



THE IMPACT OF SMALL SCALE GOLD MINERS ON ENVIRONMENT: THE CASE OF MASHAVA IN MASVINGO PROVINCE

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ABSTRACT

The main purpose of this research is to explore the impact of small scale gold miners on environment. Mashava mines, which are Lenoxo mine, Temmerria mine, King mine and Gaths mine were used during primary research. Simple random sampling technique was used to select the sample. Data analysis was done using graphs and tables. The study concluded that small scale gold miners have impacted the environment both negatively and positively in Mashava area. It was also discovered that small scale gold miners have caused a lot of health problems in Mashava area. Diseases like Malaria, HIV and TB were found to be the dominant ones from the four sampled mines. Amongst other policy prescriptions, the study recommends formalization and legalization of the artisanal gold miners, educating artisanal small scale gold miners on the importance of a clean and preserved environment, attempts to introduce environmentally friendly mining technology, strengthening of the authorities in charge of monitoring the environment, reduction of registration levies and taxes as well as promotion of other alternative livelihoods.

KEY WORDS: *Environment, Environmental management, Livelihoods, Mashava area, Miners, Small scale mining*

1. INTRODUCTION

In this era where climate change is a topical issue globally, environmental management accounting should take precedence in the mining sector (Magadi, 2014). Globally, more than 100 million people depend directly or indirectly on artisanal mining for their livelihoods (Basu, 2015). An estimated 20 million people around the world rely on artisanal small scale miners (ASM) for livelihood, working in more than 80 countries. It is further postulated that they produce some 10% of the world's mined gold (World Bank, 2013). Some stakeholders such as the government, and

the community that surround a certain company have a major concern with physical environmental impacts of corporate , such as pollution of sources of water and land degradation which is posed by mining and manufacturing companies (Burritt, 2015). Today, society expects business to act in the way that would satisfy society's interests and share benefits with those members of the society who are not business shareholders (Yakovleva, 2017). Nonetheless, to realize economic growth, many countries resort to the extraction of various natural resources and the most common activity being mining (Phiri, 2016).

Statement of the Problem

The negligence of environment costs in decision-making process in Mashava area is the real problem. This has led to health problems which have been identified in most residents of the area. The most common occupational diseases that workers are likely to develop as a result of long-term exposure in the gold mining environment are silicosis, silico-tuberculosis, pulmonary tuberculosis (TB), obstructive airways disease, occupational asthma, oral and/or nasal cavity erosions, diseases owing to ionization radiation, noise-induced hearing loss, whole body and hand-arm vibration syndrome, as well as repetitive strain injuries (Borrvalho, 2013). Given that the economic activity taking place in Mashava is small scale gold mining, it is almost unnecessary to pinpoint the reality that this economic activity has negative externalities of production which are health related and these are:

- i. Unprotected commercial sex work which results in rapid spread of HIV and sexually transmitted infections such as gonorrhoea, syphilis, chancroid, HPV, and genital herpes.
- ii. Overcrowded residential area results in the rapid spread of TB.
- iii. Water and sanitation is compromised resulting in perennial outbreaks of diarrheal diseases such as typhoid and cholera.
- iv. Stagnant waters become breeding grounds for the anopheles mosquitoes thereby resulting in an increase in new cases of malaria and its associated deaths.
- v. Mine accidents result in minor to severe injuries and deaths.
- vi. Rampant drug and alcohol abuse which may result in drug induced psychosis.
- vii. Inhalation of mine dusts which can cause lung diseases such as asbestosis and chronic obstructive pulmonary disease.

These health problems imply that the patients are going to incur medical costs such as consultation fees, hospital bedding, drugs and fees for diagnostic tests. On the other hand the government is going to use tax payers money to manage disease outbreaks such as cholera and typhoid and also to acquire ARV drugs for the treatment of new cases of HIV.

The process of mining also causes environmental destruction (land, soil, vegetation) leading to loss of forest resources, wildlife habitat, and/or agricultural cropland (Tiffany, 2012). Mashava area is characterized by many dumped open casts and the land is always being extracted which makes agricultural activities to be difficult.

There is no previous study on the impact of small scale gold miners on the environmental management accounting in the area of Mashava. The death of people and sinless animals from water borne diseases due to stagnant water and unprotected

countless pits are major problems facing the area. There is a research gap on how to mitigate these problems which seems to be beyond the control of the residents in Mashava area. This study therefore fills the research gap and thus constitutes an extension on exploratory examination to determine the impact of small scale gold miners on environmental management costing.

Research Questions

- i. How do small scale miners affect the environment in Mashava area?
- ii. Can the prevalence of disasters/diseases be determined from the mining activities in Mashava area?
- iii. What can be the mitigation measures to adopt in order to solve these environmental challenges?
- iv. Is there any relationship between mining and environmental accounting?
- v. Is there an impact of small scale miners on the ecosystem?

Research Objectives

The overall objective of the study was to assess the health and environmental impacts of Artisanal Gold Miners (AGM) in Mashava area focusing on Gaths mine, King mine, Temmaria mine and Lenoxo mine. The specific objectives are as follows:

- i. To explore how small scale miners have impacted on the environment in Mashava area
- ii. To determine major health problems faced by miners and residents of Mashava area.
- iii. To explain the mitigation measures adopted to solve these environmental challenges.
- iv. To find out that there is any relationship between mining and environmental accounting.
- v. To assess the impact of the mining industry on the ecosystem.

2. LITERATURE REVIEW

Institutional Theory

Institutional theory have been defined by institutional theorists since the early 20th century, to mean rules, that is, the predetermined patterns of conduct that are generally accepted by individuals in a society (Berger and Luckmann 1967; Rutherford 1996). Institutional theory is another theory that views the organisation as part of the larger social system in which it operates (Quen, Burritt, Monroe, 2011). They further allude that while the essence is achieving legitimacy, institutional theory has a broader view of the social system surrounding organizations (Quen, et al 2011). Within the interpretive perspectives, institutional theory has been used extensively in the accounting literature to study management accounting change (Arroyo, 2012). Institutional theory emphasizes that the institutional environment, which comprises

various economic, social, cultural and political contingencies, can help firms meet the prevailing expectations and requirements with respect to certain expected practices and behaviors (Yang, 2019). Institutional theory usually refers to a broad group of perspectives that interpret the relationship between institutions and human behavior, assuming that not only human actions, that is, behavior, perceptions, power, policy preferences, decision-making processes shape institutions, but these are also influenced by them (Diogo, Carvalho and Amaral, 2015).

The works of Selznick (1948, 1957) and Parsons (1956) are usually considered pioneers in the study of organizations (Amaral, et al, 2015). The adoption of sustainability management practices or even corporate socially responsible behavior has been often explained through institutional theory (Bansal, 2005; Boiral, 2002; Campbell, 2007; Judge et al., 2010; Patnaik et al., 2017; Windolph, Schaltegger and Herzig, 2014). Another important concept proposed in institutional theory is decoupling, that is, organization-level decoupling, which refers to situations in which firms adapt their strategies and missions closely to expectations from the institutional environment, but do not seriously implement them at the operational level (Tilcsik, 2010). The study will not focus on other theories as theoretical model as it has been so clear that institutional theory provides rich insights into the adoption of environmental management strategies/practices in the organization of a firm (Bansal, 2005; Campbell, 2007; Delmas and Toffel, 2004; Kang and Lee, 2016) such as in mining industry which is the subject under consideration. In order to systematize the different strands of institutional theory, Scapens (2006) suggests three categories, namely, new institutional economics, which identifies the structures used to govern economic transactions; new institutional sociology (NIS), which considers the institutions in the organizational environment that shape organizational structures and systems; and old institutional economics, which focuses on the institutions that shape the actions and thoughts of individual human agents.

How Small Scale Miners Have Impacted The Environment.

Erosion and sedimentation

Degradation due to erosion starts right from the source viz., rain splash on overburden dumps induce erosion which goes on increasing in the form of sheet, reel and gully erosion (Gelani et al. 2013). Taking the example of China where mining has led to gully erosion which affects the aesthetic quality of the site as well as stability of the dumps (Gelani et al. 2013). Historically, erosion and sedimentation processes have caused the build-up of thick layers of mineral fines and sediment within regional flood plains and the alteration of aquatic habitat and the loss of storage

capacity within surface waters (Barve, 2011). The main factors influencing erosion includes the volume and velocity of runoff from precipitation events, the rate of precipitation infiltration downward through the soil, the amount of vegetative cover, the slope length or the distance from the point of origin of overland flow to the point where deposition begins, and operational erosion control structures. They allude that erosion may cause significant loading of sediments to nearby water-bodies, especially during severe storm events and high snowmelt periods and nutrient value of the dumps goes down which might be helpful in re-vegetation of the dump top and dump slopes (Gelani et al. 2013).

Impacts on water quality

Surface Water

One of the problems that can be associated with mining operations is the release of pollutants to surface waters. They proceeded exploring impacts to surface waters which include the build-up of sediments that may be contaminated with heavy metals or other toxic products, short-term and long-term reductions in pH levels, destruction or degradation of aquatic habitat, and contamination of drinking water supplies and other human health issues (Gelani et al. 2013). Considering, the case of India, it is clear from the study done by Gelani et al 2013, that, many activities and sources associated with a dumpsite can contribute toxic and non-toxic materials to surface waters. The eventual discharge of surface runoff, produced from rainfall and snow melt, is one mechanism by which pollutants are released into surface waters.

Acid drainage

Formation of acid drainage and associated mobilization of contaminants are one of the major environmental problems in mining. Commonly called acid mine drainage (AMD) or acid rock drainage (ARD) primarily depends on the mineralogy of the rocks and the availability of water and oxygen. AMD occurs at mine sites when metal sulphide minerals are oxidized (Gelani et al. 2013). They reiterated this saying mining and beneficiation operations greatly increase the rate of these same chemical reactions by removing sulphide rock overburden material and exposing the material to air and water. The dominance of the oxidation reactions become obvious when discharged ground water comes into contact with oxygen, precipitating iron ox hydroxides and decreasing pH (Wisotzky and Obermann, 2001).

Ground water

Ground water can be affected by mining especially below water table due to underground working or open pits which provides a direct conduit to aquifers (Gelani et al. 2013). Ground water quality is also affected when waters, that is, natural or process waters or wastewater infiltrate through surface materials including overlying overburden waste or

other material into ground water (Thakur, 2013). Contamination can also occur when there is a hydraulic connection between surface and ground water (Gelani et al. 2013). The mentioned above has the potential to elevated pollutants levels in ground water.

Air erosion

Air erosion on the dump is very low compared to water erosion but it also degrades the air environment of the mine leasehold area as well as outside the boundary (Nriagu, 1988). The primary air pollutant of concern at mining sites is particulate matter. US/EPA has established National Ambient Air Quality Standards for particulate matter with a diameter of less than 10 microns. Operation of heavy earth moving machinery in the overburden dumps generate huge amount of dust and the high wind velocity moves the dust particle to the nearby residential areas which creates a lot of problems (Gelani et al. 2013).

Loss of soil fertility

The run-off water directly going to nearby fields or passing through them changes the salt content of soil and subsoil layers thereby reducing the fertility of the land. This manifests itself in the form of loss of yield of crop. Apart from this nearby settlement are always affected by the degraded environment in terms of water and air pollution, which also affect the health as well as their production from the fields (Nriagu, 1988). Beyond the potential for pollutant impacts on human and aquatic life, there are potential physical impacts associated with the increased runoff velocities and volumes from new land disturbance activities. Increased velocities and volumes can lead to downstream flooding, scouring of stream channels, and structural damage to bridge footings and culvert entries.

Noise pollution

The heavy earth moving machinery operations in the overburden handling leads to an increase in the noise levels in the nearby residential areas also.

Areas Affected By Mining In Zimbabwe.

Many areas have been affected by mining activities in Zimbabwe at large. Zimbabwe's huge economic potential was mineral based because of the mineral deposits she has and that dated back to the pre-colonial times. In 2009, several local people were granted mineral rights for the exploration of gold. One issue that was not taken into consideration was that mining has impacted the environment negatively (Phiri et al, 2016). It is well elaborated in the research of Gwandira and Gwandira (2012) that Chimanimani National Park environment has been depleted by artisanal miners. In Wozoli, Silobela district artisanal miners are dominating and have impacted both positively and negatively as alluded by Dube and Mapuva (2016). Jerie and Sibanda (2010) they also did

a research on the effects of gold miners on the environment in Tiger Reef gold mine in Kwekwe district. Mashava mine is one of the well-known mine in Zimbabwe which was operating effectively before its closure and because the minerals like gold are still available, small scale gold miners are negatively impacting the area. It is evident that after the closure open pits were left unclosed and many piles of sand were left unattended leading to many negative effects to the environment at large.

According to the 2013 National Budget Statement by the ministry of Finance, mining has become the most dynamic sector of the Zimbabwean economy, leading economic recovery since 2009, with an average annualized growth of more than 30%. Strong external demand for primary commodities, particularly of platinum and gold has supported higher production levels. Environmental Cost Management Accounting is critical in Zimbabwe in the mining sector considering the phenomenal growth being witnessed in the sector over the past few years.

In Gwanda, for example, gold production arena was dominated by foreign owned company named Caledonia Mining Company, which bought Blanket Gold Mine from Kinross Gold Corporation in 2006 (Phiri et al, 2016). They continue positing that Caledonia Mining Company was known to be producing about half of the gold tapped from Gwanda District. According to the company produced 37 tons from the three mines in 2003. Most gold mines in Zimbabwe are on the green stone belt. Zimbabwe's huge economic potential was mineral based because of the mineral deposits she has and that dated back to the pre-colonial times. In 2009, several local people were granted mineral rights for the exploration of gold. That led to the partitioning and fencing that took place in the district. One issue that was not taken into consideration was that mining has impacted the environment negatively. There were studies investigated on the impact caused by mining on the ecosystem. Shurugwi also is well known for these small scale gold miners near Poteregwa.

Major Health Problems Faced By Miners and Residents in Mashava

Health can be defined as a state of complete physical, mental and social wellbeing of an individual, and not merely the absence of disease and infirmity (World Health Organisation, 2005). Available literature examines the impact of mining on the health of both mine workers and the people within the surrounding communities of the mines. Stephens and Ahern (2001), posit that mining remains one of the most perilous occupations in the world, both in terms of short term injuries and fatalities, but also due to long term impacts such as cancers and respiratory conditions such as silicosis, asbestosis and pneumoconiosis.

The benefits of AGM include job creation and opportunities for local companies, infrastructure and social/community development and financial income (Tiffany, 2012). On the other hand, mining can adversely affect public health and safety, and the environment (Hermanus, 2007). Because these miners are unskilled, underequipped and not knowledgeable, they have little appreciation of the health and environmental impacts of this activity (Samuel, 2011).

AGM is a dangerous activity as it is a potential source of heavy metal (mainly mercury, lead) contamination and toxicity (Jason et al., 2002). Exposures of such chemicals are also harmful to human health (Yeboah, 2008). Other than sheer physical impacts, catastrophic slope failure can affect the environment or human health when toxic materials are released from the failure especially if it occurs in an area where such a release results in a direct pathway to receptors (Saxena, 2002).

Mercury poisoning is a tremendous burden to human health, especially in ASGM communities (Esdaile and Chalker, 2018). Mercury (Hg) is poisonous to both humans and the environment. Chronic exposure to mercury damages the neurological system causing sensory, motor and cognitive disorders (Rasheed & Amuda, 2014). Lead (Pb) is a major metal in gold sulphide deposits occurring as mineral mainly in galena (PbS). This is stable under natural conditions, however, once mining has taken place, it is broken down due to exposure to oxygen and water (Jason, Winnie, & Monica, 2002). Exposure to lead takes place mostly through drinking water, breathing polluted air or dust, and eating contaminated food, for example, food grown on soil with high Pb content. The main target for lead toxicity is the nervous system (UNEP/OCHA, 2010).

Inhalation of large amounts of siliceous dust, careless handling of mercury during gold panning and gold/mercury amalgam processing, existence of water logged pits and trenches; and large number of miners sharing poor quality air in the mines is the major causes of health hazards among miners (Jason et al., 2002). The most common occupational diseases that workers are likely to develop as a result of long-term exposure in the gold mining environment are silicosis, silico-tuberculosis, pulmonary tuberculosis (TB), obstructive airways disease, occupational asthma, oral and/or nasal cavity erosions, diseases owing to ionization radiation, noise-induced hearing loss, whole body and hand-arm vibration syndrome, as well as repetitive strain injuries (Borrhalho, 2013).

Zimbabwean Legislation On Environmental Governance

The legislature of Zimbabwe has certain guidelines to ensure a more equitable distribution and stakeholder involvement in the management of available natural resources. The legislation serves to

avoid pollution and environmental conflict. However, it appears that most of the legislation that has been proposed and approved is biased towards urban residents compared to the majority of the population which is located within the rural areas.

The Water Act of 1998 (20:25)

This is based on the principle that every human being has a right to access clean water and that water cannot be privately owned. Pollution of water is restricted and is considered an offense, with the stakeholder responsible being liable. Regarding water and land management, local authorities are able to make regulations for the administration of the area they are in. The act is executed under the Ministry of Environment, Water and Climate (Government of Zimbabwe, 2015).

The Rural District Councils Act of 1989 (29:13)

Rural district councils should try to ensure adequate supplies of water in an area for all people and activities, with councilors being responsible of rural governance of natural resources. The act is executed under the Ministry of Local Government, Public Works and National Housing (Government of Zimbabwe, 2015).

The Forest Act of 1949 (19:05)

The act allows for the recognition and demarcation of forests and natural reserves, the conservation of timber resources and the regulation of the burning of vegetation. The act is implemented under the Ministry of Environment, Water and Climate (Government of Zimbabwe, 2015).

The Mines and Minerals Act of 1961 (21:05)

The act manages the processes of obtaining mining rights, prospecting and extraction of mineral resources, as well as the closure of mining works. The act is implemented by the Ministry of Mines and Mining Development (Government of Zimbabwe, 2015).

Environmental Management Act of 2002(20:27)

The act states that every person has a right to protect the environment for the benefit of present and future generations. It ensures ecological sustainable management and use of natural resources. As a result, it serves to protect against water resources and land degradation. The act allows for environmental management and makes allowance for the formulation of environmental quality standards such as air, water, effluents and hazardous substances. The act requires that EIAs be undertaken for specific projects and lists procedures to be followed for the implementation of the EIA process. The act is executed under the Ministry of Environment, Water and Climate (Government of Zimbabwe, 2015).

Environmental Management Act / EMA Act, 2002 provides for the establishment of an appropriate

legal and institutional framework for the management of the environment and related

matters. It is a framework environmental legislation that establishes appropriate legal and institutional mechanisms for the management of the environment. It provides for improved legal and administrative co-ordination of the diverse sectoral initiatives in order to improve the national capacity for the management of the environment. This is in view of the fact that the environment constitutes the foundation of national economic, social, cultural and spiritual advancement.

The state is also an active player in mining and marketing of minerals through the Zimbabwe Mining Development Corporation (ZMDC) and Minerals Marketing Corporation of Zimbabwe (MMCZ). However, management of state entities has been weak, unaccountable and not significantly beneficial to the country. Therefore, in the coming five years our programmes will be tailored to help promote transparency and accountability by state owned and private mining companies in negotiation of contracts and revenue generation and distribution.

3. METHODOLOGY

Interpretivism Research Philosophy

The research adopted an Interpretivism research philosophy in which, according to Scotland (2012) the ontological position of Interpretivism is relativism, which is opposite to positivist epistemology which uses objectivism. According, to Scotland, (2012), the interpretive paradigm does not question ideologies; it accepts them. The interpretivism approach was chosen following advantages pointed out by Duck and McMahan (2013), which are: Interpretivism philosophy provides a deep understanding of communication that cannot be gained through other means and Communication is likely to be studied in a natural context.

Inductive Research Approach

The study used the inductive research approach which is more flexible and involves identifying patterns in a data set to reach conclusions and build theories (Hair, Celsi, Money, Samouel and Page, 2015). The researcher opted for inductive approach since it became more easier to identify patterns and to reach conclusions on the impacts of small scale gold miners to the environment. An inductive approach starts by looking at the focus of research and through investigation by various research methods, aims to generate theory from the research (Greener, 2008). Bryman & Bell (2015) points out that inductive research approach mostly uses a grounded theory approach to data analysis and theory generation. The research is subjective and hence it adopted inductive research which owes more to interpretivism (Saunders, et al 2009).

Case Study Strategy

The study used a multiple case study approach focusing on Gaths mine, Lenox mine, King mine and Temmeria mine. Saunders, et al, (2009) and Robson (2002) define case study as a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context. This approach was chosen because it assist the researcher in understanding the research problem by providing more questions which seek to explain the present circumstances, (Yin 2013). The researcher chose the multiple case study approach, which, according to Yin (2003) is more preferable to a single case study as it assist the researcher to analyze if the findings of the first case occur in other cases and come up with reliable evidence. Yin (2003) also highlights the importance of context, adding that, within a case study, the boundaries between the phenomenon being studied and the context within which it is being studied are not clearly evident. The case study strategy will be of particular interest if one wish to gain a rich understanding of the context of the research and the processes being enacted (Morris and Wood 1991; Saunders et al, 2009).

Time Horizon

The research used a cross – sectional time horizon, which, according to Gravetter and Forzano (2015), allows data to be collected in a short period of time. The researcher opted for the cross-sectional time horizon because the research is part of the university course work which has to be completed within a limited time frame. As outlined by Saunders, et al (2009), most research projects undertaken for academic courses are necessarily time constrained hence cross sectional is more suitable. The research questions, research objectives, about how small scale gold miners have destroyed the environment, the health issues, the mitigatory adopted in Mashava will be addressed in a short space or period of time.

Target Population

The study population was divided into two main groups, that is, the miners and stakeholders. The research populations are residents (stakeholders) of the Mashava mines who are the eye witnesses of the ruthless extraction done to the environment. The gold miners are also included

who are involved in the extraction of minerals as they have a direct impact on environmental hence they are able to give the required information.

Scheaffer et al (2012) asserts that population refers to a collection of elements about which we wish to make inferences. In the same breathe Bryman (2012) posits that population has a much broader meaning as compared to the everyday use of the term, whereby it tends to be associated with the nations entire population. Cooper and Schindler (2014) points out that a target population refers to any group of

individuals or events that contain the desired information and can answer the research questions.

Ralph et al (2018)'s study population was the miners and stakeholders. This study focused on employees, stakeholders and miners themselves of the 4 sampled mines in Mashava namely Gaths mine, Lenoxy mine, King mine and Temmerria mine. In each mine there is a target population of 11 individuals from four sample mines.

Non- Probability Sampling Procedures

The study purposefully picked 1 stakeholder from each mine, 2 miners from Lenoxy and Temmerria, and 4 miners from Gaths mine and King mine. Non-probability sampling (or non-random sampling) provides a range of alternative techniques to select samples based on subjective judgement (Saunders, et al 2009). The research chose a small sample so that she can be able to probe deeper into the subject under discussion during the in depth interview process (Neelankavil, 2015). Sampling techniques provide a range of methods that enable one to reduce the amount of data needed to collect by considering only data from a sub-group rather than all possible cases or elements (Saunders et al, 2009). For the purpose of this study purposive sampling described below adds that in purposive sampling sites such as organisations and people being analysed within sites are selected because of their relevance to the research questions. Hence miners and stakeholders are purposively chosen since they are relevant to the research. Since the researcher is using case study research, purposive sampling is the best to be adopted according to Saunders, et al, (2009). Thus, it enables the researcher to use judgement to selected cases that will enable the researcher to best answer the research questions and meet the objectives of how small scale gold miners have impacted the environment.

Research Instruments

For the research to be relied on research instruments should be both valid and reliable. Reliability and validity are the two most important and fundamental features in the evaluation of any measurement instrument or tool for a good research (Mohajan, 2017). Validity and reliability increase transparency, and decrease opportunities to insert

researcher bias in qualitative research (Singh, 2014). According to Tavakol & Dennick, (2011) these are important concepts in modern research, as they are used for enhancing the accuracy of the assessment and evaluation of a research work. The evidence of validity and reliability are prerequisites to assure the integrity and quality of a measurement instrument (Kimberlin & Winterstein, 2008). Reliability is referred to the stability of findings, whereas validity is represented as the truthfulness of finding (Altheide & Johnson, 1994).

To ensure the validity and reliability of in-depth interviews, the research took the following into account: that the content of the data collected was valid by ascertaining whether research instruments, in this case, the in-depth interviews contained enough questions to cover the purpose of study; Did not impose her own beliefs and frame of references through the questions she asked during the interview process; and Used interviews as a data collection technique which made the data collected reliable as interviews are recommended under the inductive research approach.

The researcher collected primary data for the research using in-depth interviews as data gathering instruments. In-depth interviews can be called unstructured interviews which are informal. Interviews were chosen because they are suitable to the researcher in gathering reliable and valid data relevant to the research questions and objectives (Saunders, et al, 2009).

4. DATA PRESENTATION & ANALYSIS

Response Rate

The researchers planned to conduct 10 in-depth interviews on the four sampled mines and 8 of them were successful, with only 2 which were not successful. Thus, the response rate was 80% and 20% non-response rate, enabling reliable and valid conclusions to be drawn out of the findings. The table below shows the interview response rate from the 4 mines in Mashava area:

Name of mine	Sample population interview	Number respondents of interviewed	Number of respondents not interviewed
King mine	3	2	1
Lenoxy mine	2	2	0
Temmeria mine	2	2	0
Gaths mine	3	2	1
Total	10	8	2

Table 1 Analysis of interviews response

Demographic Findings

Level of experience of miners (number of years)

The question on the number of years worked as artisanal miners was well responded to and the

following results were attained. 5/8 (62.5%), have more than 10 years as artisanal miners, 2/8 (25%), have more than 5 years, 1/8 (12,5%), have less than a year. This is presented in the figure below:

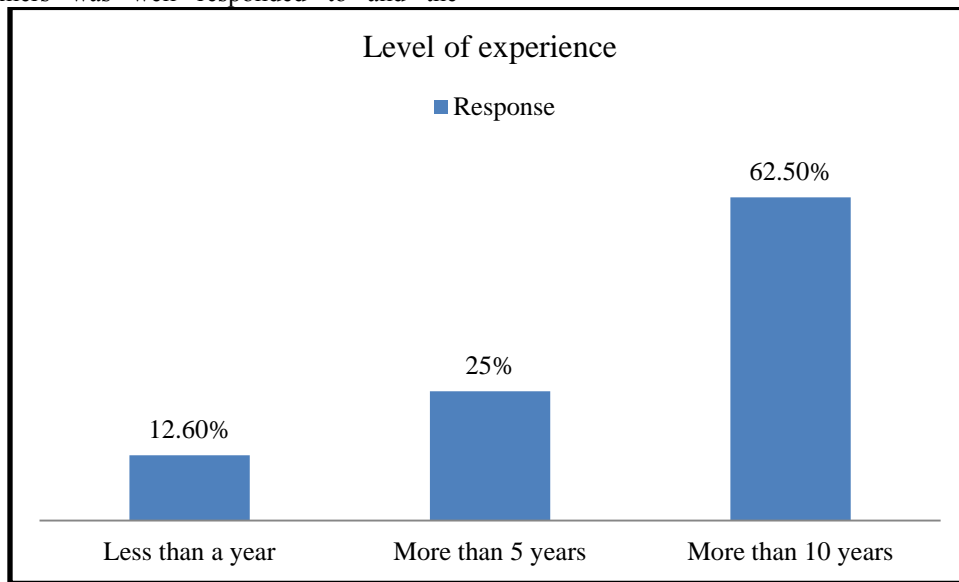


Figure 1: Level of experience

Types of respondents

The graph below shows the type of the respondents who were successfully interviewed. 27% of the total respondents were miners, 30% of the total

respondents were residents, the students yielded 8% of total respondents and 15% were nurses. The total respondent percentage was 80%.

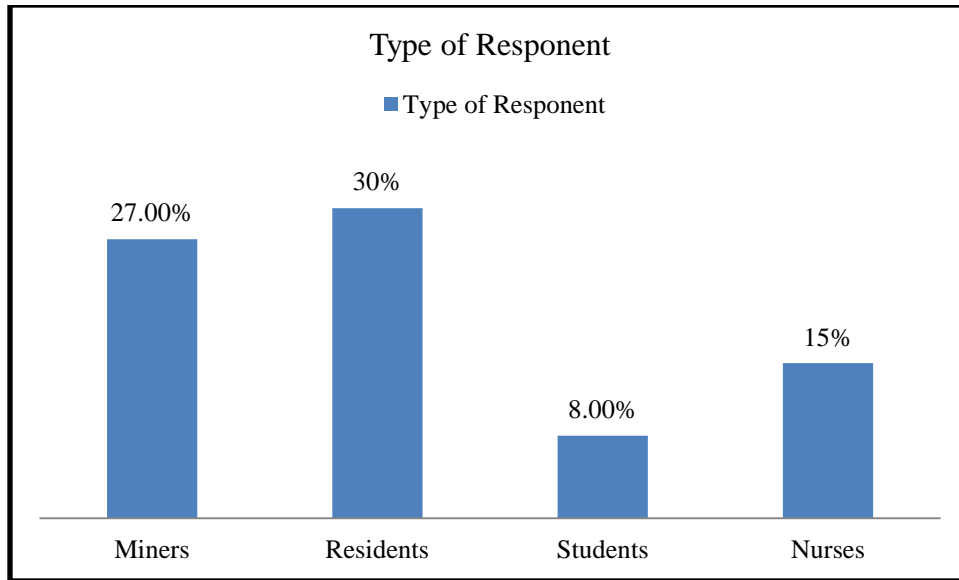


Fig 2: Types of responents

Gender and age of miners

The gender and age of the artisanal miners were observed and it was found that most of the respondents were young man and women. It was discovered that

60% were young man ranging from 15-35 years, 30% were young ladies ranging from the age of 18-30 years and 10% were elderly people. The figure below presents the gender and age of the respondents:

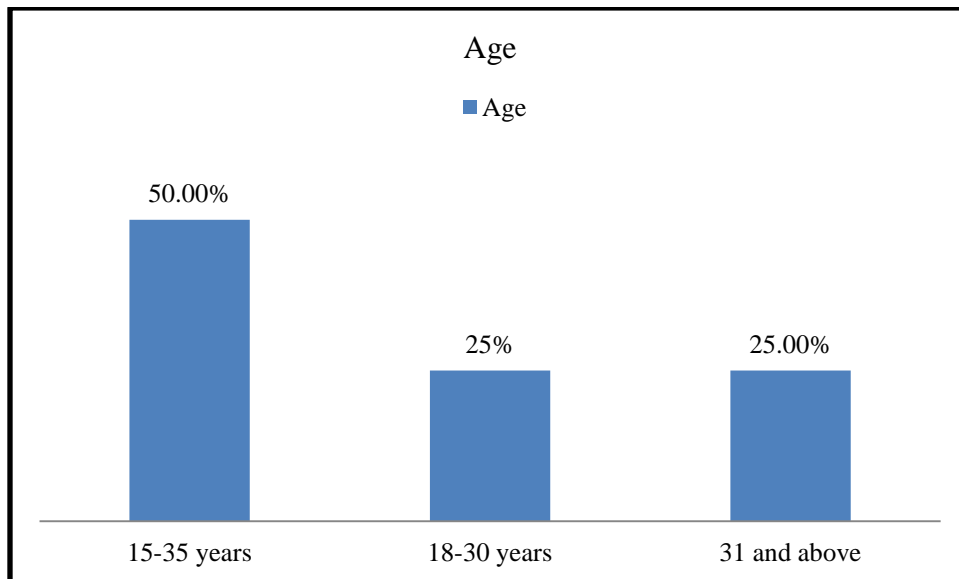


Fig 3: Gender and age of respondents

The extent to which the presence of small scale gold miners have resulted in social cost to the environment

Most of the respondents interviewed showed that small scale gold miners in Mashava have resulted in social cost to the environment. As seconded by Andersson et al 2014) who posit that regardless of the scale, mining has always left a large impact on both the

people and the landscape. This is evident by the host of social and environmental issues that have plagued mining operations across the continent. Many say it causes air and water pollution, land use issues, deforestation, and drives social inequality and protests (Hilson and Yakovleva 2007; Andersson et al. 2014). The students in Gaths were also complaining about how unsafe it is to be in Mashava area stressing out the fact that miners have damaged and are still damaging

the environment where they live. Residents of Mashava area complained of the negative externalities which are experienced in the area. To a smaller extent the miners as the other group of respondents revealed that mining does not lead to social cost only but the social benefits are attained also. They expressed the notion that presence of small scale gold miners has improved the standard of living of many individuals in Mashava area. The social benefits of miners is evident since its proponents claim it provides much needed jobs, development, and is a vital source of rising GDP (Andersson et al. 2014).

About the land which has been wasted in pursuit of small quantities of gold

During the in-depth interview which was carried out, questions on how land is wasted in pursuit of small quantities of gold were asked. Most respondents who are residents of Mashava were of the notion that small scale gold miners have destroyed the land for agricultural purposes. They revealed that the quantities of gold acquired and the land that is destroyed does not in any way match. The residents, who were once employed when Mashava mine was operating, anticipated to improve their standard of living given that the land which is ruthlessly penetrated by artisanal miners was reserved for farming. The respondents expressed that gold attained does not contribute much to Gross Domestic Product of the country, and suggested that a national park or irrigation might be the best option. The uncovering of the soil can lead to erosion, which leads to loss of land emphasized the Chiefs in King mine and Temeria mine. Gelani et al (2013) emphasized on these issues saying that one of the main factors influencing erosion includes, the amount of vegetative cover, the slope length or the distance from the point of origin of overland flow to the point where deposition begins, and operational erosion control structures (Gelani et al. 2013).

The effect of outdated mining technologies to the environment

The respondents pointed that the use of outdated mining technology has affected these mining areas in Mashava. The interviews carried out to miners in Gaths mine, King mine, Temmeria mine and Lenoxy mine on the tools that they use in extraction of gold revealed that they do not have any advanced tools. The tools used by these miners according to the respondents have affected the water quality. The surface water, ground water have been polluted by these small scale gold miners, they emphasized also on the notion that acid drainage is very high. The stakeholders complained for consuming, washing and bathing using dirty water which is being affected by these small scale miners. The residents pointed out that the small scale miners leads to contamination and this is well emphasized by Gelani et al (2013) saying, contamination can also

occur when there is a hydraulic connection between surface and ground water (Gelani et al. 2013).

The social cost of mining on air pollution

After the interviews in King mine, Temmeria mine, Gaths mine and Lenoxy mine, the respondents in those areas revealed that small scale miners have affected the air around them. Polluted air is inhaled on a daily bases and the respondents revealed of how unsafe the Mashava is to the environment. Polluted area is not a good place to reside and they expressed that since they do not have any option to relocate to, they are now risking their precious lives. Air erosion on the dump is very low compared to water erosion but it also degrades the air environment of the mine leasehold area as well as outside the boundary (Nriagu, 1988).

Health issues faced during operations in the area

Most of the stakeholders as well as miners revealed that they are affected health wise due to the operations in the area. Jason et al (2012) postulate that, Artisanal Gold Mining is a dangerous activity as it is a potential source of heavy metal (mainly mercury, lead) contamination and toxicity (Jason et al., 2012).The students and residents complained on the issues that they always suffer from stomachaches and headaches which they said it is because of dirty water consumed and polluted atmosphere. The miners are also faced with many diseases as they are the ones who directly dig the land and because they lack protective clothing, the rate of death rate has accelerated in Mashava. The miners also postulated that abuse is one of the major health issue faced by the residents in Mashava area. One of the stakeholder in Gaths mine highlighted the ruthless death of one artisanal miner in past few days, who was killed by another miner due to a pile of soil assumed to be having gold.

Number of people affected due to the mining activities

From the sampled data, the exact number of people who are ill because of mining was very large even though others are not aware that they have been affected. The respondents revealed that these diseases have a large problem of appearing in the body system after a long period of time which can be difficult to cure. The miners in Gaths mine, King mine, Temmeria mine and Lenoxy mine revealed some symptoms of the diseases that they are experiencing on their bodies and it is evident that these are the results of mining operations. Nurses in Mashava general hospital outlined that many patients with the same type of diseases like malaria for example, are visiting the hospital day in day out, hence mining has affected the health of the residents and artisanal miners in Mashava area. Residents highlighted that current loss of lives due to unsafe pits where gold is extracted are increasing.

Types of diseases that are faced due to the operation of small scale gold miners

From the in-depth interviews carried out on the types of diseases that have affected both miners and stakeholders, respondents revealed that diseases like HIV and AIDS, malaria, stomachache, headache, injuries just to mention but a few have affected them. Borralno (2013) gives the most common occupational diseases that workers are likely to develop as a result of long-term exposure in the gold mining environment which are silicosis, silico tuberculosis, pulmonary tuberculosis (TB), obstructive airways disease, occupational asthma, oral and/or nasal cavity erosions, diseases owing to ionization radiation, noise-induced

hearing loss, whole body and hand-arm vibration syndrome, as well as repetitive strain injuries (Borralho, 2013). Respondents mentioned malaria, headaches, stomachaches and injuries as the most well-known diseases in Mashava.

Types of diseases caused by operations of small scale gold miners

From the responses given by the stakeholders as well as miners, it can be deduced that injuries have affected mostly the miners, with stomachaches, malaria and headaches being other diseases which are common in the area. The graph illustrates the types of diseases and estimated percentages:

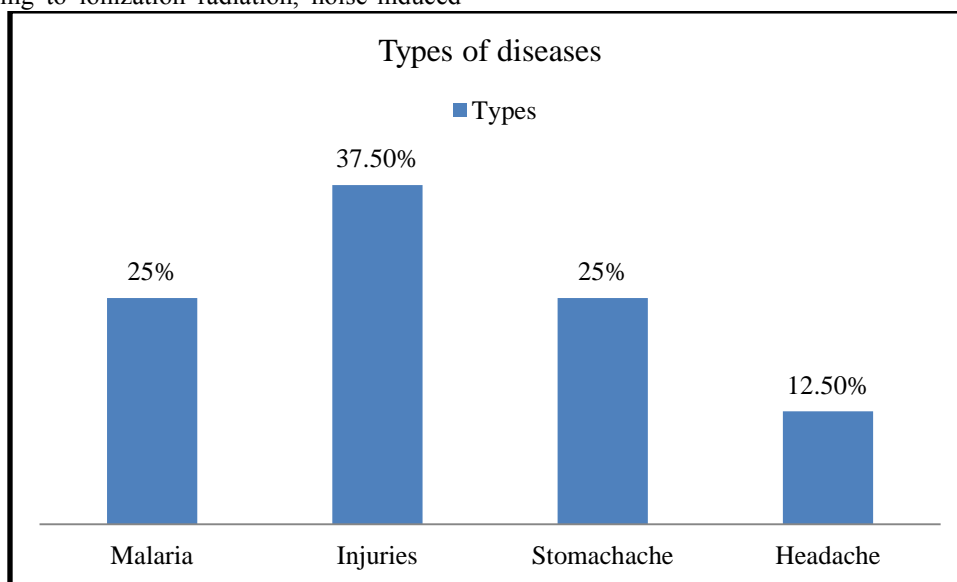


Fig 4: Types of diseases

Solutions to these challenges [that have been implemented so far]

The respondents in Mashava mining areas, which are Lenoxo mine, Gaths mine, Temmeria and King mine revealed that there are many solutions to mitigate the challenges of small scale gold miners. The stakeholders suggested that involvement of public participation can solve the problems caused by the small scale gold miners. The student suggested the enrollment of facility managers to have participation from the public as one of the mitigation plans for problem solutions.

Majority of the respondents suggested that if it is possible, water should remain safe as much as possible, which is emphasized by **The Water Act of 1998 (20:25)**. This is based on the principle that every human being has a right to access clean water and that water cannot be privately owned. Pollution of water is restricted and is considered an offense, with the stakeholder responsible being liable.

Addressing the issue of land degradation, most respondents suggested that anyone who will be found

cutting trees or clearing the land for whatever reason must be liable. **The Forest Act of 1949 (19:05)** also emphasizes on the conservation of natural resources. The act allows for the recognition and demarcation of forests and natural reserves, the conservation of timber resources and the regulation of the burning of vegetation. The act is implemented under the Ministry of Environment, Water and Climate (Government of Zimbabwe, 2015).

Majority of the respondents supported the idea of implementing the laws that will make sure their health is not affected, the environment around them is safe and clean. This was well supported by **Environmental Management Act of 2002(20:27)** EMA .The act states that every person has a right to protect the environment for the benefit of present and future generations. It ensures ecological sustainable management and use of natural resources. As a result, it serves to protect against water resources and land degradation.

Effectiveness of these solutions as far as health issues are concerned

Most of the respondents in Mashava area in Gaths mine, King mine, Temmeria mine and Lenoxy mine explained that the implementation of these solutions were effective since some of the health problems had been minimized. The nurses also in Mashava hospital emphasized on the above notion saying, „The death rate in Mashava area has been reduced as compared to the previous years because of the implementation of these solutions to mitigate the effect of small scale gold miners on environment. However some of the respondents showed that these problems were not very much effective since some of their relatives are still facing the health problems because of the social costs like air pollution and water pollution. They were of the argument that as long artisanal miners are present, health problems will be always present.

The respondents gave more insight on how effective the solutions were in mitigating problems with the ecosystem. The students in Mashava area who were interviewed commented on the issue that the policies executed by the government of Zimbabwe had to a larger extent assisted in

solving for the environmental depletion caused by these small scale gold miners. “EMA Act is of paramount importance to us as the inhabitants of Mashava area since any unlawful depletion of the environment is now a crime and penalties are now inevitable”, explained one of the respondent who was interviewed. The farmer who is a retired mine worker in Mashava baffled on the ignorance of the police officers in nearest growth point known as Balmain, on how they are failing to perform their duties on suing these artisanal miners. “How can they say they know what they are doing, when in fact are not competent in what they do”. He went on emphasizing this notion saying, “If we read **The Forest Act of 1949 (19:05)** it allows for the recognition and demarcation of forests and natural reserves, the conservation of timber resources and the regulation of the burning of vegetation, and this is exactly what is taking place in Mashava and the law enforcers are at ease. “The reptiles and small animals like snakes for example are dying in ruthless ways due to veld fires caused by artisanal miners and some of those who escaped are now residing at our places which are very dangerous”, complained the old man who resides in Mashava at Lenoxy. Effectiveness of these solutions as far as reduction in environmental degradation is concerned was over emphasized by these respondents.

The extent to which formalization and legislation of artisanal gold mining can reduce small scale miners’ impact on environment

Respondents who advocated for the formalization and legislation of the small scale miners were more than those who were saying that they should remain informal. The stakeholders supported this idea as they argued that all the social costs will be solved if these small scale gold miners were formalized. All the respondents in King mine, Gaths mine, Temeria mine and in Lenoxy mine placed their hope on the effectiveness that will be attained had these mining areas be formalized, as far as the reduction on the impacts of small scale gold mining is concerned. Respondents revealed that if the AGM miners were formalized, the environmental reports will be written

Mitigating challenges caused by small scale gold miners on the environment.

From the responses given by the respondents, it is clear that these challenges caused by small scale gold miners can be corrected. From the analysis done by the researchers these solutions can solve these challenges to a certain degree. However, to some extent these solutions failed to curb these challenges. Not everyone is willing to be educated on how to keep the environment clean and protected. Even though there are laws that prohibit cutting of trees, not everyone will comply with the regulators. 95% of the respondents were of the view that that these challenges could be solved while only 5% of the respondents thought that it is never possible to address these issues.

The possibility to mine at the same time preserving the environment

Most miners in Gaths mine, King mine, Temmeria mine and Lenoxy mine supported the idea that it is very possible for the miners to preserve the environment at the same time preserving the environment. They explained that mining is the source of income for most of the people in Mashava and if they are educated on how to mine, then it is possible for extracting the gold at the same time not harming the environment. Other respondents argued that it can be very difficult to mine at the same time preserving the land since a slight cut in land is mining and affects the land to some extent.

The kind of relationship resulting from formalization of small scale gold miners

After the small scale gold miners have been formalized, a number of benefits will be enjoyed as highlighted by other individuals. Most of the respondents were supporting the idea of formalizing these small scale gold miners arguing that, they will be responsible to the environment as per the demands from the government. Other respondents from all the mining area in Mashava , that is, King mine, Temmeria mine, Lenoxy mine and Gaths mine seemed to be

happy with the idea of formalizing these small scale miners because to some extent, the problem of land degradation, water pollution, air pollution, health issues will be solved.

The relationship between mining and environment

From the responses given by respondents, it was very much clear that there was a strong negative relationship between mining and the environment. Mining is done on the environment, and there is no way one can mine without affecting the environment, hence the relationship is very strong. However, it is not always the case that there is unfavorable relationship between mining and environment. When proper mining is done environment will be preserved and the GDP of a country can be boosted as well as the standard of living in Mashava area. It was found that the negative effects of AGM are greater the positive effects of AGM. The negative effects (75% of respondents) which include destruction of land, destruction of ecosystem and health problems to mention a few are more than the positive effects (25% of respondents) like creation of job.

The effects of extractions done on the environment to ecosystem

The respondents in Mashava area for the sampled areas revealed that ecosystem has suffered a lot due to mining activities. This is well supported from US Environmental Protection Agency office of Federal Activities, which state that forestry activities can have a variety of impacts on the environment. "I am really pained my daughters when imagining the state of Mashava area in the next 10 years if these artisanal gold miners are still destroying the ecosystem in such an increasing speed", said one of the resident in Lenox. Respondent in Temmeria emphasized that firewood is now difficult to attain because everywhere are miners who are always digging.

The possibility of sustainable management of natural resources

Most of the respondents posited that application of sustainable management can be very effective to curing these challenges. From the definition given by one of the student who was interviewed, natural resource management refers to the management of natural resources such as land, soil, water, plants and animals, focusing on how future generations will be affected. All the respondents were supporting this idea of sustainable management of natural resources. Miners in Gaths mine and Lenox mine were emphasizing that after the sustainability management of natural resources has been introduced; the government should reduce taxes of the registered miners, to make it possible for all the miners who want to register as limited companies.

The importance of educating people about clean and preservation of environment

From the study carried out, it was discovered that educating people about a clean and preserved environment was very important as far as all the respondents were concerned. Majority of people in all the four sampled mining areas supported the idea of doing clean up campaigns and teaching the small scale miners how health was important to the nation. The range of stakeholders involved in an Environmental Impact Assessment (EIA) typically includes the local people, the proponent, government agencies, NGOs and academics and all the affected people to the development projects. According to Department of Environment (DOE), public participation is essential in the preliminary assessment process, but only in ways that could be adjudged to be instrumental public participation.

The impact of small scale gold miners on the ecosystem

From the responses given by respondents it can be seen that ecosystem has been largely affected by the small scale miners (62.5% of the respondents) in Mashava area. Basing on the findings ecosystem is suffering a lot and considering the ecosystem in Mashava area for the next 10 years, it can be clear that greenhouse will be inevitable. Miners were arguing that mining does not affect ecosystem expressing that there are many factors that can affect ecosystem.

5. CONCLUSION & RECOMMENDATIONS

Artisanal gold mining is an important livelihood activity in the Mashava area providing full-time employment for those involved and an additional income for those who engage in part-time or seasonally. However, if not regulated properly it has adverse effects on the environment and limited natural resources which trigger tensions among users within the area. The emphasis should be on ensuring that the community benefits from artisanal gold mining without negatively affecting other livelihoods that utilize the same resources as artisanal gold mining activities. The following recommendations should be implemented to ensure effective environmental governance:

i. Formalization and legalization of artisanal gold mining activities

Under the current legislation, artisanal gold mining is identified as an illegal and criminal activity. Formalizing artisanal mining in the country allows authorities to have accurate figures of those involved in the trade and can prevent artisanal mining from occurring within river banks thereby reducing the negative impacts of the activity on the environment. This improves the manner in which environmental governance is implemented by stakeholder

organizations if they have population numbers of artisanal miners and control over the areas where artisanal mining can be practiced. The formalization of artisanal mining provides the government with revenue to be earned from taxes and royalties. It also protects the artisanal miners from raids and arrests by the police thereby minimizing the conflicts that occur between miners and regulatory authorities.

ii. Educating artisanal small-scale miners on the importance of a clean and preserved environment

The research showed that while some artisanal miners have no regard for the environment, most of them have realized the effects of mining on the environment. They and their communities have adopted laws to safeguard their natural resources particularly water. There is still a need to continue educating artisanal miners over the adverse effects of protecting the environment especially with regards to soil contamination and underground water pollution, as they are under the impression that disposal of mercury and effluent into dug pits does not harm the environment. Stakeholders should continue carrying out campaigns on the effects of using mercury on human health and the environment by suggesting other alternative methods such as using cloths with fine particles to extract gold. Gold can also be precipitated as a powder from ore by the use of hydrochloric acid combined with potassium hypochlorite and oxalic acid. These chemicals are less hazardous than mercury and have fewer impacts on the environment and human health if used properly. Moreso, there is need for education and awareness campaigns on issues to do with HIV and TB in the Mashava community. In line with this, there is also need to encourage more uptake of the male circumcision initiative in order to reduce heterosexual transmission of HIV and STIs. In this regard, the government should also strengthen health programs such as Malaria control and HIV/TB program collaborations.

iii. Introduce environmentally friendly mining technologies

Stakeholders can introduce environmentally friendly mining technologies to those involved in the artisanal gold mining sector. However, for this to be realistic, the equipment must also benefit the artisanal miner for it to be utilized. The technologies and methods must be less labor intensive, less time consuming, affordable and should offer high yields of gold extracted from ore. If this can be proven to the artisanal miners, it is easier to gauge their interest and have them practice the new methods of mining that are friendly to the environment.

iv. Strengthening authorities in charge of monitoring the environment.

Regulatory authorities that have been tasked with environmental monitoring and the execution of

environmental governance in the area face challenges in doing so. They have a lack of resources, are understaffed and have corrupt elements within their systems. Increased support from government and interested donors through funding enables the authorities to carry out environmental monitoring more frequently and workshops to educate locals or artisanal miners. Increased awareness should be raised particularly to groundwater pollution and ways of safely disposing effluent from artisanal small scale miners and gold stamps should be proposed.

v. Reduction of registration levies and taxes

Artisanal miners are not eager to register formally due to the high levies and taxes associated with being recognized formally. The levies and taxes should be lessened in a manner that encourages artisanal miners to register as most of them earn low incomes from the trade. Due to fear of being taxed heavily, artisanal gold miners and millers shun the registration process and risk making profit at the cost of being arrested.

vi. Promotion of other alternative livelihoods

The government should embark on promoting other livelihoods in areas where artisanal gold mining activities occur such as fishing, farming and weaving of baskets. This benefits vulnerable groups such as women and children who are forced to participate in artisanal mining to have a source of income for their households.

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