# MINISTRY OF ENVIRONMENT AND FORESTRY

## AFR/NAP ASGM/GOK Project

## National Action Plan on Artisanal Small-scale Gold Mining

### VERIFICATION OF MERCURY TO GOLD RATIO FIELD VISITS IN MIGORI, NAROK, KAKAMEGA AND SIAYA COUNTIES HELD ON 13TH - 16TH JUNE 2021

**Migori/Narok Team**

**Kakamega/Siaya Team**

## 1.0 INTRODUCTION

The Government of Kenya signed the Minamata Convention on Mercury on 10th October, 2013 after actively participating in the Intergovernmental Negotiating Committee (INC) process which led to the adoption of the Convention. Following the signing of the Convention in 2016, the Government of Kenya embarked on a Mercury Initial Assessment (MIA) Project which was funded by the Global Environment Facility. The MIA identified ASGM as one of the significant sources of mercury emissions and releases in Kenya. The Ministry of Environment and Forestry thereafter notified the Secretariat of the Convention on Mercury that "ASGM in Kenya is more than insignificant" which signaled the development of the National Action Plan (NAP) for Artisanal and Small – scale Gold Mining (ASGM) in Kenya in accordance with Article 7 of the Convention.

In 2017, Kenya embarked on the development of an action plan for ASGM as part of an eight-country regional project funded by GEF, implemented by United Nations Environment Programme (UNEP) and executed by Africa Institute (AI). The project is aimed at assisting participating countries to develop NAPs to reduce the use of mercury and mercury compounds, and the emissions and releases to the environment of mercury from ASGM.

During the development of the National Action Plan for ASGM, the NAP report indicated a mercury to gold ratio of 1:1 and the Reviewers of the NAP needed a conformation of the ratio. This led to the recommandation that a selected team of experts to validate the actual field ratios.

A technical team visited gold mining sites at Roasterman and Ikolomani in Kakamega, Oyawi in Siaya, Osiri-Matanda and Mikei in Migori and Lolgorian in Narok to verify mercury/gold ratio

### 1.2 Objective

The main purpose of the visit was to ascertain the actual ratio of mercury to gold in the ASGM sector in Kenya.

### 1.3 Overview of the gold extraction process

The teams identified gold processers at the sites, who were requested to carry out the activity starting from the raw ore which involved the following steps:

**Step 1: Crushing:** The ore was brought to the surface in sacks by a team of porters. In order for gold "liberation", crushing was then conducted. Primary crushing with hammers produced a gravel sized rock ore.

**Step 2: Milling:** Ball mill crushers were used for milling in all the processing sites to achieve an even grain size that is fine enough to liberate the gold from the ore.

**Step 3: Sluicing:** Conventional sluices lined using sisal sacks were used to concentrate gold dust based on density. The milled gold containing ore then washed down the sluice box, so that gold dust which is dense can be trapped by the lining material. Heavy gold particles were trapped in

sluice carpets as the slurry (ore and water) passes over the inclined surface. The concentrate was then collected by washing the carpets into a basin.

**Step 4: Amalgamation:** Mercury was added to the concentrate recovered from the sluice mats and mixed by hand in basins resulting in the formation of a gold amalgam. The amalgam was then squeezed through a piece of cloth to recover excess mercury.

**Step 5: Roasting of Amalgam:** Burning of amalgam was performed in the open air. Mercury vapor is released into the atmosphere and remaining gold nugget was weighed.

### 1.4 Methodology

Two technical teams were commissioned to determine mercury to gold ratio in Kenya. The first group visited Roasterman and Ikolomani in Kakamega and Oyawi site in Siaya counties respectively. The second group visited Osiri-Matanda and Mikei in Migori and Lolgorian in Narok counties respectively.

The technical teams were composed of experts from Ministry of Petroleum and Mining, Ministry of water sanitation and irrigation, NEMA, Kenya Chamber of Mines and Ministry of Environment and Forestry.

The analysis was done on concentrates acquired from crushing, drying and milling which is the normal process at the mining sites in Kenya.

The analysis followed the following procedure;

1. The initial mass of mercury (M1) was determined by using a digital weighing scales found at the various sites.
2. Mercury (M1) was added into the concentrate and panned by hand.
3. Excess mercury (M2) was recovered by squeezing the amalgam through a cloth by hand
4. The recovered mercury (M2) is weighed
5. Therefore, the mercury used is M1-M2.
6. The amalgam (M3) was weighed.
7. The amalgam (M3) was then burned in open air (mercury vapor is released into the atmosphere)
8. The resultant gold nugget/sponge Gold (M4) is weighed.
9. To determine the ratio of mercury used to trap gold;
   (M1-M2)/M4

## 1.5 Insitu Observations and Findings

### Table 1: Migori and Narok Counties Sites Results

| County | Mining Site | Sample | Mercury added to the concentrate( M1) | Mass of mercury recovered from squeezing (M2) | Mercury added to concentrate – mass of mercury recovered (M1-M2) | Mass of the amalgam (Mercury + Gold) in grams(M3) | Mass of gold nugget in grams after burning (M4) | Mass of vaporized Mercury (amalgam – nugget gold) in grams (M3-M4) | Mercury: Gold(M1-M2)/M4 |
|---|---|---|---|---|---|---|---|---|---|
| Migori | Osiri – Matanda | 1 | 6.96 | 6.56 | 0.40 | 0.71 | 0.37 | 0.34 | 1.1:1 |
| | Mikei | 1 | 8.91 | 7.92 | 0.99 | 2.11 | 1.14 | 0.97 | 0.87:1 |
| Narok | Lolgorian | 1 | 9.70 | 9.55 | 0.15 | 0.25 | 0.10 | 0.15 | 1.5:1 |

### Table 2: Kakamega and Siaya Counties Sites Results

| County | Mining Site | Sample | Mercury added to the concentrate( M1) | Mass of mercury recovered from squeezing (M2) | Mercury added to concentrate – mass of mercury recovered (M1-M2) | Mass of the amalgam (mercury +Gold) in grams (M3) | Mass of gold nugget in grams after burning (M4) | Mass of vaporized Mercur (amalgam – nugget gold) in grams (M3-M4) | Mercury: Gold (M1-M2)/M4 |
|---|---|---|---|---|---|---|---|---|---|
| Kakamega | Roasterman | 1 | 7.84 | 7.10 | 0.74 | 1.17 | 0.68 | 0.49 | 1.1:1 |
| | Rockmining Ikolomani | 1 | 9.95 | 8.94 | 1.01 | 2.53 | 1.42 | 1.11 | 0.71:1 |
| Siaya | Oyawi Goldmining | 1 | 10.21 | 9.16 | 1.05 | 1.26 | 0.55 | 0.71 | 1.91:1 |

## 1.5. Discussion

The different samples presented different results as tabulated above. The average ratio of mercury to gold was found to be about 0.71-1.91 to 1 (Table 1 and 2). The difference could be attributed to

non-homogeneity of the ore material where some may contain mercury impurities with others none of the impurities.

### 1.6 Overall challenges

- Lack of openness from the miners resulting to poor provision of information.
- The miners expected that the team had come to demonstrate an alternative gold recovery method that does not use mercury.
- There was general lack of understanding of the difference between the NAP and Planet Gold projects by the miners.
- There were some laxities in performing the processes by the miners as requested.

### Limitations and assumptions of the study

- The Gold nugget that is obtained from burning of amalgam is not pure gold.
- There exists no standard for determining how the weighing machines are calibrated or how the purity is calculated.
- The measurements were done on site (not in a controlled environment).

### 1.7 Itinerary

The teams were welcomed by officials of the local miners' association who lead the teams to visit the gold mining sites and conducted the verification process as tabulated below.

| County | Mining Area | Dates | Field Coordinator(s) | Miner Group |
|---|---|---|---|---|
| Migori | Osiri – Matanda | Day 1 | George Odhiambo & Eunice Atieno | Migori County Artisanal Miners Cooperative & MOKA women group |
| | Mikei | | | MICODEPRO- |
| Narok | Lolgorian | Day 2 | Simon Jaramba & David Kipintoi | Lolgorian Miners Association |
| Kakamega | Rosterman and Ikolomani | Day 1 | Jimmy Makosi and Timothy Saleh | Rosterman and Ikolomani Miners' Association |
| Siaya | Oyawi | Day 2 | Morris Otimbo | Oyawi Gold Mining Cooperative Society |

## 1.8 Conclusion

1. It takes 0.71g to 1.91g of mercury to recover 1.00 g of gold nugget as a result of non-homogeneity of the ore material, site conditions and location.
2. From the findings, on average, the mercury to gold ratio is 1.2:1 on the visited sites.