International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 43 No. 1 February 2024, pp. 92-104

Problem Of Artisanal Gold Mining In The Mining Area Of Mangi, Tshopo Province In The Democratic Republic Of Congo

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Abstract

Objective: assess the environmental and health risks generated by artisanal gold mining in the community of MANGI.
Methods: This is a descriptive cross-sectional study carried out from October 2021 to June 2022. Data collection was done through direct observations and survey questionnaires. ArcGIS software was used to carry out our cartographic analyses. Landsat images from 2003 and 2023 were used to assess the deforestation rate of the mining area. Of the 362 questionnaires distributed to various artisanal miners and other stakeholders, 229 responses were collected, representing a response rate of 63.26%. Data analysis is done with Epi-info 7.2.5 software and Excel 2016 software.
Results: The area generally suffered deforestation of 2.3% and particularly forest degradation of around 10.9% due to artisanal gold mining over a period of twenty years. Mercury is the only chemical element used by gold miners in the processing of gold. A presence of minors on operating sites estimated at 9.2%. The level of ignorance of operators on the health impacts of the use of mercury was estimated at 96.5% and that of knowledge on the environmental impacts was at 64.6%. Deforestation was 100% certified. It was also noted the pollution of waterways and a disappearance of fish criticized by 92.6%; also the presence of rock debris in all sites studied with abandoned gaping holes. 91% of respondents experienced accidents/incidents during the activity. 94% of operators complained of lower back pain due to activity, 67% of chest pain, 62% of chronic cough, 21% of chronic digestive disorders, 81% of insomnia, 67% of persistent headaches, 13% of cases of memory loss, 39% of respondents presenting limb tremors. This study also reports 86% of cases of permanent conflicts linked to the activity with excessive alcohol consumption noted among the majority of operators (86%).
Conclusion: Gold panning has promoted the economic stability of several households in the region, but unfortunately, it is the basis of several health and environmental risks that it is essential to manage effectively. Raising awareness among operators and rigorous control over the application of texts are alternatives to be considered by the political-administrative authorities in this sector.

Keywords – Risks, Artisanal Mining, Gold, Mercury, Mangi, Tshopo, DR Congo.

INTRODUCTION

Worldwide, the Artisanal and Small-Scale Gold Mining (ASM) sector provides direct livelihoods to around 16 million artisanal miners and other sector actors and around 100 million people in indirect livelihoods (Seccatore et al, 2014). Although a provider of employment and the main source of income for gold mining communities, the sector generates various environmental impacts. In its report on biodiversity in the DRC, USAID (2010) shows that there are considerable overlaps between mining reserves and tropical forests, which presents a risk for the protection of this biodiversity. The potential environmental impacts of mining, according to this report, are: deforestation, siltation of waterways, land degradation, dust pollution, mortality of wild animals (poaching) and water pollution by acid, copper, lead, arsenic, cyanide or mercury. Certainly, one of the particularities of this activity is the use of chemicals, the most common of which are cyanide and mercury. Mercury is a "heavy" metal which several

studies prove to be the cause of harmful effects on the neurological, digestive and immune systems as well as on the lungs, kidneys and eyes, particularly among unborn children and newborns (Grasmick et al.1998). The transport mechanisms of mercury in the environment are one of the main reasons why it was decided that global action was needed to tackle the problem of mercury pollution. Thus, United Nations member states negotiated the Minamata Convention on Mercury, a global treaty aimed at protecting human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds (PAN, 2019). However, this sector represents 37.7% of anthropogenic atmospheric emissions of mercury into the environment. This is even more serious in Sub-Saharan Africa where gold ASM contributes up to 80% of mercury emissions (UNEP, 2018).

In the DRC, artisanal mining is not informal. It has existed for years and has followed a regulatory formalization process. It is with the economic liberalization measures decided by the Zairian Government in 1982 that artisanal mining has grown to this day. The Government has decided to liberalize research, possession, transport and trade in diamonds and gold from artisanal mining. The North-East of DR Congo, formerly called Orientale Province, which brought together the current Provinces of Tshopo, Bas-Uélé, Haut-Uélé and Ituri contains the main gold resources of the country. These resources make this part of the country a pole of attraction for international and national mining companies, but also for artisanal miners. Gold mining has grown significantly in the area for decades with the discovery of gold veins and the increase in poverty. In this region, gold panning feeds several families and has taken an important place in the local economy (Bedidjo, 2018). Artisanal gold extraction is an essential reality in rural areas, an occupation in the same way as agriculture and livestock breeding. The agglomeration of MANGI in the territory of BANALIA is today one of the most active artisanal mining areas in the province of TSHOPO. This activity constitutes the main source of income in this part of the country. In the various mining sites that are the subject of this study, mercury is the main chemical used for the processing of gold. However, this metal causes several negative impacts on the environment and health risks for the population. This reality motivated our study with a view to contributing to the improvement of operating conditions in this mining sector.

STUDY ENVIRONMENT, MATERIALS AND METHODS

Study environment

This study on the exploitation of gold and the use of mercury is carried out in the twenty-three operating sites of the MANGI mining zone located mainly in the BABOA DE KOLE Sector, Territory of BANALIA, Province of TSHOPO in the Democratic Republic of Congo

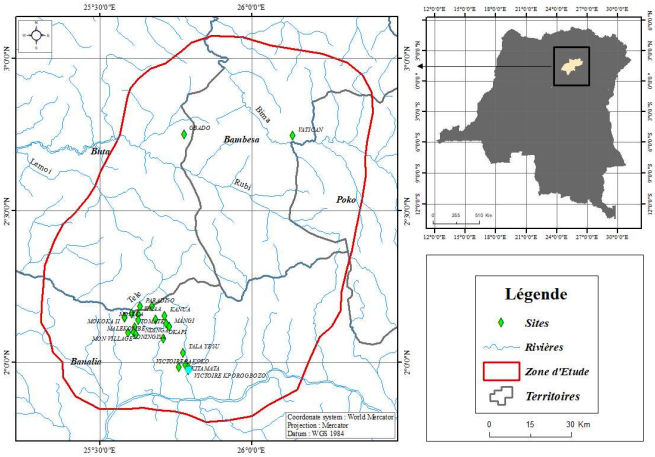


Figure 1. Study area and its hydrography (Geomatics Laboratory -UNIKIN 2023)

Methodology

This is a descriptive cross-sectional study carried out from October 2021 to June 2022, i.e. 9 months, in twenty-three operating sites in the area. To collect the information necessary for this study, practices were observed using observation grids and a survey based on a questionnaire. We also used a certain number of materials in particular: the Garmin brand GPS to collect the geographical coordinates of the mining sites in the study area, the ArcGIS software with its ArcMap extension made it possible to carry out our analyzes cartographic which were presented in the form of maps, the Google Earth software which made it possible

to visualize the different mining sites on satellite image backgrounds, the SRTM image with a resolution of 90 m pixel was used to generate a model digital terrain (DTM) as well as to extract the topography of the area under study, Landsat images from 2003 and 2023 for the evaluation of plant cover and the rate of deforestation and/or forest degradation. The study population consisted of all operators and stakeholders working on the 23 sites in the area. The sampling technique was stratified probability with an estimated sample size of 362 individuals. After collection, the data underwent statistical processing using Epi Info and Excel software. The results from these data processing revealed information which was analyzed and then interpreted.

RESULTS

I. OBSERVATION RESULTS

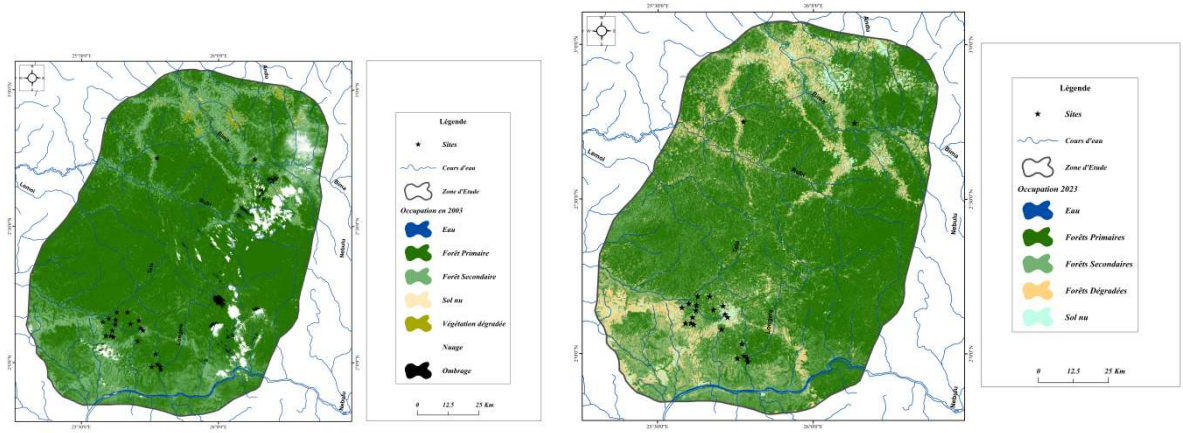
I.1. Mining technique and method of processing gold ore

In the Mangi mining area, four main types of gold mining have been categorized. Namely alluvial mining along watercourses, open-cast eluvial mining, deep eluvial mining, open-cast hard rock mining. The ore is reduced into small pieces of at least 1 cm3 using 2kg hammers. It is then put in the sun to be dried on tarpaulins. Once dried, the crushed ore is poured into a mechanical crusher tank containing several hundred kilograms of steel balls which transform it into a fine powder. The powder is poured into water and leached in a sluice box to obtain the pulps which will be amalgamated to recover the gold. The pulp obtained after leaching is poured into a basin then mixed with a small quantity of water. A person designated by his teammates begins to stir this mixture of mercury and gold concentrate contained in the pulp with his bare hand in order to obtain the amalgam. The amalgam is pressed in a cloth to remove the unamalgamated mercury. The pure and dry amalgam is finally heated over a fire in a pan to recover only the raw gold. Another part of the Hg evaporates during the operation. In the study environment, artisanal workers do not know of any other methods of recovering gold apart from amalgamation. They all use mercury as the only means of processing the ore to obtain gold.

I.2. Impacts of alluvial and eluvial extraction on forest resources and soil in the area

- ***Deforestation and forest degradation***

Deforestation is one of the unavoidable elements observed on gold sites. It constitutes one of the most visible impacts. Over a period of twenty years, the dynamics of deforestation occurs mainly in the exploitation zones as illustrated in the following figures.



a) In 2003 b) In 2023

Figure 2. Land cover maps *(Geomatics Laboratory -UNIKIN 2023)*

The results are as follows:

Table 1: Land Cover Classification

N°	**Classes**	Percentage **2003**	Percentage **2023**
01.	Water	0, 3	0,3
02.	Primary Forest	69,7	59,3
03.	Secondary Forest	28,3	25,5
04.	Degraded Forest	0,7	11,6
05.	Bare Soil	1	3,4
	Total	**100**	**100**

The total area of the study area being 12,722 km2 while the area occupied respectively in 2002 and 2023 by forest vegetation is 12,556,614 and 12,264,008 km2. Thus, the percentage of vegetation cover is respectively 98.7% and 96.4% in 2003 and 2023. The results obtained show that the mining area of Mangi has generally suffered deforestation of 2.3% and particularly forest degradation of around 10.9% due to artisanal gold mining between 2003 and 2023.

- ***Soil degradation***

❖ ***Presence of numerous excavations and soil erosion***

Gold mining in the area has left thousands of abandoned pits and excavations. This imbalance caused over-siltation of valleys and sedimentation of rivers.

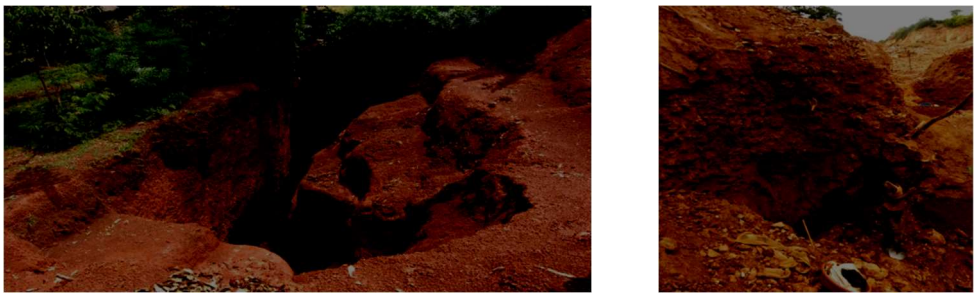


Figure 3: Abandoned shafts and excavations (Zuwa Idée and Loningisa site)

I.3. Impacts of extraction on surface water resources

The presence of mercury in freshwater is mainly due to mine discharges after amalgamation, runoff through dissolved contents in the soil, but also through atmospheric deposition.

Figure 4: Presence of sediments and mining discharges containing Hg on the banks and in the watercourse

II. SURVEY RESULTS

II.1. General informations

a) Response rate

Table 2: Distribution of respondents by site

N°	Mining site	Workforce	Samples	Respondents	%
01.	VICTOIRE KPOROGBOZA	175	11	6	**54,54**
02.	OKAPI	200	12	8	**66,67**
03.	TALA YESU	190	11	5	**45,45**
04.	BAKOKO	250	15	6	**40**
05.	VICTOIRE	199	12	5	**41,67**
06.	KITAMATA	300	18	10	**55,56**
07.	MALEKOMBE	290	18	11	**61,11**
08.	VATICAN	250	15	10	**66,67**
09.	GBADO	350	21	15	**71,43**
10.	DIEU VOIT TOUT	250	15	9	**60**
11.	NDINDA	179	11	5	**45,45**
12.	KANUA	300	18	12	**66,67**
13.	MOTUKA MUNENE	270	16	10	**62,5**
14.	ZUA IDEE	350	21	13	**61,90**
15.	PARADISO	220	13	8	**61,54**
16.	TIKAA	233	14	7	**50**
17.	MOTEMA NA MWANA	260	16	9	**56,25**
18.	TOMATE	240	14	8	**57,14**
19.	MOKOKA	290	17	11	**64,71**
20.	MOKOKA I	330	20	15	**75**
21.	LONINGISA	245	15	13	**86,67**
22.	MON VILLAGE	305	18	18	**100**
23.	MOSEKA	350	21	15	**71,43**
	Total	**6026**	**362**	**229**	**63,26**

b) Age of operators

The different age groups found in the operating sites are presented as follows:

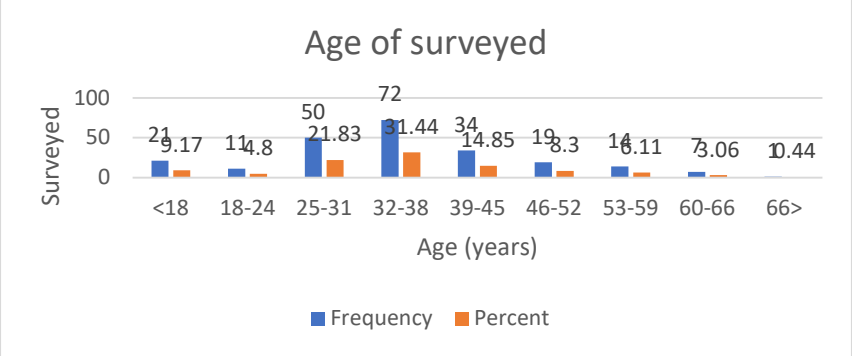


Fig. 4: Distribution by age

c) Socio-professional categories

It appears that 77.73% of those interviewed were artisanal operators followed by 13.54% of agents of SAEMAPE (State service responsible for the supervision and assistance of artisanal exploitation), 4.8% of land chiefs and 3.93% of AFMs/mining site managers.

Table 03: Socio-professional categories

Position occupied	**Frequency**	**Percent**
AFM/site manager	9	3,93
State agent (SAEMAPE)	31	13,54
Lands Chiefs	11	4,8
Artisanal miner/digger	178	77,73
Total	229	100

The level of knowledge of the health impacts of gold mining with the use of mercury is as follows.

d) Gender

A predominantly male rate reached 90% during the study on the different sites.

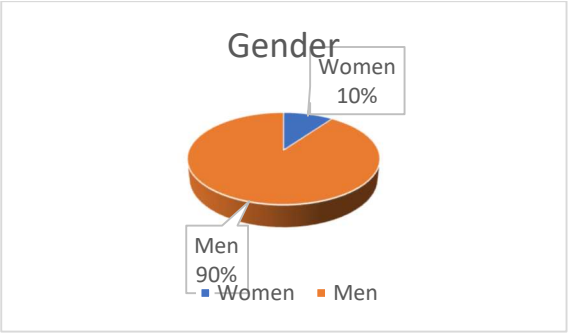


Figure 05: Distribution by gender

II.2. Level of knowledge of the impacts of exploitation by operators

In terms of knowledge of the impacts of artisanal gold mining, the results obtained from the various stakeholders in this sector are as shown below.

a) Knowledge of health impacts

The various stakeholders in the sector show a high level of ignorance at 96.5% on the health impacts of the use of mercury in gold mining.

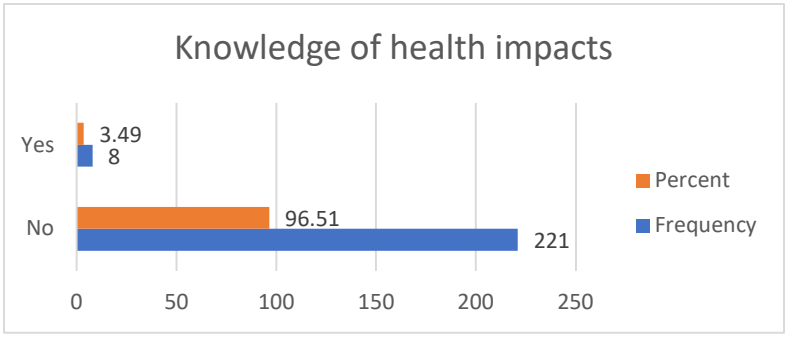


Figure 06: Level of knowledge of health impacts

b) Level of knowledge of environmental impacts

In terms of knowledge of the impacts of artisanal gold mining, the results obtained show that 64.6% of operators recognize that their activity creates impacts on their environment.

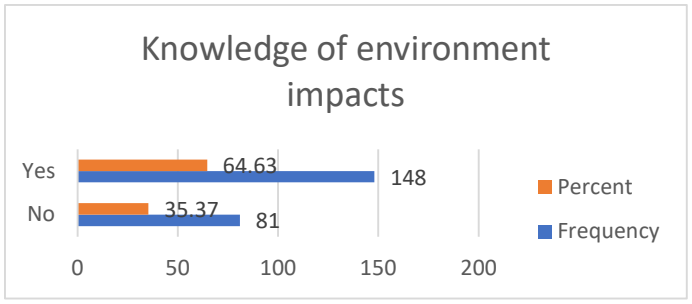


Figure 07: Knowledge of the environmental impacts of gold mining

c) The use of chemical substances

The results report that the chemical element used for the treatment of gold is mercury in 100% of cases. The use of mercury in gold processing is confirmed by all operators.

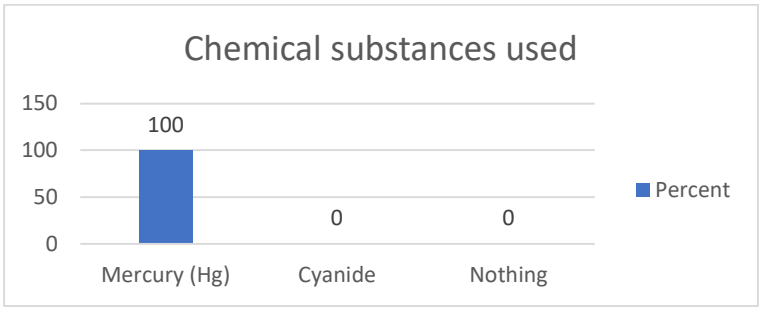


Figure 08: chemical substances used in gold processing

d) Surface water pollution

The figure below shows recognition of a level of pollution of waterways estimated at 91.27%.

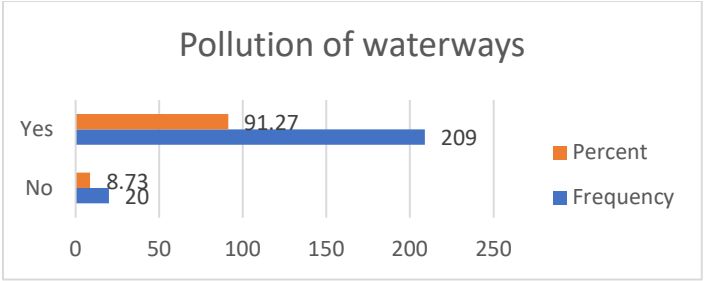


Figure 09: Pollution of rivers

II.3. Identification of health and social impacts

a) Accidents at work

Almost all of our respondents have experienced accidents/incidents (minor or major) during artisanal mining.

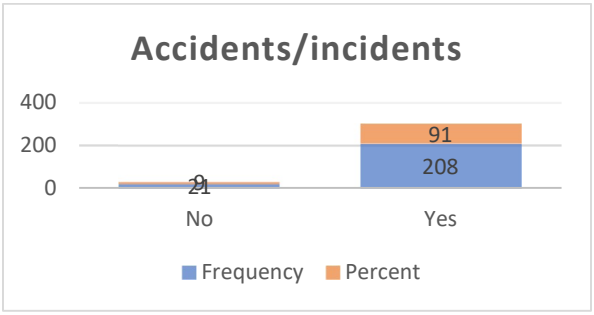


Figure 10: Accident/incident rate

b) Cases of insomnia and memory loss

Surveys report that 81% of operators experience insomnia and 13% say they do not remember some of their actions.

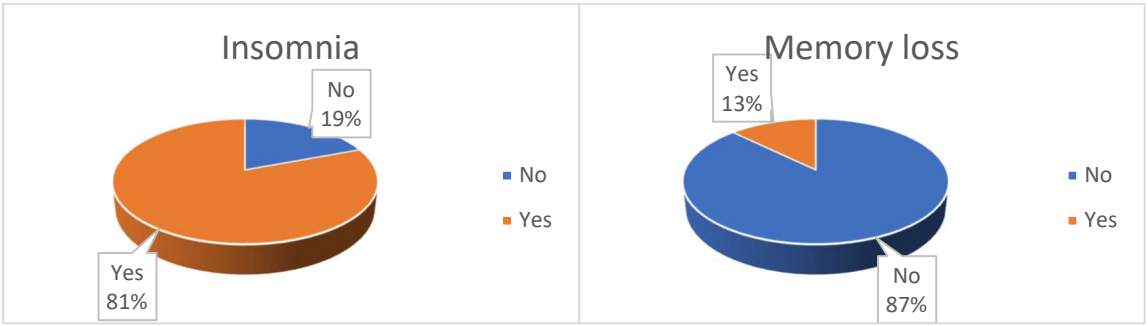


Figure 11: (i) Complaints of insomnia (ii) Cases of memory loss

c) Consumption of narcotics in mining sites

Among artisanal miners, 86% drink alcoholic beverages for different reasons.

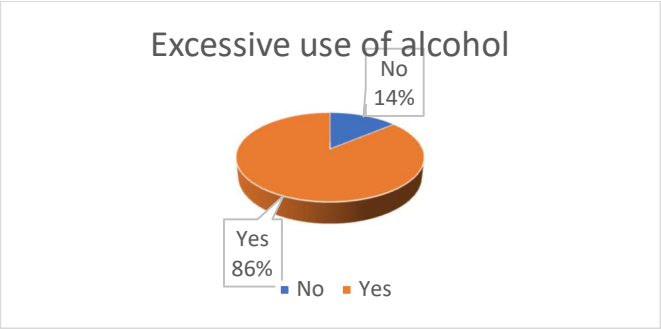


Figure 12: Rate of alcohol use

d) Cases of conflicts and complaints in operations

Cases of conflicts of various causes within artisanal industries have been reported with a rate of 86%. Among mining operators, 94% of cases of lower back pain, 67% of chest pain, 62% of chronic cough, 21% of digestive disorders, 67% of persistent headaches and 39% of cases of head tremor were noted. upper members

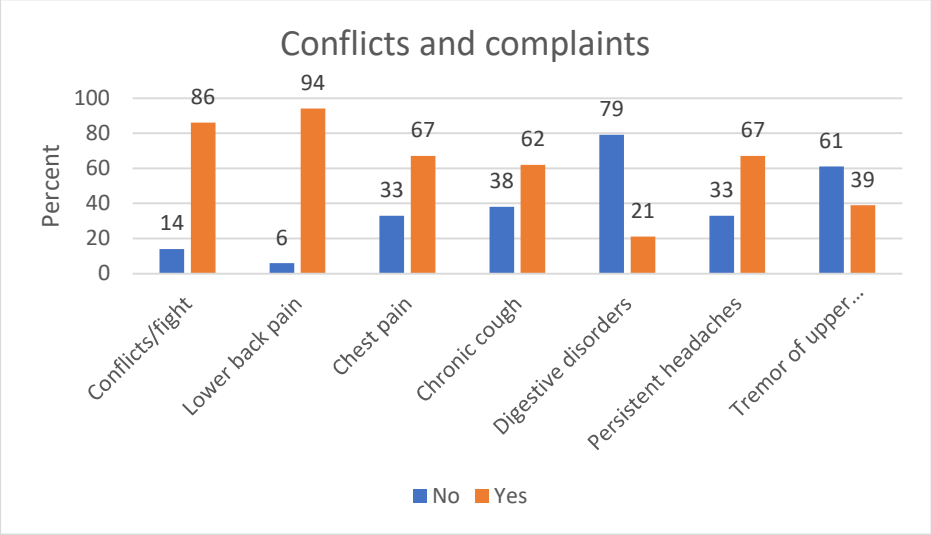


Figure 13: Conflicts and Complaints

DISCUSSION

(a) Environmental, health and social impacts

In the DRC, the principle of environmental responsibility is regulated by the Mining Code and Regulations, which require industrial operators to assess the impact of their activities on the environment and to submit a project to restore it. The Code clearly explains that industrial operators have a responsibility to ensure the restoration of the environment by requiring 0.5% of their turnover as collateral. As for artisanal diggers, the Mining Code strictly prohibits them from using mercury or any other substance harmful to health or the environment.

The Mining Code stipulates that environmental protection is one of the reasons that may lead the Prime Minister to declare a zone prohibited from mining (Article 6). The Mining Regulations also stipulate that any processing of mining products using mercury or other hazardous substances may only be carried out in a workshop or factory approved by the Minister of Mines (Article 238). An artisanal miner who undertakes the processing of his products on his own using mercury or other harmful products may lose his operator card. Article 575 prohibits the use of mercury in artisanal mining and specifies that only gravimetric separation and processes using reagents that do not cause serious harm to ecosystems are permitted. Annex IV of the Mining Regulations provides a comprehensive overview of the Code of Conduct for Artisanal Miners with regard to the protection of the environment.

As is often the case in the DRC, the application of the Code and the regulations is practically not taken into consideration, as was an observation made during our study.

However, this study reports an estimated deforestation rate of 2.3% in the area and particularly a forest degradation of around 10.9% due to artisanal gold mining between 2003 and 2023. Operators say they are 100% aware of the negative impact of their activity on the forest ecosystem, 92.6% say they are aware of the negative impact of fish and 91.27% of their water pollution. Rock debris was present at all sites. We have recorded 100% of the cases of abandoned holes

NDIAYE (2020) notes that 30% of respondents say that the discharge of mercury into the river's waters kills fish. Some of these respondents say that "mercury contaminates fish, and the people who eat those fish."

In the study carried out by Bossissi Nkuba et al (2016), all of them state that the real environmental problems caused by mining activities are deforestation and the pollution of rivers by clay and sandy particles released during gold extraction. While deforestation and river disturbance are clearly visible, the effects of mercury are not directly visible and can be difficult to identify.

In terms of health impacts, 62% of farmers have a chronic cough during their activity. 81% of farmers with insomnia due to the activity. 13% of cases of memory loss collected from artisanal miners who use mercury in their farms. Surveys conducted by Sène et al., (2019) on the locality of Tinkoto showed that 43% of respondents claim to have experienced respiratory problems, headaches, health problems that are related to mercury exposure.

Although mercury is not visible to the naked eye and its harmfulness is not universally recognized, it is a chemical time bomb. It does pose a real danger to humans (its effects on the central nervous system and on the growth of foetuses are particularly deplorable) and aquatic organisms (which are subject to physiological disturbances). It would therefore be dangerous to limit ourselves to directly visible impacts and ignore those that hide in the shadows, without being any less dangerous, at the risk of experiencing a case similar to that of Minamata, where mercury poisoned more than 2000 people, half of whom died. In the gold mining industry, there are several cases of permanent conflicts and fights (86%) and cases (86%) of excessive alcohol consumption before, during and after the activity, which hinder the maintenance of good and lasting social relations.

(b) Presence of minors

Our study reports the presence of minors (9.2%) on the exploitation sites studied, which is prohibited by Congolese law. Bossissi Nkuba et al, also report that children are present in all mines in South Kivu, despite the prohibition by national and international laws. In the study area, they are involved in the transport of minerals, processing, water supply, etc. They are often there for various reasons: the disappearance of their father (death) and/or the poverty of their families. Many drop out of school to work permanently (thus reducing the chances of being able to work and thus perpetuating an unskilled and very unproductive workforce in the region), thus indulging in alcohol or drugs, etc. But a few use the same opportunity to finance their schooling or to keep themselves busy rather than engaging in criminal activities.

(c) Level of knowledge

The gold miners surveyed showed a 96.5% level of ignorance about the health impacts of the use of mercury in gold mining. And a level of knowledge on the environmental impacts of gold mining at 64.6%. NDIAYE (2020) reports that 81% of respondents say that water will be undrinkable when it is contaminated with mercury. The rest of the respondents reported that they did not know the effects of mercury on water resources. It found that 49% of respondents were unaware of the health effects of mercury and 39% said that mercury degrades the soil, seeps and persists in the soil. The remaining 12% say mercury has no effect on the soil. The results of Bossissi Nkuba et al (2016) also showed that diggers are unaware of the health and environmental risks posed by mercury.

This is due to the fact that no organization has so far organized an awareness campaign.

(d) Chemicals used

The chemical element used for gold processing is mercury in 100% of cases. In Senegal, Ndiaye reveals that 88% of respondents use mercury for gold recovery. However, the DRC's mining code strictly prohibits the use of mercury or any other substance that is harmful to health or the environment.

CONCLUSION

Artisanal gold mining has favored the development of several localities in the territory of Banalia, including that of Mangi. This locality is currently one of the most active gold sites in the Tshopo province. Gold panning is practiced intensively in the study area with the use of mercury for the processing of gold. This study made it possible to carry out an analysis of certain environmental and health problems caused by artisanal gold mining in general and by mercury in particular. In addition to the elemental mercury used to form the gold-mercury alloy, the population of the Mangi mining area is exposed to methylmercury through the consumption of fish which would be contaminated by mercurial emissions. This exposure may cause adverse health effects. In addition, in the area there is a lack of qualified health personnel to diagnose the effects of exposure to mercury. Despite the difficulties of the diggers' lives and the damage caused to the environment, artisanal gold mining (EMA) remains the best and sometimes the only means of survival for several families in the territory of Banalia and the engine of the economy of several mining villages and neighboring towns. Protecting the environment through law enforcement and increasing pressure on their source of income is neither realistic nor socially just given the widespread poverty in the study area. We recommend that authorized state services and civil society can support them in formalizing their activities, facilitate their access to finances to better produce and train them in gold processing techniques without the use of mercury and economically viable in their situation. At the local level among artisanal gold miners in the Mangi mining area, it currently seems difficult, if not impossible, to do without mercury because the miners have been using it for years. And they don't seem to know any other techniques that would allow them to extract gold without using mercury. However, gold miners can be made aware of taking specific measures to reduce and if possible eliminate the worst practices in the use of mercury, for example the washing of ore during processing at surface water level, the release of mercury onto the ground. in order to limit the contamination of groundwater and surface water, the burning of amalgam in the open air and in areas inhabited by the population. The Democratic Republic of Congo has developed a national action plan aimed at gradually banning the use of mercury by 2036 at gold mining sites through the application of national regulations in relation to the convention of Minamata. It is important to strengthen these measures to be able to resolve this problem of mercury use throughout the national territory. It is important that the State tries to initiate an awareness policy among gold panning communities on the impact of mercury. These awareness-raising measures could focus on the different impacts that mercury causes on aquatic resources, soil and air. Focus this awareness on certain key people such as mercury sellers, who through them, mercury is present on the sites, people in charge of site security, the Mining Services (SAEMAPE and Mines Division) as well as the village chief who represents the highest authority on the operating sites. It is also possible to train certain local opinion leaders on the harmful effects of mercury and its various environmental impacts and health risks that it can cause, and to integrate awareness-raising measures at school level to reach students from a young age.

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