mining site, Mubende district had this to say during the survey;

“It is women who handle the activity of gold amalgamation, I am not very certain how much mercury I use per week, ask women they know better; here men, especially, the land owners and those with a certain level of money usually employ women to handle this task because it is a lighter activity compared to say rock blasting, which requires young and energetic boys.”

Fig. 6: Graphic illustration of the number of years exposed to mercury use by the sampled miners in Mubende and Busia Gold mining sites.

Source: Primary Data; March 2018
4.4 Findings on Artisanal Miners’ Perceptions and Knowledge on the use of Mercury in the Gold Mining Processes

To find out artisanal miners’ perceptions and knowledge on the use of mercury in gold mining, the survey included categorical questions that required respondents to state their level of concern on the way mercury is used, their knowledge of environmental and health effects of mercury, and factors influencing their use of mercury as opposed to other gold extraction methods.

4.4.1 Concern About the way Mercury is Used

Findings indicate that majority of the respondents (n=140, 69%) were not concerned about the current state of mercury use in their specific areas of operation. It was further found out that majority of those who were not concerned about the way mercury is currently used were those who had no formal education background and those who had only attained primary level education – a summative of which is represented by n=115. In addition, the lack of concern among the 115 respondents can be attributed to absence of awareness programs on the effects of mercury and trainings on appropriate ways of handling mercury as revealed by 100% of the respondents in Mubende and 61% in Busia.

Table 6: Responses on concern about the current state of the way mercury is used in sampled sites of Mubende and Busia districts

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Concerned</td>
<td>140</td>
<td>69</td>
<td>140</td>
</tr>
<tr>
<td>Concerned</td>
<td>64</td>
<td>31</td>
<td>204</td>
</tr>
<tr>
<td>No Opinion</td>
<td>0</td>
<td>0</td>
<td>204</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>204</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Primary Data; March, 2018

Table 6 shows that 69% (n=140) of the respondents were not concerned about the way mercury is currently used at their sites of operation, while 31% (n=64) were concerned and were willing to be introduced to other environmentally safer methods of gold amalgamation than use of mercury.
4.4.2 Knowledge of Environmental and Health Effects of Mercury

All artisanal gold miners in the 4 sites that formed part of the study used elemental mercury to amalgamate Gold. The majority of the respondents (n=118, 58%) expressed fears regarding the health and environmental implications of mercury use in gold extraction. They expressed specific concern over the possibility of polluting food and water resources. It was revealed by the miners that a maximum of 1,000gms of mercury are used by at least 20 people (see table 4) each using between 300 and 1,000gms a week in gold extractions. Indeed, observation revealed that the mining sites were close to the water sources that accounted for 95% of water requirements for domestic use putting the health of the miners and community members at a great health risk. Interviews with the district leaders, and leaders of the artisanal gold miners indicated that miners get mercury mainly from Chinese traders, Indian traders, and from Hospitals, especially, laboratory officers who sell the chemical to miners. It is important to note that the practice of gold amalgamation close to water sources is contrary to international guidelines on mercury use which states that “No amalgamation washing and sluicing using mercury shall be done along or close to rivers, streams or any other water sources.”
Even with knowledge and awareness of mercury toxicity as indicated by 58% of the respondents, there is, often, no relationship between how one acts and the decisions one makes concerning avoidance, control or protection against exposure as revealed by 100% of the respondents who indicated no use of protective gear during use of mercury (n=204, 100%).

Source: Taken by ACCC Research Team at Kayonza gold mining site in Mubende on 23rd March, 2018

Pictures 10 &11: A youth miner in Tira mining site showing how use of mercury has affected his fingers

Source: Taken by ACCC Research Team at Tira gold mining site on 14th March, 2018
Therefore, while the findings of this study indicated that the majority of the miners expressed fears about mercury toxicity, it was observed during the study that artisanal miners were using mercury with their bare hands to amalgamate gold in open air. A study by Charles et al., (2013) indicates that the necessity of generating a livelihood often outweighs the potential negative health outcomes associated with mercury use among the artisanal gold miners in Tanzania. Thus, this study’s finding seems to concur with that of Charles et al., (2013) in Tanzania.

In terms of protection of pregnant women and children from mercury pollution, it is noted through literature review that International Guidelines on mercury–use require small–scale and artisanal miners to ensure that people who perform amalgamation, retorting melting gold or handling mercury must ensure that no pregnant women, or children under the age of sixteen, enter the structure, facility or locale in which mercury is being used. However, through field observation, the study team observed that pregnant women and children below the age of sixteen were present at almost all the mining sites visited during the study. See picture 13.
4.4.3 Factors influencing use of mercury by the miners in Busia and Mubende gold-mining sites

In order to establish factors influencing use of mercury by artisanal gold-miners and not any other alternative method of gold-extraction, the research team sought out for specific responses to the following questions:

a. What are the main reasons influencing miners’ use of mercury in Busia and Mubende gold mining sites?

b. Out of the identified factors, which ones are more predominant?

Findings show that lack of awareness and skills about the use of other methods other than mercury is the major reason for use of mercury by the miners in the sampled sites of Busia and Mubende mining sites represented by n=164 (50%) of the responses. This is followed by the high cost of other alternatives (20%), availability and affordability of mercury (17%), and the lack of appropriately gazetted national laws and regulations on mercury use (13%). Results are presented in table 7.
Table 7: Responses on factors influencing miners to use mercury for gold extraction in the sampled sites of Mubende and Busia districts

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage (%)</th>
<th>Cumulative frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of appropriately gazetted national laws and regulations on Mercury Use</td>
<td>43</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>Availability and affordability of Mercury</td>
<td>55</td>
<td>17</td>
<td>98</td>
</tr>
<tr>
<td>High Cost of other alternatives</td>
<td>64</td>
<td>20</td>
<td>162</td>
</tr>
<tr>
<td>Lack of awareness and skills about the use of other methods other than Mercury</td>
<td>164</td>
<td>50</td>
<td>326</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>326</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Primary Data; March, 2018

Interviews and focus group discussions with the key informants included district leaders, local council leaders, environmental officers, community development officers, and leaders of the artisanal gold miners’ associations. These revealed that there is lack of awareness and skills about the use of other methods other than mercury. This is attributed to absence of clear programs and trainings among the miners on proper use of mercury and cheaper – easy to use alternative technologies. Secondly, it was revealed by the district leaders that government has not been able to embark on awareness programs on the use of mercury among the artisanal miners partly because artisanal small-scale gold mining is not yet legalized in Uganda. As such, government had by the time of this study closed some gold mines and miners evicted in certain gold-mining sites in Mubende district without legal basis for their compensation.

Observation revealed that eviction of miners seems not to be a lasting solution as miners had already acquired other mining sites, and mercury extensively used by the miners in the new sites.
4.5 Findings on the Storage and Disposal Practices Adopted by the Artisanal Miners in the Management of Mercury in Mubende and Busia Gold Mining Sites

Findings on existing storage practices of mercury by the artisanal miners were collected by asking respondents to indicate all forms of practices they use for storing mercury, and how they manage the empty mercury containers after using the mercury. Findings indicate that mercury in Busia and Mubende gold mining sites is stored by the miners using different practices which include; open containers, and closed containers kept either at home or at the mining site. The different waste practices identified include; open dumping of the used mercury containers, burning of the used containers in soil, burning, and re–using of the bottles among other management practices.

4.5.1 Storage of Mercury by the artisanal gold miners in Mubende and Busia mining sites

Respondents were asked to indicate the various practices they use to store mercury after buying it from the mercury traders. Findings show that most of the miners store mercury in closed containers (n=118, 40%), which they either keep at home (n=109, 37%) or at the site (n=57, 20%). Detailed findings are presented in table 8.

Table 8: Response on mercury storage practices by the artisanal gold miners in the sampled mining sites

<table>
<thead>
<tr>
<th>Mercury storage Practices</th>
<th>Busia United</th>
<th>Tira Landlords, Busia</th>
<th>Kayonza, Mubende</th>
<th>Lugongwe, Mubende</th>
<th>Total</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Containers</td>
<td>22</td>
<td>17</td>
<td>43</td>
<td>36</td>
<td>118</td>
<td>40</td>
</tr>
<tr>
<td>Open Containers</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Plastic bags</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>At home</td>
<td>22</td>
<td>33</td>
<td>31</td>
<td>23</td>
<td>109</td>
<td>37</td>
</tr>
<tr>
<td>At the site</td>
<td>14</td>
<td>8</td>
<td>19</td>
<td>16</td>
<td>57</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>58</td>
<td>97</td>
<td>78</td>
<td>103</td>
<td>100</td>
</tr>
</tbody>
</table>

*Multiple Responses

Source: Primary Data; March, 2018
From table 8, Findings show that most of the respondents keep mercury in closed containers (40%). This implies less health and environmental risks associated with poor storage of mercury. However, this should not mean neglect of vigilance of environmental and health damage due to improper storage and management of mercury, especially given the fact that a considerable number of the sampled miners keep mercury at home (n=109) where it can easily be accessed by children. It was further established that the 20% of the miners who keep mercury at the site, hide it in bushes, trenches, and others bury it in soil where other miners cannot easily access it. These storage practices pose a great danger of contaminating environmental resources with mercury if not well monitored. This observation is in line with Hinton’s (2011) conclusion that the use of mercury in gold–mining is detrimental to the environment and that for every gramme of gold produced; artisanal gold miners release about two grammes of mercury into the environment through the different gold–mining practices.

**4.5.2 Existing Management Practices of Used Mercury Bottles**

Respondents were asked to indicate the various practices they use to manage used mercury bottles. Findings show that majority of the miners use open dumping at the site represented by n=103 (35%) of the sampled miners in Mubende and Busia gold–mining sites. See table 9 for details.

**Table 9: Existing Management Practices of Used Mercury Bottles**

<table>
<thead>
<tr>
<th>PRACTICES</th>
<th>Busia United</th>
<th>Tira Landlords, Busia</th>
<th>Kayonza, Mubende</th>
<th>Lugongwe, Mubende</th>
<th>Total</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Bury</td>
<td>22</td>
<td>15</td>
<td>31</td>
<td>16</td>
<td>84</td>
<td>28</td>
</tr>
<tr>
<td>Trenches</td>
<td>8</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>
## Table 1: Disposal Practices of Used Mercury Bottles

<table>
<thead>
<tr>
<th>Method</th>
<th>Busia United</th>
<th>Tira Landlords, Busia Kayonza, Mubende</th>
<th>Lugongwe, Mubende</th>
<th>Total</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>At home in the garden</td>
<td>16</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>On Road</td>
<td>8</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td>31</td>
</tr>
<tr>
<td>Dump site</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Garbage truck</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Recycle</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Re-use</td>
<td>4</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Open dumping at site</td>
<td>6</td>
<td>2</td>
<td>57</td>
<td>38</td>
<td>103</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>76</strong></td>
<td><strong>48</strong></td>
<td><strong>106</strong></td>
<td><strong>67</strong></td>
<td><strong>297</strong></td>
</tr>
</tbody>
</table>

Source: Primary Data; March, 2018

From table 9, majority of the sampled artisanal miners manage their used mercury bottles through open dumping at the site represented by 35% of the responses. This practice is followed by those who manage it through burying (28%), dumping on the road (10%), at home in the garden (9%), those who re-use the bottles (6%), dump in the trenches and channels (5%), burning (4%), and other methods (1%), which included throwing the bottles in pit latrines, and collection of bottles and taking them back to the trading stores. The table further reveals that none (0%) of the sampled artisanal miners manages mercury waste through recycling or collect it and wait for garbage trucks to take it to gazetted dumping sites.

The practice of open dumping of used mercury containers, dumping by the road side, and burning of the used mercury containers by the sampled artisanal miners in Mubende and Busia gold-mining sites was attributed to lack of knowledge about better management practices of mercury waste. For instance, one of the respondents in Mubende had this to say when interviewed on reasons why miners adopt the use of open dumping and burning to manage mercury waste:
“The only known and effective way of dealing with plastic mercury bottles is by burning them or burying in soil. I usually dump mine here at the site, sometimes, anywhere along the roads or throw in any nearby channel.”

The foregoing assertion indicates that, indeed, lack of awareness about better management practices of used mercury bottles and mercury waste in general has led miners to resort to unscrupulous methods that pose a great risk to peoples’ health and the environment. This finding is in line with the findings of the UNEP (1999) report on waste management practices in Africa, which indicates that between 20% and 80% of solid waste in Africa is disposed of by dumping in open spaces, water bodies and surface drains as a result of inadequate infrastructure and lack of awareness about better management practices among the community members.
Waste water contaminated with Mercury at Busia United Mining site

Some of the community members collecting untreated waste water from Busia United Gold Mining site
This section presents the dangers of mercury, existing opportunities, possible alternative mercury-free-technologies, recommendations and conclusions drawn from the study findings.

5.0 Dangers of Mercury to Human Health and Environment

Mercury is a shiny liquid metal that attacks the nervous system. Mercury is so dangerous to human health and environment. Mercury contamination of the environment from the abandoned and ongoing mining sites that rely on mercury amalgamation for gold extraction is challenging and worrying. Contamination is particularly severe in the immediate vicinity of gold extraction and refining operations. Mercury, especially in the form of water-soluble methyl mercury, may be transported to other sensitive areas such as water systems, wetlands, forests, farmlands, settlements through rainwater, flooding, and other forms.

According to WHO (2003), mercury can cause damage to the nervous system at even relatively low levels of exposure. Mercury may enter the body through the skin, gastrointestinal tract, and the respiratory tract (by breathing of mercury vapour or mercury-contaminated dust). The inhalation of mercury vapour can produce harmful effects on the nervous, digestive and immune systems, lungs and kidneys, and cause disabilities among children, cancer and may be fatal. Symptoms include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction.

Some miners in Mubende and Busia expressed fears that Mercury has contributed to miscarriages, abnormalities among children, increasing cases of cancer, impotence and infertility among men and women. Issues of sleep, dizziness, headaches, and skin issues were equally reported by the miners. To make a conclusive attribution of mercury to the miners’ health in the visited sites would require laboratory tests of blood samples.


9 Exposure to mercury can result in life-long disability, and is particularly harmful to children. In higher doses, mercury can kill. Many children in Mubende and Busia mining areas are exposed to mercury before and from the moment of their birth.
5.1 Existing Opportunities

a. **Willingness** of the miners to receive trainings and awareness programs on other gold extraction technologies other than mercury, and protective approaches against the effects of mercury. Majority of Artisanal miners in the sampled gold–mining sites expressed interest and willingness to receive trainings and awareness programs on mercury use and being introduced to new and better alternatives for gold extraction.

b. **There is a good possibility for better working relationships between the ASGMs and the District Local Governments.** It was found out that one intending to interface with the miners needed to first get clearance from the district authorities. This was the ubiquitous position from Mubende and Busia artisanal gold miners. A letter of introduction endorsed by the district officials is enough stepping stone for any one intending to introduce awareness programs, or any important interventions the artisanal miners. This can be used as a stepping stone by both the private sector and government to introduce awareness programs, bi–laws and regulations that can empower both the local leaders and the artisanal miners as far as effective management of the ASGM sector and eventual elimination of mercury use are concerned.

c. **The On–going Review of National Environment Legislation.** Schedule 5 of the Bill provides for a number of internationally banned and phased out chemicals, but mercury use in the ASGM sector is not captured. Therefore, the on–going review of the National Environment Law provides opportunities for the integration of mercury use in the ASGM sector among those internationally phased–out chemicals in the sub–sector.

d. **The district technical team especially the district environment officers** are willing to undergo trainings on mercury use and alternative technologies to its use. This in essence enhances their capacity to monitor all aspects with regard to mercury use in gold mining.

e. **The media fraternity is willing to partner with ACCC to amplify the plight of the miners** in the face of the use of mercury in gold extraction and purification processes. They are committed to receive tailor made trainings and providing coverage on the processes of gold mining, mercury use, national laws and international conventions with respect to mercury use.
5.2 Mercury–Free–Technologies

Taking into consideration the environmental, health and social dangers associated with mercury–use in the artisanal gold–mining sub–sector of Uganda, the following mercury–free–technologies are proposed; some of the methods include use of borax, magnets, sluice boxes, and shaking tables among others.

**Mercury–Free Gold Extraction Using Borax (Baking Soda)**

Borax was discovered more than thirty years ago by a group of small–scale gold miners in Philippines. The method is currently used by artisanal gold miners in Indonesia, Tanzania, Bolivia, and Zimbabwe among other nations where artisanal gold mining takes place. The method, works as follows.

The mined gold ore is crushed and milled in drums with hard metal rods or balls. The milled material is drained into a sluice and further washed down a chute covered with felt. The heavy minerals including gold are captured by the felt. When the felt is loaded, it is rinsed by washing in a tub and subsequently a gold concentrate is produced by panning. The gold concentrate is placed in a small piece of plastic together with equal amounts of borax and a few drops of water and then placed in a clay bowl. Heating with a gasoline burner or acetylene.
flame causes all the heavy minerals to melt and the molten gold will collect in the bottom of the bowl, from where a gold pellet can be picked up by the tip of a knife. Gold has a melting point of 1063°C. By adding borax the melting point decreases for gold and the other heavy minerals. The main advantage is that it is mercury–free and thus environmentally benign.

Further advantages to other mercury–free methods is that Borax does not require investment in expensive equipment, it is easy to learn for small–scale miners, and it takes approximately the same time as whole ore amalgamation. In addition, the method comes with economic benefits to the small–scale miner, since gold is not lost to the environment in as the case is, with mercury.

**Use of Sluices**

Sluices work on the principle that heavy particles sink to the bottom of a stream of water while lighter particles tend to be carried downstream and discharged. A rough surface, typically carpets, can trap the gold and other heavy particles. Like a ball rolling down a hill, flow and momentum increase with distance, making the trapping mechanism less effective further down the sluice, particularly, for fine gold. For efficient sluice operation, consistent water supply is important. When buckets are used to deliver sediment and water onto sluices, surges in
flow can lift gold particles off the carpets, reducing gold recovery. This can be avoided by filling a small reservoir like an oil barrel that delivers consistent flow to the sluice. Large sluice boxes can be constructed with wooden timbers and lined with plastic and carpets.

**Picture 18: Small-scale gold miners in Indonesia using sluice box constructed out of wooden material to extract gold ore**

*Source: Adopted from UNEP, 2012*

**Shaking Tables**

Shaking tables are slightly inclined with a trough along the lower edge, and slightly raised ridges along their length. The mineral feed and water are added along the high edge of the table, and a motor is used to shake the table. Inclination, water-flow and shaking, result in particle movement along the table towards the lowest corner. Lighter particles are more easily washed over the ridges than heavy particles separating them along the table and creating a heavy gold rich concentrate (see schematic).
Shaking tables can provide excellent separation of liberated gold from other minerals and produce high grade concentrates greater than 50%. The gold must still be extracted from the concentrate using another process (gravity, or direct smelting for example). However, as noted by UNEP (2012), Tables can be expensive, and require careful attention and training to operate effectively. As a result, they will likely only be accessible to organized small-scale miners with access to capital.

**Use of Magnets**

Magnets are often used as a tool to enhance concentration and to remove magnetic minerals – mostly magnetite. Magnetic minerals are typically dark in colour but some such as pyrrhotite (a sulfide) can be bronze colored and have a metallic lustre. A handheld magnet is used to remove unwanted minerals, with care to avoid losing gold. To do this, the magnet is used below the pan to separate magnetic from non-magnetic minerals.

Frequently wet mineral concentrate is heated to dry the minerals before using magnets for this purpose. This also increases the strength of magnetism in some minerals. A piece of paper or plastic is often used to cover the magnet so that the minerals can be easily removed from it.
Picture 17: A Small-scale gold miner- using borax in Tanzania
Recommendations

The following recommendations were informed by the study findings, literature review, and the discussions held with District leaders in Busia and Mubende, representatives from NEMA and Uganda’s Ministry of Energy and Mineral Development (MEMD). Thus, the following recommendations are provided with the aim of aiding Chemicals Management Regulators in Uganda, MEMD, NEMA, Leaders of ASMGs, and Opinion Leaders to establish and improve safeguards on mercury use among the ASMGs in Uganda. Thus, the study provides six major recommendations on mercury use in the ASGM sub-sector of Uganda;

a. **Trainings and awareness programs on mercury use, storage, and management**

A considerable number of ASMGs in this study had limited awareness and knowledge about the health risks associated with mercury use and related toxicity irrespective of educational levels. Therefore, there is need to focus on incentives and trainings on mercury use, storage and management rather than on the traditional monitoring and enforcement systems. A key part of this should involve illustrating the environmental and health cost of mercury vis-à-vis the chemicals availability and affordability to the miners.

b. **Legalization and formalization of the ASGM sector**

The environmental legislation in Uganda requires an Environmental Impact Assessment (EIA) including an Environment Management Plan for any kind of exploitation of mineral raw materials. Nevertheless, the applicable laws and regulations, are oriented towards large-scale and licensed mining sector, and do not take into account the inferior possibilities of small-scale and artisanal mining, thus giving way to environmental pollution and health risks in the small-scale mining communities.

- In order to address the health and environmental impacts associated with use of mercury by the artisanal gold miners, the legalization and formalization of the ASGM sector needs to be promoted because then, the Environmental and Social Impact Assessment requirement including Environmental and Social Management Plan (ESMP), environmental auditing and monitoring would be mandatory to form the legal basis for protection of human health and environmental protection against the foul use of mercury by the artisanal
gold miners. Studies indicate that in countries such as Ecuador, Mongolia, Indonesia, Zimbabwe, and Tanzania among others where there has been legalization of the sector, use of mercury by the artisanal miners has drastically reduced leading to improvements in environment and health quality.

c. **Development of Policy, Legislation and Regulations on Mercury Use that will lead to improved practices of artisanal and small–scale gold mining (ASGM) in Uganda:**

The government of Uganda, through MEMD, UNBS, and NEMA should develop guidelines providing for minimum standards regarding mercury use, storage, and disposal, especially in ASGM operations and where feasible, eliminate mercury use in artisanal and small scale gold mining, as per the Minamata Convention on Mercury.

d. **Need for Low Cost Alternatives to Mercury**

The study established that reductions in mercury use are more likely to be accepted by miners and become permanent if there are cheaper, easy to use, and low–cost alternatives to mercury. Therefore, there is need by MEMD and NEMA to identify and promote alternative mercury–free technologies that increase (or at least maintain) income for miners, and are better for health and environment protection. Such methods may include; the gravity method, panning and direct smelting (borax) among others.

e. **Need to develop effective strategies for managing mercury contaminated Waste and Reclamation of contaminated sites**

One of the main challenges identified by the study is the issue of managing waste mercury bottles and tailings. The Artisanal and Small Scale Gold Miners (ASGM) generally do not practice appropriate methods of managing mercury contaminated waste. This results into persistently contaminated sites. There is therefore need by MEMD and NEMA to centralize waste management among the ASGMs by establishing waste management systems especially for contaminated waste water, used mercury bottles, and tailings. This system should be developed in such a way that is affordable and accessible for the ASGMs. This system has been adopted in other jurisdictions such as Ecuador and Mongolia among others and involves;

- Establishment of a local governance structures for management of mercury waste.
- Clean up of contaminated sites – reprocess and dispose of existing poorly managed tailings.
- Established environmental monitoring systems through regular environmental assessments of mercury contamination.
- Elimination of mercury–use in gold processing.
- Environmental, Health and Safety (EHS) educational programs, which serve to increase miners’ awareness and serve as further disincentives to mercury use.

f. **Need to examine the level of contamination of water bodies and agricultural soils by mercury in the gold–mining sites where mercury is extensively used.**

It was observed that, indeed, most of the mining sites are located close to water sources and agricultural fields or water sources and agriculture fields are situated within the mining sites almost in all the visited sites. It was further observed that community members depend on these water sources and agricultural gardens for their livelihoods; yet, the extent of toxicity of such water bodies and soils is not yet known and cannot adequately be remedied. The level of contamination by mercury needs to be established through laboratory tests. There is, therefore, a need by NEMA and relevant institutions to examine the level of concentration of mercury in the existing water bodies and agricultural soils in the gold–mining sites of Mubende and Busia so as to come up with a proper and lasting solution in lieu of public health and environmental quality protection.
Conclusion

This study has revealed a number of aspects on the way mercury is used by the ASGMs in Busia and Mubende gold mining sites. The miners’ perceptions on mercury use, quantity, sources of mercury use have been established. Elemental mercury destined for use in ASGM is largely uncontrolled and unregulated in Uganda. Mercury is used in the process of gold purification/amalgamation by all miners in Busia and Mubende. The study findings indicate that the majority (58%) of the sampled artisanal gold miners use an average of 1–50gms of mercury per person/week. This translates into an estimated amount of 2,800gms per miner/year. In Uganda, the ASGM sector contributes an estimated annual mercury input to society of 18,495 kg/y of which 12136kg/y is released in the air, 3333kg/y is released in water, and 3027 kg/y is released on land (NEMA, 2017). Mercury in Mubende and Busia originates from Chinese and Indian traders, also smuggled from the government laboratories/hospitals and then distributed to the agents and dealers in towns and finally to the miners.

Mercury (Hg) is a powerful neurotoxin that is harmful to people. Men, women and children are less concerned about the dangers of mercury and as such use their bare hands and feet in washing crushed rocks mixed with mercury to get gold. It is dangerous to all categories of human life at different ages and stages. It is however, mostly dangerous to pregnant mothers, developing fetuses, and young children. Mercury and its effects can be transboundary in nature. Mercury storage and handling practices among ASGM are the worst and requires immediate remedial and corrective actions. In terms of the legal and policy frameworks, Uganda has an excellent legal regime on environment, however, the legal regime, especially, that regulating gold mining sector has not benchmarked associated environmental and health compliance demands. There is a need to incorporate the ASGM affairs and mercury use in the central planning, development agenda and finally regulate the ASGM sub sector in Uganda. This study too, presents a number of recommendations, which if adopted by the different stakeholders including the government of Uganda, private sector, and international development partners will go a long way in contributing towards the sustainable management of the ASGM sub–sector in Uganda.
References

Charles E., Deborah S.K., Deborah D., Mark D., Sospatro E.N., & Eveline K., (2013). *A cross-sectional survey on knowledge and perceptions of health risks associated with arsenic and mercury contamination from artisanal gold mining in Tanzania.* School of Public Health, Catholic University of Health and Allied Sciences, Mwanza, Tanzania

COWI (2016): *Country Reports on Mercury Trade and Use for Artisanal and Small-Scale Gold Mining.* Parallelvej 2; 2800 Kongens Lyngby, Denmark


Minamata Convention on mercury: www.mercuryconvention.org/Convention


APPENDIX I: UNIDO Technical Guidelines on Mercury Management in Artisanal and Small-Scale Gold Mining

These guidelines and measures were formulated based on health, environmental, technical, socioeconomic and legal assessments that were undertaken by the Global Mercury Project. According to UNEP (2012) the project was initiated with the support of the Governments of Zimbabwe, Tanzania, Sudan, Indonesia, Brazil and Laos, with the United Nations Industrial Development Organization (UNIDO), the Global Environmental Facility (GEF) and the United Nations Development Program (UNDP). These measures and guidelines can also be accessed from www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/ASGM/UNIDO%20Guidelines%20on%20Mercury%20Management%20April08.pdf. A Summary of these measures is here presented as follows;

1. RESPONSIBILITY OF EMPLOYERS OF MINING/PROCESSING PLANTS / GOLDSHOPS OPERATION

In all cases, the primary mining/ore processing license holder and gold shop owners should be held legally responsible for safe practices, including those involving mercury. The mining license holder or gold shop owner should institute reasonable safety measures to prevent the exposure of employees or other persons to mercury fumes.

2. LICENSE TO WORK WITH MERCURY

All licensed operations where mercury is used or handled should obtain a special license specifically for mercury at its facility. When miners apply for mining licenses and before beginning operations, miners should demonstrate awareness of how to comply with these guidelines.

3. NO WHOLE ORE MERCURY AMALGAMATION
No person should amalgamate the entire ore, through the use of a mercury–copper plate or using mercury directly into any gravity concentrator, centrifuge, or ball mill, Chilean mill of stamp mill.

This causes mercury flouring which reduces recovery and induce that a large portion of mercury is lost to the environment with tailings. Amalgamation must be used ONLY for gravity concentrates.

4. **MERCURY AMALGAM BURNING**

No person should heat/burn mercury amalgam to recover the gold without using a retort. Retorts contain and condense the mercury vapor releases and should be used to recycle mercury (in the form of a bowl retort, pipe retort, hood, etc). Amalgamation burning must not take place in domestic residences. This must be done distant (say MORE THAN 500m) from any house. No children and pregnant women must be present during the retorting activities.

5. **NO MERCURY–CYANIDE INTERACTION**

No person should use mercury in conjunction with cyanide, or conduct cyanidation of mercury rich tailings as this practice increases mercury methylation.

6. **AMALGAM BARREL**

Amalgamation of concentrates must NOT be conducted manually. This must be conducted in small plastic or steel rotating barrels with rubber balls or a chain inside to increase the homogenization of the mixture of concentrate and mercury. Amalgamation time should be kept as short as possible. Amalgamation should be controlled and stopped, if no visible free gold can be seen. The amount of mercury added into the barrels must be gradual, until all free gold is caught. No cyanide or potassium permanganate or any other oxidizing agent must be allowed to be added to the barrel; only a dash of detergent is enough to clean gold particle surfaces. An amalgam separator such as an elutriator must be promoted to separate amalgam from heavy minerals after amalgamation. A carpet sluice placed after the elutriator will ensure that the fine mercury is captured.

7. **CENTRALIZED AMALGAMATION SITES**

Amalgamation and retorting should only be conducted in designated sites (amalgamation pools and isolated retorting places) distant at least 500 m from any inhabited place. For any mining location where amalgamation occurs, the primary license holder or mine manager shall designate a portion of the mining location
as the prescribed structure, facility or locale where amalgamation may take place. Amalgamation may only take place in such structure, facility or locale. The holder of an ASGM license shall ensure that washing or settling ponds are constructed in his or her license area to provide for washing and sluicing, and no such washing and sluicing shall be done along or close to rivers, streams or any other water sources.

8. PROTECTION OF WATER BODIES

No person should conduct amalgamation or separation of amalgam from concentrates or burning amalgam or retorting in any natural water body or within a distance of 100 metres from any natural water body, including rivers, streams, lakes, and other water bodies.

Amalgamation tailings must not be discharged into a water body or in places susceptible to flooding.

9. PROTECTION OF RESIDENTIAL AREAS

No person should use mercury for amalgamation or any other purposes in residential areas or within a distance of 100 metres from any residential areas, including villages, towns, cities, or settlement areas.

10. DISPOSAL OF MERCURY OR MERCURY–CONTAMINATED TAILINGS

Any disposal of mercury–contaminated tailings should be done in a safe and proper way. No person should discharge mercury–contaminated tailings into a water body or in places susceptible to flooding. Disposal of mercury–contaminated tailings must be done by placing it on a clay or laterite soil–lined pit of several metres depth, located 100 metres away from any water body.

When the hole is filled with mercury–contaminated tailings, this must be covered with 1 meter of clay or laterite, then compacted, covered with soil, and re–vegetated.

11. EXTRACTING RESIDUAL GOLD FROM MERCURY–CONTAMINATED TAILINGS

Mercury–contaminated tailings must not be recycled to the concentration circuit once this contaminates the primary tailings. If any process is to be applied to recover residual gold from mercury–contaminated tailings such as leaching with cyanide, thiourea, etc., the residual mercury must be removed (e.g. by gravity concentration) prior to leaching. The effluents and tailings from gold extraction must still be treated as mercury–contaminated tailings and must be buried.
12. CONDENSERS FOR GOLD SHOPS
Any shop buying retorted gold, or any shop that is retorting gold, must have a proper fume hood installed to capture, condense and recycle mercury. The design of the fume hood should be such that over 90% of the mercury is captured.

13. STORAGE OF MERCURY
Metallic mercury should be stored safely at all times when not used; in (a) a secure location that is inaccessible to children; and (b) unbreakable air–tight containers that are covered with a thin layer of water (e.g. 1 centimetre) to prevent mercury evaporation. Mercury should NOT be stored in a domestic residence.

14. PROTECTION OF PREGNANT WOMEN AND CHILDREN
People who perform amalgamation, retorting, melting gold or handling mercury must ensure that no pregnant women, or children under the age of sixteen, enter the structure, facility or locale in which mercury is being used.

15. MERCURY–FREE METHODS
The above guidelines demonstrate minimum threshold requirements. These measures significantly reduce mercury emission and exposure where properly implemented. However, in all cases possible, miners should be encouraged to adopt appropriate mercury–free mineral processing methods. For small amounts of concentrate, the blowing–tapping method should be promoted.