

ARTISANAL GOLD MINING AND ITS ADVERSE IMPACTS ON THE NGOYLA-MINTOM FOREST MASSIF, CAMEROON

BY

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ABSTRACT.

Artisanal gold mining is an activity which provides income and employment to many in the rural areas where it is practised. This activity is an age old practice and in recent years its effects have been extended unto pristine ecological ecosystems. This paper looks at the adverse impacts of artisanal gold in the Ngoyla-Mintom Forest Massif (NMFM) in south eastern Cameroon. Using questionnaire, focus group discussions, interview to stakeholders, direct field observation and data collected from secondary sources, it was revealed that miners earn an average of \$160 per month which is close to 2 times the average minimum salary of an average Cameroonian. The results also show that despite its livelihood benefits, artisanal gold mining has negative social impacts on the local population through Health problems, low levels of education, alcoholism and prostitution.. Mining in the NMFM equally leads to deforestation, soil erosion, pollution of river courses, and is also a danger to wildlife conservation. Although the impacts of gold mining in the NMFM on the environment are still at a small scale, they are likely going to increase as the mining population increases. There is need to put in place sustainable management strategies to mitigate the negative impacts of mining on the environment while preserving livelihood incomes.

Keywords: Artisanal gold mining, livelihoods, Social impacts, environmental impacts, Ngoyla-Mintom Forest Massif

INTRODUCTION

Artisanal gold mining is carried out in developing countries of Africa, Oceania and Central and South America. Artisanal mining broadly refers to mining by individuals, groups, families or cooperatives with minimal mechanization, often in the informal sector of the market (Hentschel *et al.* 2002). In Cameroon, the mining code defines artisanal mining as any activity that consists of extracting and concentrating mineral substances using manual methods or little mechanisation (Republic of Cameroon, 2010). According to Hentschel *et al.* (2002),

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globally the number of people estimated to be involved in this activity is 80–100 million people. It has been estimated that artisanal and small scale mining generates up to five times more income than other rural poverty-driven activity, including agriculture and forestry, and that it employs ten times more people than large-scale mining. According to Veiga and Morais, (2015) gold is the preferred target mineral of artisanal mining since the metal's price has risen dramatically over the past decades. An estimated 10 to 15 million people in over 70 countries are directly involved in the gold mining sector, and extract 15% - 20% of the world's annual gold production (Veiga and Morais, 2015).

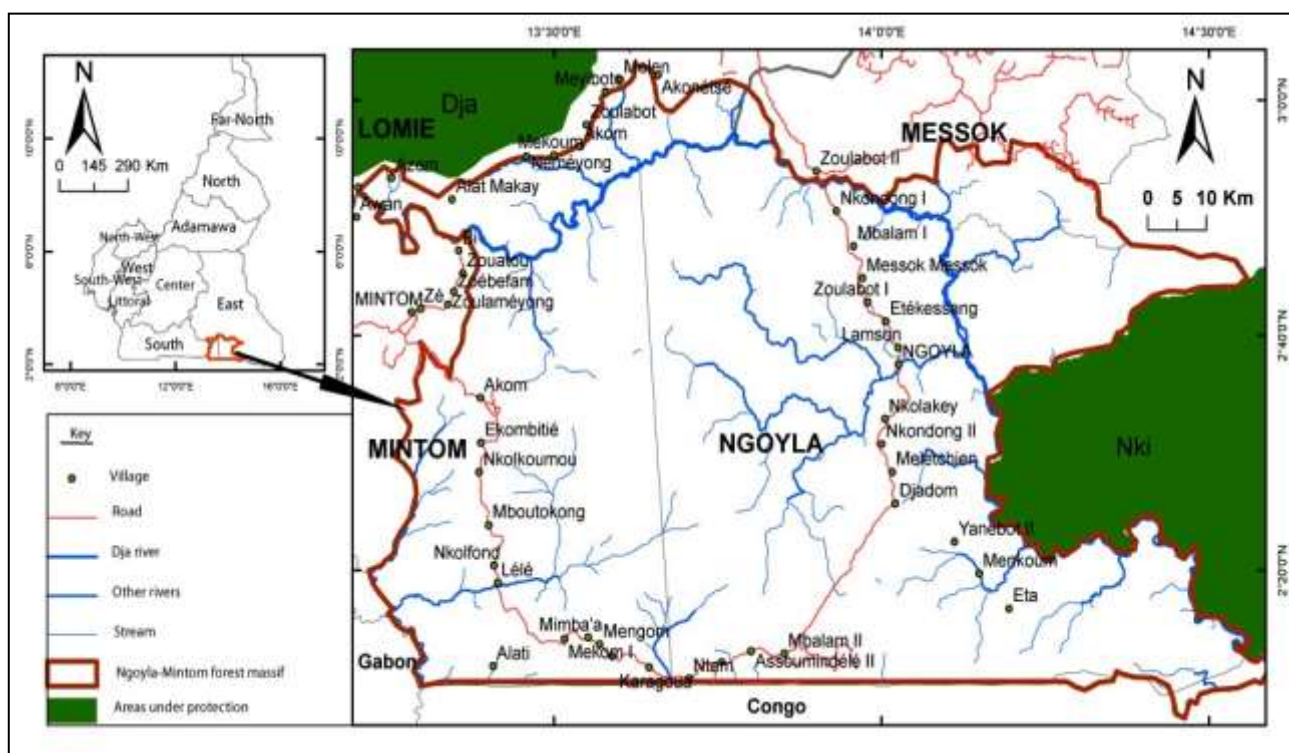
In Cameroon, artisanal mining is an aged old activity which dates far back before the independence of the country in 1960. This activity has been providing livelihood to thousands of Cameroonians notably in the East, South and Adamawa regions. The contribution of ASM to sustaining livelihoods is increasingly acknowledged after decades of being overlooked due to its criminalization, informality and lack of legal status (Spiegel and Veiga, 2009).

Artisanal Gold entails a series of processes from excavation to the final product (Carney, 1999; Hinton et al 2003; Hilson, 2009; Arthur et al 2016; and Ashley). Artisanal Gold mining has got resounding positive impacts on livelihood (Bakia, 2013; Kitula, 2004). Other than being a livelihood sustainer, artisanal mining has adverse social impacts on the local populations. Health risk, child labour, sexually transmissible diseases and HIV, and prostitution are among impacts raised so far (Hentschel *et al.* 2002; Hinton, 2006. Spiegel and Veiga, 2009; Veiga and Morais, 2015).

Recent studies have also documented the impacts of artisanal mining on the environment in fragile ecosystems. These impacts worth mentioning include acid Mine drainage, deforestation, soil erosion, river silting and sedimentation, destruction of wildlife habitat, overfishing and poaching, pollution of water with toxic compounds, dust pollution, mercury vapour (Hentschel *et al.* 2002; Hinton et al 2003a; Nzooh D.Z., 2003; Tieguhong *et al.* 2009). Verina Ingram *et al.*, 2011; Veiga and Morais, 2015; . The activity has been gaining much ground in Cameroon within recent years as more and more people are getting involved and have extended to the most fragile ecosystems (WWF, 2014). It is in a similar way that this activity is now been carried out in protected forests areas of the East, South, Adamawa and North regions. Artisanal mining has been gaining much ground in the Ngoyla-Mintom forest massif (NMF) in recent years. The main problem of this research centres around the nature and the adverse socio-ecological impacts of artisanal gold mining in the Ngoyla-Mintom Forest

REGIONAL SETTING AND BACKGROUND

The Ngoyla-Mintom forest massif (Figure 1) is located in the south and east regions of Cameroon. It gets its name from the two subdivisions it covers, which are the Mintom Subdivision in the South Region and Ngoyla in the East Region. The Massif is made up of nine Forest Management Units (FMUs). The Ngoyla-Mintom Forest Massif is situated between latitudes 2°10' N and 3°00' N of the Equator and Longitudes 13°20' E and 14°35' E of the Greenwich Meridian. There is no agreement on the surface area of the Ngoyla-Mintom forest massif but the figures range from 932,142 ha (MINFOF 2006; WWF 2006) to 988,000 ha (World Bank 2010). The area is located between the Dja Forest Reserve, Nki National Park (Cameroon) and Minkebe National Park (Gabon) and is part of the TRIDOM (made up of Dja, Odzala and Minkébé national parks in Cameroon, Congo, and Gabon, respectively) zone.



Source: MINFOF, 2011 and Field work 2013

Figure 1: Map of Ngoyla-Mintom Forest Massif and surveyed mining camps

The Cameroon mining sector is governed by law No 001 of 16th April 2001 (the mining code), and is implemented through decree No 2002/046/PM of 26th March 2002 (Mining Regulation). Many other laws and decrees modify and complete certain dispositions of the mining code notably Law No 2010/011 of 29 July 2010. All these laws abrogate any other laws that had existed before then like Law No 64/LF/3 of April 1964 governing mineral substances and Law No 78/24 of December 1978 fixing the fiscal regime for collecting mining revenue which are the first ever laws which regulated the mining sector independence.

MATERIALS AND METHODS

Quantitative and qualitative data were collected using appropriate methods. The methods used to collect the data presented in this paper included:

Desk review of scientific reports, articles, laws and regulations related to the mining sector. Documentation from structures like CAPAM (Cadre d'Appui et de Promotion de l'Artisanat Minier- Small Scale Mining Support Framework Unit), the Ministries of Mines and Power (MINMEE) Forestry and Fauna (MINFOF) the Environment and Nature Protection the main libraries of the University of Yaounde I, the World Bank, as well as the Councils of Ngoyla and Mintom.. Topographic sheets of the East and South region at the scales of 1: 100 000 were used for location.

- Field visits to eight mining sites at the periphery of Mintom were conducted between October and November 2013 and February 2014. Observations were carried out and mapping of these camps was done with the use of a GPS. and photographs were taken to show processes of mining and the impacts on the environment.
- Focus group discussions (FGD) and key stakeholders consultations were carried out. Four FGDs were also conducted with miners and one with all actors in the artisanal mining system (miners, porters, and catering, business persons). Each FGD comprised 8-15 participants of different ages ranging from 15 to 65 years and above. The FGD was very relevant in this case because it sougthed miners perception regarding their situation, mining activities and its impacts on the environment in the NMFm.
- A total of 95 miners were interviewed using a guided questionnaire. Miners were interviewed on their income, difficulties, and livelihood strategies. Their perceptions on the impacts of artisanal mining on the environment were also sorted.

The simple random sampling technic was used to select the sampled population as it generally produces an unbiased sample. This was done according to the estimated population of each camp surveyed. It is in this light that a total of 8 camps were surveyed (Table 1). The number of questionnaires administered in each camp depended on the population of the camp. This was done to get a good representation of the population.

Table 1: Mining camps surveyed

Mining camp	Frequency	Percentage	Estimated population	Age of camp
Nzom	11	11.6	50	20
Boule d'or	20	21.1	120	3
Mvan	8	8.4	30	7
Zambata	14	14.7	50	15
Cool	7	7.4	80	2
Obac	18	18.9	130	8
Moi meme	5	5.3	12	1
Paradis terrestre	12	12.6	25	6
Total	95	100.0	497	

Data analysis was done in three phases: data entry, checking and correcting; the data was analysed qualitatively. The field notes, interviews and transcriptions of the FGDs and questionnaires were coded and analysed using Statistical Package for Social Sciences (SPSS 16.0 version) software for descriptive analysis and Microsoft Excel 2010. The final output has been presented in this scientific work basically in the form of texts, graphs, statistics, and direct quotes from key informants/ stakeholders, FGDs and local community members. Financial data was collected in the French African Financial Community (FCFA) and then converted into the US dollars using the exchange rate at the time of the study which stood at XAF 500= 1 US \$.

RESULTS

A) Characteristics And Functioning Of Artisanal Mining Communities

1) Biodata of respondents

The results obtained from the analyses of questionnaires to sampled gold Miners to realize that they are basically from all age groups and both sexes. With regards to the perception on the age and sex of Miners, 80% of the respondents were less than 35 years. The ages of miners ranged from 15 to 65 years. This can be explained by the fact that mining is a labour intensive activity and suitable only for the physically young and strong age groups. Only two miners were found to be above 50 years of age (Figure 2)

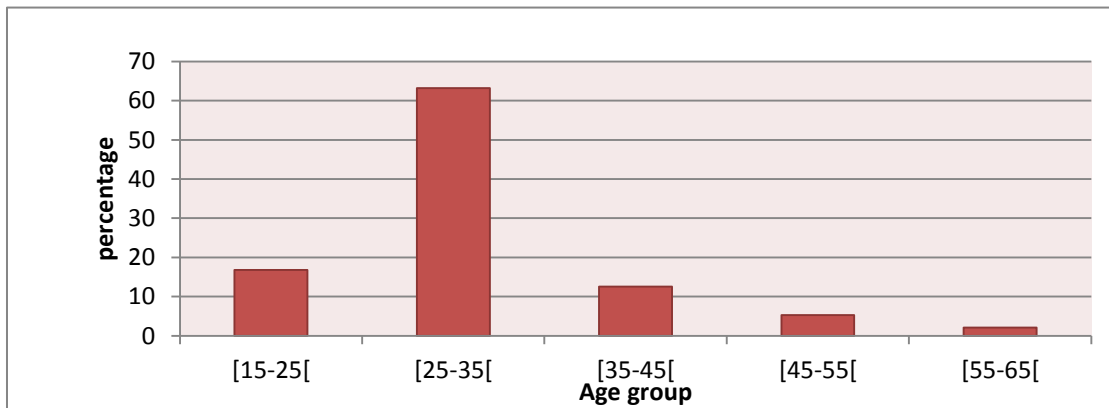


Figure 2: Miners age groups

Only 3% of the 95 miners interviewed were women. In Ngoyla-Mintom women are not very involved in mining activities due to local beliefs that they will bring bad luck if they do, especially during their periods. Some women transgress these beliefs and own holes and even participate in digging.

A total of 51 marriages for 54% of total miners was surveyed, with 2 divorces (2%) and 1 widowed against 43% single. Only two cases of polygamy were reported. Those generally not married were either non-Nationals or Youths who just came to make a fortune and then leave. With regards to Nationality and ethnic origin, 85% of the respondents are Cameroonians. Cameroonians came from 13 different ethnic groups with the most representative being the Bulus' with 22% (Figure 3).

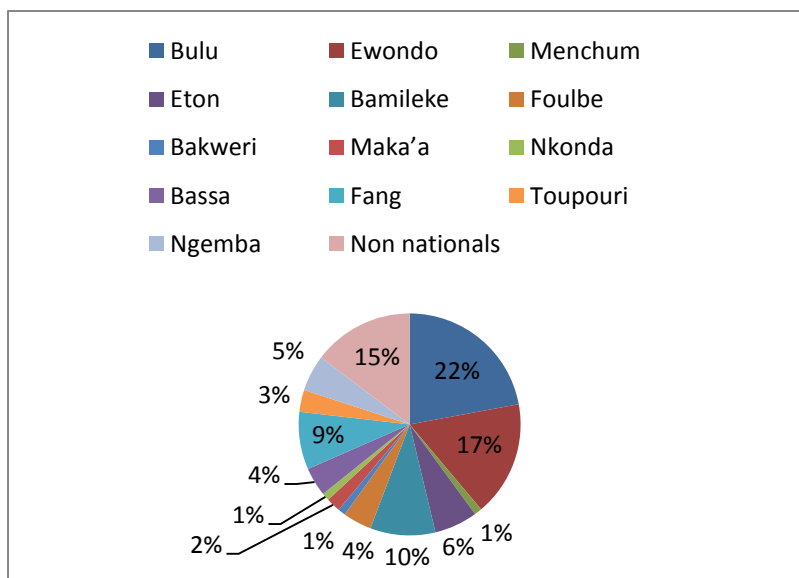


Figure 3: Nationality and ethnic origin of miners

Foreigners represented 15% of the miners surveyed and came from Burkina Faso (4%), Central African Republic (2%), Chad (1%), Gabon (2%), Mali (4%), and Niger (2%). This

diversity in the ethnic origin and nationality of miners could be attributed first to the fact that gold mining is a very lucrative activity and so attracts many people all over the territory and nearby countries since the Ngoyla-Mintom forest massif is at the border with many countries.

As far as the perception on level of education and profession are concerned, it is generally believed that unskilled labour is reserved for school drop outs and illiterates. To ascertain or disproof this fact, the perceptions of miners' level of education were computed. The highest class attained was prioritised to certificate obtained for the simple fact that those who have attained a certain level of education even without obtaining a certificate are better off than those who did not all. Among the 95 miners surveyed, 10% of them did not receive any formal education. Miners with the First School Leaving Certificate (FSLC) (equivalent to the *Certificat d'Etude Primaires – C.E.P* in the francophone subsystem of education in Cameroon) represented 29%. It was discovered that a good number of miners were secondary school dropouts. Of those miners interviewed, 33% of them had the ordinary levels, while 4% had the advance levels Only 1 miner went up to university education (Figure 4).

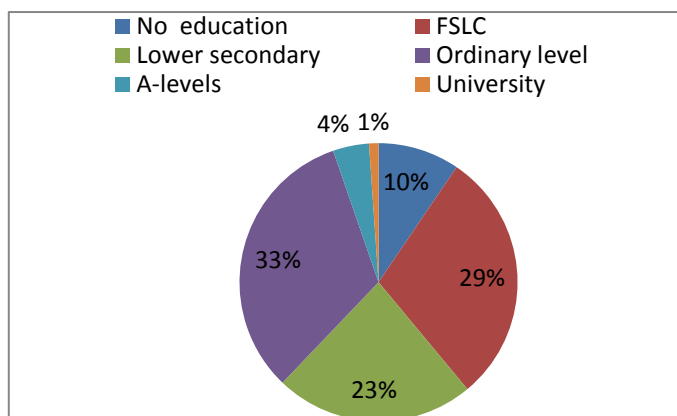


Figure 4: Level of education

Miners were asked if they had a profession before joining mining. Over 48% of respondents confirmed that mining was their first profession. Of those interviewed on the question of first job 13% were farmers, 8%, Mechanics, 11%, businesspersons, 8%, woodworkers, 6%, electricians 2%, builders and 1% of them teachers. Many of them joined mining because it fetched more revenue than the other activities. Meanwhile, others held that this was in order to complement their income from other activities.

2) Organizational Structure Of Mining Communities

Mining communities in the Ngoyla-Mintom area are generally found far from villages. Although these communities recognize the village authorities where the camp is found, they have their own leadership and well organized social structure (fig 4).

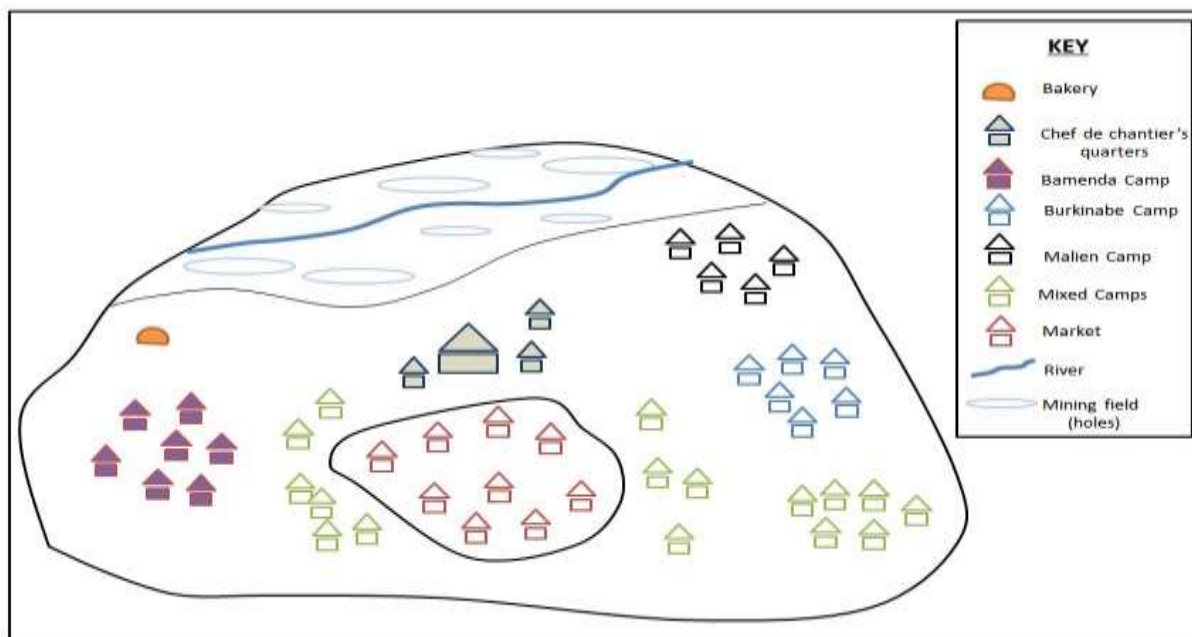


Figure 4: Settlement pattern in mining camps

A mining community is headed by a leader called *chef de chantier*. He who discovers a deposit is the natural head of the camp. There is a head for land and working committee voted by pit owners. There is also a security committee or vigilante group which guards and ensures the security of the camp. Finally there is a peace or justice committee whose role is to settle conflicts already reported by miners as being very frequent. Miners generally quarreled over land, sharing of gravel and women.

All the camps surveyed had the same social structure and settlement patterns. The camps are divided into quarters according to ethnic affiliation. Foreigners generally live at the extreme end of the settlement. This is probably because they would evade the police or gendarmes with ease since a majority of them are living illegally in the Country.

Four main types of Miners carry out mining in Ngoyla-Mintom.

-Individual Miners: These are people who work alone and finance their activity by themselves. They either hire labour or work with family members (wife, children, brothers). Results from the analysis of questionnaire show that 49% of the respondents are individual miners

-Laborers: They offer their services to individual miners and others for daily, weekly or monthly payment or on contract basis for task work. Many labourers do not have capital to own personal holes

-Group workers: A group is made up of two or more people. Two types of groups were identified. The first type of group was made up of independent workers who form what they called “*njangui*” where by all members of the group assist each other especially during

digging. The second type of group is made up of individuals who put their resources together and work collectively and then share the proceeds at the end.

-Entrepreneurs: They are generally business persons, collectors, simple individuals settled either in the mines or not, who provide the materials and finances needed. They hire labourers who do the work for them and are paid according to an agreed contract. Entrepreneurs do not work in the holes, they are just financiers.

3) Labour and mining technics

The technics used for gold mining in Ngoyla-Mintom are rudimentary and/or artisanal. Miners use exclusively manual tools and man power. Cutlasses, Crowbars, spades, pickaxes and are the principal tools used. Labour is organised by the *chef de chantier*. He is the one who shares mining land. Any new comer into the camp is given a portion after doing some work for the *chef de chantier*. This is called *new man tax*. This is done in the form of labour by digging a pit for the chief and bringing out the gold bearing gravel. Once this is done he is attributed his own portion of land. Whatever he produces from that new piece of land belongs to him. Tetsopgang et al. (2007) states that in the eastern part of the country in Betare-Oya and many other localities, the owner of a Mine gets a percentage of all produce from his mine. The situation is different here: artisans affirmed that once the *new man's tax* is paid, nothing more is owed to the *chef du chantier*, except as a gift from an individual who may give him something after a fruitful wash. The average depth of holes (plate 1a) in the NMFM is 2 m . These holes are dug in rectangular form and the sizes can go up to 10mx5 (Plate 1b). Since mining is mostly done here along river beds and swamp forest areas, water fills the holes as miners dig so they use motorised pumps to bailout this water (Plate 1 b).

**Plate 1**

- a- digging process
- b- motorised pump for bailing water
- c- washing table
- d- washing process
- e- Gold

Plate 1: Processes of Artisanal Gold Mining

Once the gold bearing gravel is reached, a portion of land is cleared where it is removed and stocked. Gold exploited in the NMFM is principally secondary, that is gold transported and deposited by the action of water. It is for this reason that the gold bearing gravel needs no form of transformation before washing. Washing is done using a wooden sluice box fitted with wool carpets to trap the gold (plate 1c).

The gravel is filled in the washing table with spades and water is pumped on it and it flows down on the carpet (Plate 1d). The sluice creates flurry which slows the speed of water permitting the carpet to trap even the finest gold particle. At the end, the content of the carpet is emptied in a *bate*. The final concentrate is then panned delicately and any excess fine sand and other minerals are removed. The final product is then heated on fire and placed on a piece of paper and any remaining impurities are removed delicately by blowing. Gold in the NMFM is among the purest gold found in Cameroon with up to 23.6 carats. (CAPAM, 2013) see (Plate 1d).

4) Production, Income and livelihood strategies

There is little or no correlation between capitals invested in gold mining and income. Artisanal mining is done through trial and error. Although miners do little prospection before engaging in digging a pit, production is not always guaranteed. However, Miners said that they earn more income from mining than from other traditional activities. Miners reported that they produced between 5 and 10grams of gold per month. Some miners reported that they produced up to 100grams a month. Production varies from Miner to Miner and this highly depends on the type of deposit exploited and the size of the pit dug. A gram of gold sold at XAF 17 000 at the time of the study, and so Miners made a minimum of XAF 80 000 and a maximum of XAF 800 000 per month.

The modalities through which miners are remunerated are diverse. Labour is paid either on a daily, weekly, monthly base or as a percentage of what is produced. The pay for Labour ranges from 3000 (6 US\$) FCFA to 5000 FCFA (10 US\$) per day. In very rare cases, Miners receive up to 7000 FCFA as daily payment. Some Miners who are paid 3000 FCFA are provided a daily ration of food. For weekly payment, the number of days worked inside the week is multiplied by the daily payment. Miners receive between 140,000 (280 US\$) and 200,000 (400 US\$) FCFA as monthly salary depending on their daily payment. Salary applied to mining labourers who received remuneration on monthly basis.

All miners interviewed cited at least three basic needs that they met with income from mining and they are specifically food, health and clothing. Other uses of mining income cited by miners were; sending children to school, and sending money to family and relatives for miners who came from afar. Other miners said they used mining income to increase their farm sizes. Miners also spent much money on leisure and luxury. Some miners were reported to have bought cars with income from mining.

More than half (52.6%) of the Miners said they practiced only mining because it fetched more revenue, and 47.4% of them practised Mining alongside other activities. Among the activities mentioned, 20%, of the Miners preferred agriculture alongside, 7.4%, preferred fishing alongside, 7.4% preferred portage alongside, 5.3% preferred business alongside, 4.3% preferred hunting alongside 2.1%, preferred a combination of fishing and agriculture alongside, meanwhile, 1.1% preferred the collection of Non Timber Forest Products (NTFPs) alongside Mining. From these answers it was established that miners carryout mining because it is their best choice and soto them mining is not a poverty driven activity.

B) THE ADVERSE IMPACTS OF GOLD MINING

1) Negative social impacts of gold mining on the local population.

Impacts on health

A majority of miners raised a series of problems that they face on a daily bases in carrying out mining. Health problems were top on miners list of complaints. Only 24% of miners

interviewed said they do not face particular health problems as a result of mining. The other 76% cited a series of health issues. notably 46% of them complained of body pain, 9% Body rashes 11%, malaria and 6% complained of stomach problems. Water-borne diseases are also a preoccupation because of lack of portable water in the mines. Some Gold Miners have Sexually Transmissible Diseases (STD), especially because of the proliferation of prostitution in the mining camps. Rural populations generally have little or no knowledge on protection methods and some of those who are aware of it, say that they do not like to use condoms for it reduces pleasure.

The open mines left behind by mining carry stagnant water, which are breeding grounds for mosquitoes. Malaria caused by these mosquitoes is one of the diseases, which is a problem to artisanal miners. Only 20% of miners replied that they go to the nearest health Centre when asked how they treat themselves in case they fall sick in the mining camps. The remaining 80% said they practice auto medication. Although there was no report of medication errors in the camps, it is clear that auto medication is a risk to the life of those practicing it.

Occupational Risk

Artisanal mining is generally characterized by a lack of occupational safety. When asked whether they usually have accidents in the course of mining, 49.5% of the Miners interviewed cited wounds from sharp tools like, cutlasses and spades, which they use. The other 10.5% of the Miners held that they face dangers from falling trees and branches as well as soil failures/collapse; with the risk of being overwhelmed in holes. The risk of soil failure was also reported as a risk especially when Miners try to extract gravel by small tunnels. The remaining 40% answered that they have never had any accidents. Miners are aware of the fact that mining is a very risky activity and some miners said they have witnessed deadly accidents in the past. In addition to this, exposure to wild animal attacks is also a risk faced by Miners every day. They do not take particular safety measures but rely on God's guidance for protection. With regards to the perception of miners on safety, 92.5% of them said that they do not take any particular safety measures to avoid accidents. Only 7.5% said they take minor precautions at work, like working with gloves, and being cautious at work.

Low levels of Education and child labour

In the mining camps surveyed, children as young as 15 years are involved in mining activities. With regards to the perception on education, 10% of those surveyed did not receive any formal education and only 29% received primary education. It was generally observed that children between the ages of 1 and 12 live inside mining camps with their parents. These children do not go to school. When interviewed on why her children do not go to school, a woman in Boule d'or replied that there is nobody to stay in the village with the children while

she works in the mines and therefore they live with her in the camp. Other than the fact that educational facilities are far from mining settlements some parents said that education is for the rich, even if their children go to school they would not be able to see them through higher education for them to be able to get jobs. So they prefer to teach them the trade of mining which will according to them would fetch them revenue. They re-iterated that when these children live in mining camps they will always tend to help their parents. .

According to Hentschel *et al.* (2002), children working in mining sectors are likely to have problems in physical and psychological development, health and accidents. This has great impacts on the future of the children for they are condemned to carry out mining all their lives or remain in the informal sector and carry out primary activities like farming.

Alcoholism, moral decadence and Prostitution

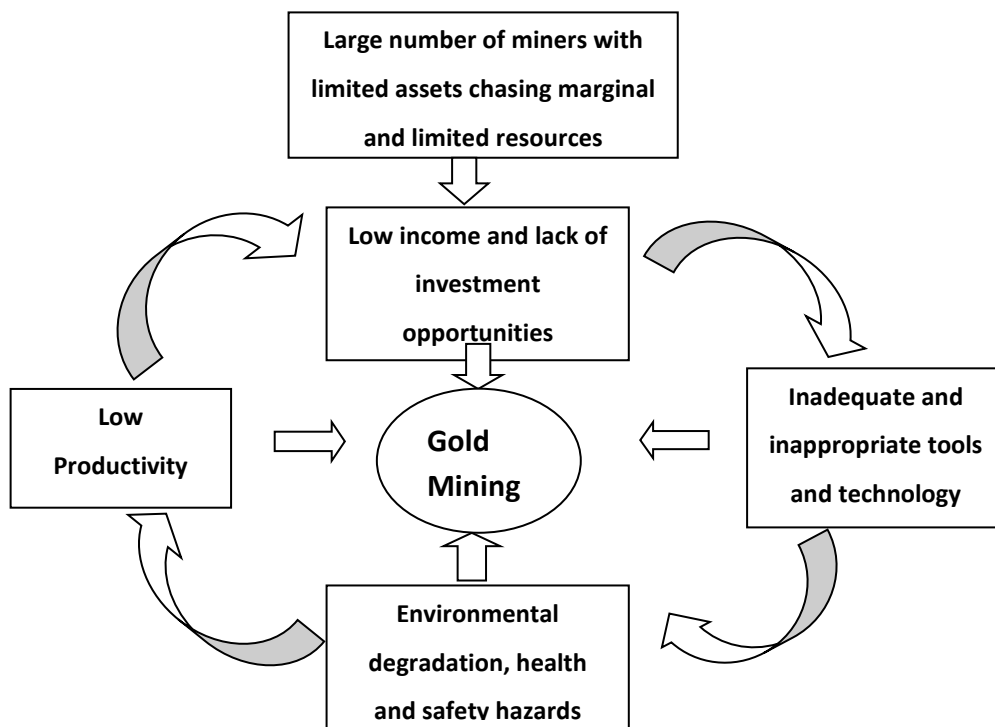
Alcohol was discovered to be one of the highest commodities sold and consumed in mining camps. With no legislation in Cameroon restricting the age to purchase alcohol, it is accessible to all and available at all prices. There are whisky sachets of 25ml and 50ml sold at 50FCFA and 100 FCFA respectively. This means that with less than 200 FCFA a miner can get drunk. Those who consumed the highest quantity of alcohol were less than 25 years of age. Alongside alcohol many of the youths associate other drugs like marijuana and Tramadol which they say gives them strength to work for very long hours without getting tired. The consequences of these drugs are moral decadence and a reduction in moral values. An old man in Obac told the survey team that one of his sons who was under the influence of drug and alcohol almost beat him to death. Meanwhile, a lady reported the rape of her 8 year old daughter who was helpless. This moral decadence is partly due to lack of education and the fact that most children are abandoned to themselves with no control from the parents. It is equally due to the fact that they start earning money at tender ages.

According to Hinton *et al.* (2003) women engaged in mining also tend to take on other jobs to supplement their incomes. In Guinea, although women undertake the same labour as men, inequities in pay (because men are paid four times more for the same quantity of gold) often leads to a “troc”, or trade of sex for additional money or gold. Lured by the promise of riches and opportunity (and often an initial lump sum of money), many young girls are brought to remote regions to work in “night clubs” as prostitutes. In the NMFm the situation is not different although only a few women are involved in mining. Some young girls are brought in to sell in bars and the payment is not often good and so they decide to earn more by prostituting themselves. The mode of payment is not fixed and women generally go with the highest bidder. Some other women came to mining camps and took onto prostitution as their principal activity as reported by some miners in boule d’or camp. These women are also a source of conflicts among men at times when a woman abandons the man who brought her to the camp and goes with another who offered a higher some of money or gold.

Vulnerability of mining communities to poverty

Labonne and Gilman (1990) note that poverty results from a denial of choices and opportunities and implies living on marginal and vulnerable environment as well as further exhausting this environment. Most rural poverty is exacerbated by a lack of access to sufficient productive resources of good quality that is land, good soils and water. In the case of the NFM miners depend on a non-renewable resource (gold) and we find a large number of them depending on marginal deposits. Miners generally have a problem of income management for a larger percentage of what they earned is spent on alcohol and women and there is, quite often, less consideration for reinvestment or savings. According to Hentschel *et al.*(2002), in many of the regions where there is “gold rush”, tons of gold have been produced but once the gold rush is over, poverty comes back and sometimes even with more problems due to the cultural damage, which happened in these areas.

This lack in rechanneling income from mining to spur up other activities causes miners to be caught in a poverty circle. Here, a large number of them depend on a limited resource which since they use inadequate exploitation technics to exploit and consequently leading to a fast degradation of the resources and exhaustion.. A fast degradation of the resource signifies low income for miners and consequently they remain poor. (Figure 5)



Source: Adapted from Labonne and Gilman (1990) and Tieguhong *et al.*(2010).

Figure 5: Artisanal mining poverty trap

2) Ecological Impacts of Artisanal gold mining

This study gathered information from miners' perception on the implication of their activity on the environment.. Three quarter (75%) of the respondents said that mining has no negative impact on the environment meanwhile 25% of them said it does. These denials were interpreted by the research team as either a lack of understanding of environmental impacts by the miners or simply from fear of repressions considering the fact that 92% of miners are aware that there is legislation governing mining and acknowledged working illegally. The remaining 25% of miners cited deforestation and soil destruction as the negative environmental impacts they have observed.

All miners interviewed during the survey reported that they do not use mercury or any form of chemical in the process of mining. Direct observations did not reveal the use of any chemical but a series of impacts on the environment were observed.

Impacts on forest

The Ngyla Mintom area is located at the pinnacle of the equatorial evergreen forest. This is a clear indication that there cannot be any mining activity without opening up the space for excavation. This therefore supposes a wanton clear-cutting and felling of the vegetation that is mainly composed of tree species. Most of these trees have taken more than 150 years to establish. They are removed instantly to establish mines there by distorting the original system that used to be.

Mining was done in the yesteryears with machetes and hands and so miners could cut down only small trees. Miners reported that today they make use of engine saws and consequently cut down larger trees and increase mining space. Mining camps have opened roads into the forest. These roads provide evacuation routes for illegal timber.

Mining in all the eight mining camps surveyed was alluvial and so practiced on river courses and forests swamp areas. More than 90% of mining activities in the Ngoyla-Mintom is done either on river beds or lowland marshy forest swamps. Forests swamps are complex forests ecosystems and maintain the equilibrium in terms of: groundwater recharge and discharge, flood control, sediment and toxicant retention, nutrient retention, biomass export, wildlife resources, fisheries resources and water supply (Dugan 1990). When this equilibrium is destroyed (Plate 2c and 2e), it has long term negative impacts on the environment. The condition become even more precarious as most of the inhabitants in the mining camps also cut trees to obtain fuelwood and charcoal. This situation is aggravated by the contuous increase in the number of Miners during the past decade.

Open mines and soil degradation

One of the main environmental damage of artisanal mining in the NMFEM is soil degradation and land damage. Artisanal mining of gold cannot be done without excavation. Often time this excavation entails loosening and scooping/removing the the superficial layer of the crust.

Meanwhile the soil is deposit no far from the pit where the work of rain water sets. A keen observation at spotted mines permitted us to visualize traces of unconcentrated forms (Young, 1960; Carson and Kirkby 1972) of erosion as sheet erosion on the plane surfaces at the periphery of pits. On the mounds of earth excavated from the pit are found some micro erosional forms such as earth pillars. During sporadic torrential downpours we observed splash erosion and splash saltation fluxes that would not occur if the mound was covered with vegetation. Where pits and the pile of material excavated has been exposed for long and subject to the force of rainwater concentrated forms of erosion such as rills have developed. On some mounds and adjacent lowlands, these rills have evolved into gullies.

Miners do not refill land after mining. Pits lengths, widths and depths averages are 4, 3 and 2m respectively. Abandoned after mining, these open mines become traps for animals and breeding grounds for mosquitoes. Flora growth around the area becomes impossible. Open mines have one of the most adverse effects of mining on the environment. When bush grows around these holes, they become almost impossible to see and then become a real danger for man and animals. A case of a lady who felt in one of these open mines and sprung an ankle was reported in Boule d'or.

Miners turn the soil upside down and abandon pits all over the forest where it practically impossible for vegetation to recolonize. Huge piles of soil are dug up and abandoned by miners. In case of heavy rains in some places, there is mass movement of this soil. Since most of the material from the pit is deposited around the pit, this loose material rests on a comparatively hard and consistent surface. With the infiltration of water into the unconsolidated material on steep slopes, during heavy rainfalls the loose material is forced to follow the force of gravity as minor slides. In other cases, the soil is over wetted so that it cannot withstand the force of gravity and move as mudflow. When carrying out prospection, miners dig holes haphazardly inside the forest. These prospection holes are generally not deep but during heavy rains, runoff continues digging these holes haphazardly, forming rills and gullies and with time they form ravines especially when they are found on very steep slopes .

Pollution, siltation and sedimentation of river courses

The impacts of mining on water in course of this study were measured through observations and miners and stakeholders opinions. Gold washing generally produces huge quantities of mud, sand and silt. Tailings from washing tables are channeled directly into river courses. Most of the fine sediment constitutes stream load that is held in suspension and is usually responsible for the changed colour of the stream (Plate 2a). As observed on the plate, the reddish colour of the stream is a clear indication of the presence minerals of iron oxides (FeO₃). Were observed initially that the streams in this forest that have not had the influence

of material from mines are usually dark coloured. This shows that the colour changes as mining increases and this also means an increase in stream pollution. The particles released from mines also sediments that leads to the sedimentation and siltation of these river courses. This silt is dangerous to aquatic life and other animals that drink from these rivers

Miners divert river courses to dig the river beds for gold. Due to the diversion of these river courses ground water recharge is sometimes altered. Pollution from oil and metals waste from motor pumps is disposed in the surrounding forest and rivers by miners. The soil in this area is rich in a number of minerals other than that exploited by miners. These minerals occur everywhere even though in minute and un-exploitable quantities. Meanwhile it is realized that, Metallic pollution can also be caused by Metallic Trace Elements (MTE) from the soils dug by miners. This is obviously dangerous for aquatic life and animals drinking from these rivers and streams. Although the impacts and traces of MTE was not measured in the course of this study, it is believed to be one of the highest causes of pollution from tailings in gold mining as raised by several studies. (Antwi-Agyei et al.2009; USEPA, 1994; Pradeep Mehta, 2002; Altaher, 2001).

Impacts on Wildlife

The principal source of protein in mining camps comes from bush meat hunted on the spot in the forest. According to Nzooh (2003) hunters in the Ngoyla-Mintom forest zone cover distances of up to 30km into the forest from villages. The main source of protein in these mining camps comes from bush meat. Mining camps have created contact points for poachers and so permit them to cover longer distances inside the forest to hunt. Poachers hide behind mining and poach protected and endangered species like the giant pangolin (*Manis gigantean*), gorilla (*Gorilla gorilla*) and forest elephants (*Loxodonta africana cyclotis*) (. (Plate 2 f) In Boule d'or mining camp, the survey team came in contact with a hunter who had gorilla parts notably legs and hands for sale (Plate 2f). This illegal transactions and trade in protected species was very recurrent in mining camps miners said. The NMFPM is host to a number of endangered animal species considered to be emblematic of the Congo basin forest region according to the International Union for Nature Conservation Red Book (Table 4).

Table 4: Some endangered species in the NMF

Scientific name	Common name
<i>Hyemoschus aquaticus</i>	Water chevrotain
<i>Cephalophus sylvicutor</i>	Yellow back duiker
<i>Gorilla gorilla</i>	gorilla
<i>Pan troglodytes</i>	Chimpanzee
<i>Panthera pardus</i>	Leopard
<i>Loxodonta africana cyclotis</i>	Elephant
<i>Mandrillus sphinx</i>	Mandrill
<i>Tragelaphus spekii</i>	Sitatunga
<i>Manis gigantea</i>	Giant pangolin
<i>Synerus caffer nanus</i>	buffalo

Source: MINFOF, 2012

According to WWF, (2007) there is an estimated population of 3000 elephants, 4000 gorillas and 1500 chimpanzees concentrated in the southern and central parts of the NMF. These animals habitat is already highly threatened and will further be as mining activities keep increasing. Other than hunting, mining destroys the natural habitat of these animals like the water chevrotain (*Hyemoschus aquaticus*). Human presence has a negative impact on animal behaviour and feeding habits as some of these animals roam around mining camps at night and feed on human waste.



Plate 2

- a -Siltation of a river course
- b -Open mines abandoned
- c -A forest swamp destroyed
- d- Illegal logging activities in NMFM
- e -Illegal hunting of protected animal

Plate 2: Elements of adverse ecological effects

DISCUSSIONS

This study revealed that artisanal gold mining has been gaining ground as more and more people are joining the activity in the forests areas of southeast Cameroon. An estimated 50 000 people depend on the activity this day as estimated by CAPAM (2011). Although the actual number of people engaged in Artisanal and small scale mining in Cameroon in general is not known, there is need to carry out such a census as proposed by Schure, J.*et al.* (2011) and Bakia, (2013)..

The fact that the mining population in the NMFM is principally young is reflective of the fact that mining is a recent activity in the region to the one hand and the fact that it is a labour intensive activity and needs the physically strong to the other hand. Mining in the NMFM is gender bias as only 3% of miners interviewed were women. This corroborates with what occurs in other parts of the world which shows that only 40% of artisanal miners worldwide are women (Hinton, 2011; Hentschel *et al.* 2002; Bakia, 2013; Tieguhong *et al.*, 2009; Francis Arthur *et al.*, 2016). Levels of education among miners in the NMFM are

relatively high with 29% haven received basic education, 33% with the ordinary level and even a university graduate. This shows figures contrary to that of other studies (Bakia, 2013; Tieguhong *et al.*, 2009; J. Schure *et al.*, 2011; Ingram *et al.*, 2011) which showed that education levels within artisanal mining communities in the central African sub region are lowest within rural milieus .

Many people join mining for the huge and fast incomes it fetches. Miners earn a minimum of XAF 80 000 a month and some miners earn up to XAF 800 000 a month. These income levels are two times higher than the minimum average in Cameroon which stood at XAF 29 000 at the time of this study. Despite miners' huge incomes, they remain relatively poor as they are caught in a vicious poverty cycle. This corroborates with reflections in other parts of the world (Tieguhong *et al.*, 2009; Hentschel *et al.* 2002 and Labonne and Gilman, 1990).

Health problems, occupational risk, alcoholism, low levels of education, prostitution and fall in moral values are some of the negative aspects that artisanal gold mining comes along with. These issues are not new in artisanal mining communities as underlined by many researchers (Kitula, 2006; Hentschel *et al.* 2002; Veiga and Morais, 2015; J.Hinton, 2011). Government for the past years have tried to support the artisanal mining sector by creating the Small scale mining support and promotion framework unit (CAPAM). CAPAM tried organizing miners by creating Common initiative groups for miners which has been a failure up to this point. CAPAM has for the past years focused more on the benefits and revenues that ASM can mobilise than addressing pressing social and environmental issues for a more sustainable. According to Schure J, et al. (2011), formalization is often considered as the way forward for integrating artisanal mining into the national economy and building a mechanism to look into sustainability and livelihood issues.

In the NMFm 25% of miners were aware that mining has negative impacts on the environment but said mining remained their best livelihood strategy and have no other choices than to mine. The environmental impacts observed in the NMFm in the course of this study ranged from pollution siltation and sedimentation of river courses, open mines and destruction of the forest environment. These impacts uphold what other researchers had earlier found in other parts of the world (Hentschel *et al.* 2002; Spiegel and Veiga, 2009; Veiga and Morais, 2015; Hinton, 2006.).

Miners in the NMFm did not make use of mercury or any other chemical to amalgamate their gold. These findings confirms those of Bakia, (2013), WWF, (2014) and Tieguhong et al, (2009) who found that miners in East Cameroon, those at the peripheries of the Nki national park and the TNS landscape (Cameroon and Central African Republic) respectively did not use any chemicals in extracting gold.

Few studies have raised issues on the impacts of mining in critical ecosystems (WWF, 2014; World Bank, 2012 and Ingram *et al.* 2011). The most adverse of these impact is going

to be on wildlife as mining population increases with demand for bush meat as also predicted by Ingram *et al.* (2011). Bush meat is not consumed only in mining camps but it is also a source of revenue for households. According to Ingram *et al.* (2011) bush meat hunting in the TNS landscape provides up to 4700 US \$ is gross average income to households. There is therefore need to address such issues through the introduction of alternative sources of protein. This could be done by diversifying miner's income by transforming the open mines left behind by mining into fish ponds. . There is overlapping of mining rights and other land uses like forestry, land tenure, water resources and agriculture energy, agriculture and infrastructure. There are conflicts of interest and overlapping rights and obligations, which reflect the urgent need for such research and appropriate decision-making (Nguiffo and Nguelpjouo (2009).

CONCLUSIONS

Drawing from the above study, it is realized that Artisanal gold mining in the NMFM provides livelihood to thousands of miners and their dependents. Miners earn more income than from any other traditional activities like agriculture, hunting, fishing and collecting non timber forest products. At least three basic needs are met with income from mining. Basic needs include food, shelter and clothing. The Miners are exposure occupational risk due to accidents from working tools and probable landslips/slides . Meanwhile face enormous health problems related to malaria, waterborne diseases, Sexually Transmissible Diseases and HIV/AIDS as well as body pains resulting from the tedious work of mining. It was equally realized that despite the huge incomes of Miners', they still remain relatively poor. Miners are caught in a vicious poverty trap whereby they depend on a non-resilient resource and above all they mine through trial and error and so at times lose all reinvested profits in mining. None of the miners interviewed had any legal papers and only a few of them sold their products to licensed structures like

It is realized from the findings of this study that Artisanal gold mining has negative impacts on the forest environment. This is seen through the cutting down of trees to extract gold. It equally deduced from soil erosion as epitomized by the numerous micro erosional forms. The effects on ecology are also realized through the pits that are excavated for the extraction of gold that are eventually abandoned until they become traps to man and animals as well as breeding ground for mosquitoes that cause malaria. Sedimentation and pollution of river courses, and poaching are some of the negative impact that mining has on the environment. Although these impacts are still negligible, they are probably going to increase in the near future as the mining population increases. There is need to address these issues early enough before they become a real danger both to livelihood and the environments. `

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