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Impacts of Poverty and Artisanal Mining on Municipal Water Utilities; the Case of Kpapi River in Minna, Nigeria

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Abstract

That unemployment, poverty, artisanal mining, and community vulnerability are interwoven is re-emphasizing the reality of life. This study assesses the effect of artisanal mining activities on River Kpapi and the adjoining settlements in Minna putting into consideration Sustainable Development Goal 8 (SDG8). Observatory field survey was carried out on the entire river channel, and laboratory analysis of water samples taking to determine its hydro-chemical and Water Quality Index (WQI) characteristics using the silver nitrate method of the American Public Health Association (APHA) and the Water Quality Index (WQI) mathematical model. Questionnaires were also administered to the adjoining communities on river water usability. The result revealed that the hydro-chemical parameters heavy metals of Cd, Pb and Cr^{2+} with mean concentrations of 0.04mg/l, 0.39mg/l and 0.44mg/l respectively are above WHO permissible limit. Also, the WQI varies from 2045.35 at middle course, 2709.89 at the upper course and 30.87.46 at the lower course is above the tolerance level for human consumption. The study, therefore, recommended that both the riparian and the solid mineral law should be under the state government to ease implementation and that the artisanal miners and that inclusive planning should be adhere to in all policy formation.

Keywords: ASM; Mineral Mining; Poverty; Vulnerability; Water Safety, and WQI

Introduction

Generally, artisanal and small-scale mining refers to mining by individuals, groups, families or cooperatives with minimal or no mechanization, often in the informal (illegal) sector of the market. Although, there seem not be a common definition of Artisanal and Small-cale Miners (ASM), in most baseline reports, ASM activities are characterized as being environmentally destructive which includes deforestation, abandoned pits and trenches, as well as mercury contamination of people and the ecosystem. Only in a few cases are there quantitative data on them, for instance, in Ghana, about 15,000 hectares of land are potentially affected (Ghana, 2001), while in Tanzania, about 16,000 hectares are reportedly destroyed.

It has been observed that about 44.75 million people working across more than 80countries make their living directly in ASM. While most of the world's large-scale miners enjoy relative security, ASM work almost exclusively in difficult and dangerous conditions, and their contributions to global mineral supply chains for everyday remain hidden even though they provide raw minerals for modern day communications, clean energy technologies [21,51]. They also contribute greatly to the production women's jewellery; tin and tantalum for laptops, Smartphone, and electronic devices; batteries cobalt in electric vehicles; phosphates for fertilizers. In fact, they supply up to 30 percent of the world's cobalt that is a key battery metal powering the world's clean energy transition (OECD 2019).

For instance, an estimated 500,000 individuals and their families, including 18,000 women and children are directly employed in artisanal and small-scale gold mining (ASGM) in the Philippines [9, 31, 33, 40]. Among these small-scale miners, roughly 75 percent are engaged in subsistence mining [14]. ASGM in the Philippines is believed to support the livelihoods of around 2.3 million people (Planet Gold 2020). In term of percentage total land area impacted in some African countries, it amount to 0.06 % in Ghana and 0.02 % in Tanzania.

Women working in artisanal mining are generally required to perform heavy and sometimes dangerous work. In gold panning, they are constantly exposed to mercury or cyanide in ore treatment process to separate it from tailings [23]. According to [29] these women have the lowest earnings and yet they have a high volume of manual labour. Sand and river gravel are the most commonly mined commodities in the world, as in the extraction of gravel from Fiji's perennial rivers that has been the driver of environmental change, controversy, and conflict [14]. This study assessed the effect of unemployment, poverty and artisanal mining on Kpapi River and the adjoining settlements in Minna as it relate to Goal 8 of the SDGs.

Review of Literature

The challenge of surface water pollution is a global phenomenon that have caught the attention of both government and environmental researchers. In fact, an EPA inspection of some U.S. mines and processing facilities between 1990 and 1995 found out that about 20 percent were polluting air or water in violation of federal environmental laws, Hard rock mining on Federal Lands (1999). In another case study in 1998, EPA documented dozens of toxic releases from mines and processing facilities in Arizona, New Mexico, and Nevada (EPA, 1998). Eight out of 12 major mines in Montana have major water quality problems that were not predicted by federal agencies at the time of permitting them, Hard rock Mining on Federal Lands (1999). At the same time, the importance of water in human survival have been expressed in previous studies by El Jurdi, Batat & Jafari (2017); Noorani (2018); and Prima (2018), while EPA (2019) and water.org also address the importance of water saving.

Vulnerability according to GTZ (2002) means inability to protect oneself, against the adverse impacts of external threatening event or recover quickly from such impact. Vulnerability is made up of socio-political, economic and ethno-cultural factors, while resilience refers to the ability of people to cope with and withstand new, changing or unexpected events or situations. In general, resilience focuses on community capacity to absorb external stresses without losing their functional characteristics [54].

The current debate on disaster does not view natural hazards as the sole cause of an ensuing disastrous situation; but that hazards must coincide with a vulnerable society in order to trigger a disaster. In this case, the poverty trap can be described as a downward spiral, ending in a hopeless situation for the affected people. Poverty in its multiple dimensions has a strong influence on people's vulnerability to disaster, and vice versa, and apart from the economic aspect of poverty that is most apparent, the socio-political dimensions is impactful. People in or below a particular social stratum often lack access to dignify employment, where it is cash-and-carry. In fact, ASM in Nigeria is accidental, occasioned by socioeconomic push; and the minimal capital associated with artisanal mining with anticipated high payoffs

Ironically, poverty translates into environmental mismanagement with human-induced disasters in all its forms that make the attainment of the United Nations Sustainable Development Goals (SDGs) a mirage in Nigeria. It has been reported that more than 20 million people in Sub-Saharan Africa are vulnerable to one disaster or the other due to different levels of environmental degradation. The United Nations (2016) confirmed that Yemen, Somalia, South Sudan and Nigeria top the list of countries where over20 million people are facing the threat of starvation and famine. Nigeria in particular may soon be facing one of the worst humanitarian crisis as poverty aggravates in the land where over 2 million persons internally displaced are confronted with extreme hunger. Separate reports from the Central Bank of Nigeria (CBN,2017), African Development Bank (AFDB, 2017) and World Bank (WB 2017) consistently agree that most of the most vulnerable to poverty are in northern Nigeria. The whole of these are aggravating the degradation of the finite environmental, hence the need for this study.

The application of current global indices to Sub-Saharan African countries in recent times reveals that there has been a persistent increase in poverty levels across the region. According to Oyedepo et al (2018) citing Insight Nigeria, (2014), the absolute measure of poverty puts the poor in Nigeria at 99.284 million (60.9%); and the dollar per day measure puts it at 99.75 million (61.2%); while the subjective measure of poverty rating puts it at 153.08 million (93.9%).While Ahiuma-Young, (2016) quoting the National Bureau of Statistics(NBS), states that about 112 million Nigerians (67.1%) of the country's total population of 220 million live in poverty as global poor hits one billion mark.

It is on this basis that this study is aimed at assessing the impact of ASM on River Kpapi and the adjoining settlements in Minna so as to promote inclusive an equitable economic growth, protect the environment, and enhance the well-being of the people as it relate to Goal 8 of the SDGs.

Methodology

The Study Area

Minna which is presently the administrative capital of Niger State derived its initial growth and importance from the development of the Lagos-Kaduna rail line in 1911 and the subsequent transfer of the local government headquarter from Kuta to Minna. Geographically, the town lies between latitude 90 38' - 90 45' N and Longitude 60 33'- 6039'East and is about 135 km away from Abuja the Federal Capital Territory (FCT) of Nigeria south-west, as shown in Figure 1. Minna with an average total land area of 74,344 km2which is approximately 8% of the total land area of the country has a population estimate of about 352,000, 396,000, and 456,030 in the year 2012, 2016, and 2020 respectively (World Population Stat, 2021). This is not unconnected to the relative peace in the town that attracted the influx of people from riotous neighbouring states like Kano, Jos and Kaduna and also the positive influence of Abuja, the federal capital.

The studied River Kpapi is a tributary to the main River Chanchaga that serves as a municipal water supply to Minna. The river takes its source from Maitumbi in the north-west and flow southward to join River Chanchaga with a total length of about 11kms. This same river is been used for various irrigation activities and domestic activities by the adjoining settlements including Sango and Chanchaga.

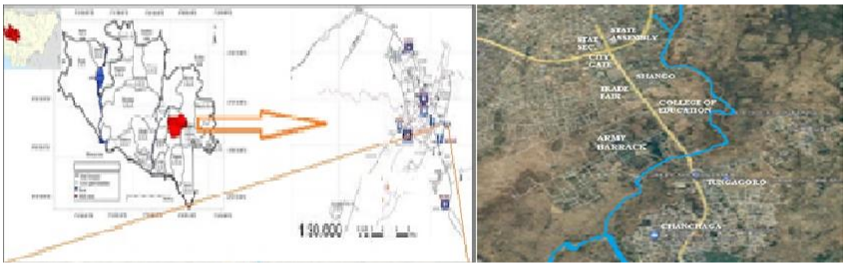

Figure 1: Map of the Minna and the River Course

Material and Method

This study wholly uses primary data collected through field survey, participatory interview and sample collections, other instrumentations includes linear tapes, Gamine 78 GPS, and digital Camera.

Field Work

Three sets of field workers were employed to carry out the field study. The river course were divided into the upper, middle and lower course as the mining activities span the whole lengths of the river, and more so the levels of pollution concentration in the river differs as observed even in the colouration. Each of the group carried out measurements of the river width, and water samples for laboratory analysis, see Table 1 and Figure 2 for the field survey points and field filed.

Table 1: Field Sample Points along River Kpapi

S/No	Sampling Sites	Coordinates	Elevation (m)	location
1	Site A1	N 9° 55′ 517″/ E 6° 59′ 64″	217	Upstream
2	Site A2	N 9° 57′ 69″/ E 6° 58′ 72″	212	Midstream
3	Site A3	N 9° 55′ 29″/ E 6° 55′ 78″	207	Downstream

Figure 2: Research Filed Workers Recording Observations Measurements

Laboratory Analysis

Seven water samples were collected for laboratory analysis, two sample per river stages (upper, middle and lower course), while the seventh sample was taking from the main river Chanchaga as control. The physical parameters (Temperature, pH, EC, TDS) were determined using the Wagtech H1 Model 98311 waterproof EC/TDS meter, Total dissolved solid TDS of all the samples were calculated from the value of electrical conductivity of each sample by multiplying EC by 0.6.

a. Hardness Measurement Procedure: In other to attain a pH of 10.0 to 10.1 require for the determination of water hardness, 1-2 ml buffer solutions were added to 25ml of the sample diluted with distilled water, and the total hardness was calculated with the following equation:

Calculation

Total Hardness (EDTA), $CaCO_3$ mg/L = $\frac{A \times B \times 1000}{mLSample}$ 1

Where: A = mL EDTA titrated for sample

B = mg $CaCO_3$ equivalent to 1.00 mL EDTA titrant.

b. Calcium and Magnesium: EDTA titrimetric method was use in determining Calcium and Magnesium concentration present in the sample with Calver II added as an indicator. The value of calcium hardness and total hardness was used to determine Magnesium hardness in the sample.

c. Potassium and Sodium: This was done using photometer. This procedure was in line with instructional manual of Sherwood flame photometer 410.

d. Chloride: Silver nitrate method of American Public Health Association (APHA 1995) was used to determine Chloride precipitated. The standardized silver nitrate solution was titrated with precise volume of samples,

e. Sulphate: Turbidimetric method (APHA, 1995) was used to determine Sulphate ($SO42^-$) ion. In other to form barium sulphate ($BaSO_4$) crystals of uniform size, this was precipitated in barium chloride (BaCl2) with acetic acid.

f. Heavy Metals, Heavy elements were investigated using Atomic Absorption Spectroscopy methodology (AAS). The sample were initially put on absorption tube in the block digester and heat the specimen to 95 °C and reflux for 10 min without bubbling.

Water Quality Assessment

To determine the water quality and degree of contamination, a Water Quality Index (WQI) mathematical model was used with the World Health Organization (WHO.drinking water quality recommendation. Sub-indexes were calculated using the following expression.

$$WQI = \frac{\Sigma \mathrm{qnWn}}{\Sigma \mathrm{Wn}} \quad 2$$

$$qn = 100\frac{(\mathrm{Vn} - \mathrm{Vio})}{(\mathrm{Sn} - \mathrm{Vio})} \quad 3$$

$$Wn = \frac{k}{Sn} \quad 4$$

Where *qn* = Quality rating for the nth Water quality parameter *Vn*= Estimated value of the *nth* parameter at a given water sampling station *Sn* = Standard permissible value of the *nth* parameter. Vio = Ideal value of nth parameter in pure water (i.e., 0 for all other parameters except the parameters pH and Dissolve oxygen (7.0 and 14.6 mg/l respectively). The standard suitability of WQI values for human consumption is as stated in Table 2

Table 2: Water Quality Index and Status

S/N	Water quality index level	Water quality status
1	0-25	Excellent water quality
2	25-50	Good water quality
3	51-75	Poor water quality
4	76-100	Very poor water quality
5	>100	Unsuitable for drinking

Results

Mining Operations

In order to assess the artisanal mining activities, and the adjoining community vulnerability, the field observation revealed that the miners use local tools like digger, axes, hoes, cutlass, head-pans and buckets to carry out their operation. Since they lack electronic detectors of solid minerals, they use their experiences to spot out where to dig and transfer the dugouts to water for washing using locally made sieves placed on tilted table frame as indicated in figure 3.

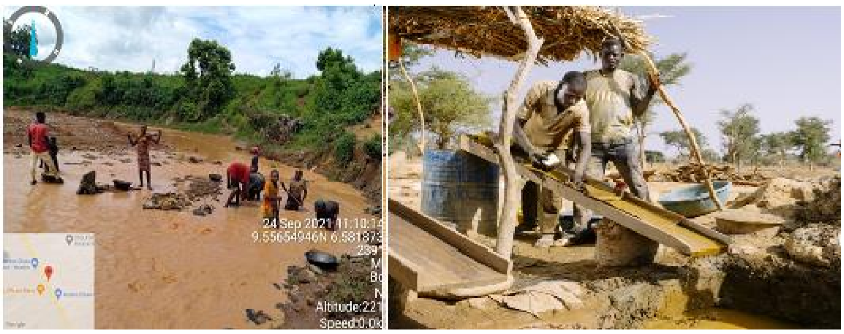

Figure 3: Gold washing separation processing in River Kpapi-Minna.

1Hydro-Chemical Parameter Analysis and Their Potential Public Health Effects

The physical observation of the river shows a muddy creamlike liquid due to the high soluble that cannot sustain any aquatic life. All the aquatic lives in the river are dead due the mining pollutants. The turbidity of the brown coloured water was viewed to be high due both the local individual miners and the Chimes gold mining company located at the upper course of the river that releases their waste water from gold mining processing directly into the same river.

Based on the laboratory analysis, the pH of the river ranges between 7.13 to 7.66 downstream with mean value of 7.41 which is lower than 8.5 indicated by WHO (2011).A pH value higher than 8.5 indicates that a significant amount of sodium bicarbonate may be present in the water which most a time affect digestive enzyme. The surface water temperature analyzed ranges between 29°C and 31°C with a mean temperature of 31.75°C which is above 23.05 WHO permissible limits for human consumption. While the electrical conductivity results are all below the WHO permissible limit of 1000. The lower course of the river has 179. The total alkalinity is highest at the upper course with 140mg/l value, and this is still below 200mg/l indicated by WHO standard.

The total water hardness of 100mg/l was recorded at the upper course of the river and is lower than the WHO permissible limit of 150mg/l. In the case of Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) in the river, sample analysed showed a mean concentration of 8.2mg/l and 5.38mg/l respectively, and these values are far below the WHO consumption limit of 200mg/l. For Chloride (Cl), the laboratory result showed mean concentrations of 46.06mg/l is also far below the 250mg/l of WHO standard. The Carbonates (CO_3^{2-}) and bicarbonates (HCO_3) analysis result gave a mean concentration of 44.07mg/l and 41.42mg/l, respectively.

Excess chloride content in water, according to Anon (1997), can cause bad taste and cause corrosion in the system when consumed. Dissolve Oxygen (DO) analyzed is below the WHO permissible limit of 10mg/l with a mean value of 6.33mg/l. This is very poor for aquatic life, hence the disappearance of water creatures

Probe for Heavy Metals Presence

Heavy metals like Zn^{2+}, Cd, Pb^{2+} and Cr^{3+} were all assessed as indicated in table 3, and results gave a mean concentration of 0.04mg/l, 0.39mg/land 0.44mg/l respectively, which are all greater than the WHO permissible limit of 0.03mg/l, 0.01mg/l and 0.05mg/l respectively. Except Zn and Cu^{2+} which have concentration of 0.56mg/l and 0.44mg/l that are below the permissible limit of 5.00mg/l and 1.00mg/l respectively.

Table 3: Hydro-chemical parameter analysis

Parameters	CC	RC	MC	UC	Mean	WHO
pH	7.66	7.13	7.38	7.45	7.41	8.5
T°C	30	29	29	31	29.75	23.05
EC μ□/cm	179	67	186	96	132.00	1000
TA mg/l	88	44	90	140	90.50	200
T/Hardness mg/l	36	12	30	100	44.50	150
Ca mg/l	10.09	3.36	10.93	8.41	8.20	200
Mg mg/l	2.41	0.6	17.69	0.8	5.38	200
Cl	12.74	11.76	12.74	147	46.06	250
HCO_3 mg/l	42.78	20.1	43.81	69.58	44.07	
CO_3 mg/l	40.21	18.89	41.18	65.41	41.42	
TDS mg/l	114.56	42.88	119.04	61.44	84.48	500
DO mg/l	6.8	5	6.5	7	6.33	10
BOD mg/l	4.2	3.6	4	5.6	4.35	
COD mg/l	110	180	60	100	112.50	
$P0_4$ mg/l	2.33	2.52	1.85	2.43	2.28	
$N0_3$ mg/l	6.25	8.44	3.72	5.56	5.99	50
Zn (mg/l)	0.4	0.48	0.74	0.6	0.56	5
Cd (mg/l)	0.02	0.02	0.04	0.06	0.04	0.03
Cu (mg/l)	0.4	0.26	0.5	0.58	0.44	1.00
Pb (mg/l)	0.48	0.36	0.3	0.4	0.39	0.01
Cr (mg/l)	0.28	0.26	0.56	0.66	0.44	0.05

Water Quality Index (WQI) of the Sample Waters

The calculated WQI indicated that the water samples are generally unsuitable for human consumption as indicated in table 4. The WQI established varies from 2045.35 from the midstream of the river Kpapi, 2709.89 from Upper stream and 30.87.46 from the downstream while in control River Chanchaga has WQI of 2331.5.

These values were found to be greater than 50 recommended for good water quality and far greater than 100 recommended for quality unsuitable for drinking. Parameters identify to have influenced the value of WQI are Cadmium, Lead and Chromium.

Table 4: Water Quality Index (WQI) of River Kpapi sample

Parameters	US(qn*w)	MS(qn*w)	DS(qn*w)	RC(qn*w)	Wn
pH	0.02	0.02	0.03	0.01	0.00
EC μ⊠/cm	0.00	0.00	0.00	0.00	0.00
TA mg/l	0.00	0.00	0.00	0.00	0.00
T/Hardness mg/l	0.00	0.00	0.00	0.00	0.00
Ca mg/l	0.00	0.00	0.00	0.00	0.00
Cl	0.00	0.00	0.00	0.00	0.00
TDS mg/l	0.00	0.00	0.00	0.00	0.00
DO mg/l	0.04	0.11	0.11	0.03	0.00
N03 mg/l	0.00	0.00	0.00	0.00	0.00
T°C	0.04	0.03	0.04	0.03	0.00
Zn (mg/l)	0.02	0.02	0.01	0.01	0.00
Cd (mg/l)	41.71	27.81	13.90	13.90	0.21
Cu (mg/l)	0.36	0.31	0.25	0.16	0.01
Pb (mg/l)	2502.53	1876.90	3003.04	2252.28	0.63
Cr (mg/l)	165.17	140.14	70.07	65.07	0.13
ΣqnWn	2709.89	2045.35	3087.46	2331.5	ΣWn = 1.00
WQI= ΣqnWn/ΣWn	**2709.89**	**2045.35**	**3087.46**	**2331.5**	

Source: Researcher's Laboratory analysis result

Impact of the Mining Activities on the Utility of River Kpapi

The analysis of the questionnaire administered revealed that there is a general loss of fishing activities on the river, although the fishing activities are secondary to their main occupation during the dry season. The irrigation farmers interviewed lamented their inability to use the water on their farmland due to the muddy nature. 50% of them said that they lost their pumping machine due to the particulate matter clogging to the machine. This has affected them negatively thereby aggravating their poverty level and vulnerability to other hazards. In the area of domestic utilization of the river, 80% of the respondents said that the river is no longer usable for any domestic activity. Many of them now spend much money on the purchase of water from water vendors.

In terms of environmental degradation, the indiscriminate excavation of farmlands adjacent to the river in search of gold has led to the development of series of badlands with impunity. Also, the river channel has more than double in width due to the continuous digging in search of solid minerals. This has greatly modified the river course where deposition activities are found at middle due to soil creep and landslide even close to the upper course of the river as illustrated in figure 4. Also the continuous dredging of the river bed for building materials like river-gravel and sand tends to rejuvenate the river erosion activities at the middle course. Deforestation of the river banks and the adjoining land areas is another environmental issue as the area are rendered derelict. The general ecological setting of the area is destabilized due to these mining activities, artificial ponds are created and erosion activities on the other hand are on the increase.

Figure 4: The nature of Rivers Kpapi and at its confluence with River Chanchaga

The Trade and Supply Chain of the ASM

The oral interview of the miners revealed that on average, the women miners made about ₦2000 (USD4.3) per day, while their male counterparts made between ₦5000 to ₦6000 (USD10.6 to USD12.7) daily. The products are sold directly or indirectly to the minor gold traders in Minna who in turn sold to the major gold traders abroad (majorly Chimes). The proceeds from mining activities are far better than farming, hence most of the unskilled able bodies within and around Minna do engage in mining activities. Also the presence of the licensed gold mining Chimes firm in the same area serves as local buyer of their proceeds. The supply chain of gold in Minna follow the same pattern elsewhere as illustrated in figure 5.The key challenging issue in the ASM is the loss of revenue to the government at all levels. They neither pay royalty nor pay tax to the government, their economic contribution globally are often neglected or unaccounted for since data on their activities are difficult to capture

Figure 5: Supply Chain and Impacts of ASGM in Minna

Discussion

This study has revealed a lot about artisanal small scale gold mining activities along River Kpapi in Minna Niger State of Nigeria. The key findings are as stated bellow:

Minna environ has some gold deposit that are not in commercial quantity per location. This does not attract investment by major miners, hence the operation of the ASMs in the area. The major problem is the gold processing methods of ASM that is crude in nature thereby impacting negatively on the ecological setting especially on River Kpapi. There are loss of aquatic lives and heavy metal pollution occurrences.

It is also observed that able bodies within and around Minna now abandon farming for mining activities because of its high remuneration comparatively. The highly polluted river is rendered useless to the communities thereby eroding their livelihood opportunities. The polluted River Kpapi as a tributary to River Chanchaga is a major concern as it serves as the major municipal water supply downstream.

Daminchi, a Chimes company that is licensed as a major gold mining firm operating in the area is also contributing to the degradation of the entire area by releasing their waste water directly into the river without any treatment. The firm has been operating there for the past 5 years. And they are said to have been engaging in cooperate community services by employing local labourers, drilling borehole and renovating community schools.

The hydro-chemical parameters analyzed indicated that Cd, Pb and Cr^{2+} whose mean concentration of 0.04mg/l, 0.39mg/l and 0.44mg/l are above WHO permissible limit of 0.03mg/l, 0.01mg/l and 0.05mg/l respectively.

Also the WQI calculated which varies from 2045.35 at middle course, 2709.89 at the upper course and 30.87.46 at the lower course, and even River Chanchaga that serve as control with WQI of 2331.5 indicated that the water are generally unsuitable for human consumption.

The periodic invasion by the government task forces does not deter the operations of the ASMs in the area. The miners who are always at alert do charge themselves with illicit drugs and even local weapons to resist their abductors, while some easily escaped when sighted by suspected force men

The Vulnerability Level of People

Mining is one of the anthropogenic activities which adversely affect the quality of water sources, especially surface water like rivers, lakes, and wetlands [52]. The mining of gold within Minna metropolis is a major challenge to the government and the populace.ASM had a negative impact on the community by destroying water bodies, farmlands and leaving open-pit death traps for children and animals. Although ASM has contributed significantly to various livelihood developments through the employment of able bodies and high earnings from the sales of solid minerals like gold, beryl, tourmaline, jewelleries amongst others (Walser, 2000; Ntori, 2017)Despite its contribution to national gold production, ASM has negatively impacted on water bodies in Nigeria and several other countries as observed by [1,22].

In relation to the impact on health, some of the inhabitants of the communities have experienced health problems possibly due to the contaminated water bodies and exposure to chemicals. Although some of the mining communities are aware of health risks associated with ASM activities due to exposure to heavy metals, yet the need to earn some income to provide for their families overshadows the health concerns. ASM is a practice thatis characterized by manual processes, hazardous working conditions, and negative human and environmental health impacts as reported by [6,19].Health issues (infections, malaria, respiratory infections, HIV and sexually transmitted diseases), and safety conditions are frequently observed among mining communities, in addition to mining specific hazards such as accidents due to subsidence and rock-falls and poisonings.

Systemic violence – Crime and violence prevail throughout the sector due to hard drugs: Hazardous mining operations jeopardize local communities and, in many cases, communities have become subject to forced relocation, threats and intimidation. The labour-intensive nature of the operation also causes the agglomeration of people with poor social backgrounds that engender all sort of social vices in mining communities. In fact, banditry is associated with artisanal miners in states like Zanfara, Kebbi, Nassarawa and Niger in Nigeria.

The state government been aware of the characteristics of ASM's vicious cycle of discovery, migration, and relative economic prosperity, which is then immediately followed by resource depletion, outmigration, and economic destitution, tries to use force to disengage them, but yield no positive result. It is also observed that after the depletion of the reserves, sites are abandoned, and the community is left open with a legacy of environmental devastation and extreme poverty. Economic hardship seems to blur peoples' realization that human existence is dependent on the environment and thus all human engagements are dependent on nature's services as also observed in the work of Hill (2010).

Access to quality water remains a topical issue for policymakers and researchers for decades, but the poor awareness and ineffective implementation and enforcement of environmental policies, in addition to seemly poor knowledge of the impact of ASM activities on water bodies contributed to the continuous pollution of water bodies across the nation. Heavy metal concentrations exceeding the WHO limit for drinking water as observed in the sampled water from River Kpapi is prevalent. Studies have shown that an average man (of 53 kg – 63kg body weight), requires about 3 litres of water in liquid and food daily to keep healthy, that is why water is regarded as one of the most indispensable substances in life amidst population pressure on the limited supply of portable water as also reported by researchers like [32, 39, 48]. In fact, Minna is one of the towns that recoded high rate of cholera outbreak in the year 2021 with recorded death.

The contamination of public water supply by industries and ASM activities is a common phenomenon in developing countries due to poor adherence to Strategic Environmental Analysis (SEA) and environmental audit. This is in line with the work of Yusuf and Sonibre (2004) on the effluents from the textile industry on the water resources in Kaduna Metropolis in northern Nigeria.

The use of Water Quality Index (WQI) in this study to evaluate the utility level of River Kpapi revealed that the river is far from been use for any domestic activities not to talk of human consumption. The index was also used by Oyeku and Eludoyin (2010) to evaluate the water qualities of surface and subsurface water of the Oluyole Industrial estate, while Mahanadet al., (2010), also carried out a preliminary assessment of the groundwater quality of the Baghdad district and observed high number of micro-organisms counts in the groundwater which they linked to the contaminations from human activities.

The afore discussion reveals that if the SDGs achievement will not be a mirage in developing countries of the world where ASM is prevalent, ASM activities must be seen as an ecological issue with layers of socioeconomic activity operating via interdependent production networks. Poverty does not understand nor regard sustainable development, therefore, the use of force in the curtailment of ASM will not and will never yield any positive result. Round table discussion will go a long way in addressing environmental quagmire as opine by researchers like [17, 34]. If the influxes of artisan miners into states are not immediately checked, it will metamorphose into something worse than banditry. Now that the people's farmlands are being turned into mining sites, there will surely be resistance from them. "If this happens, there will certainly be a breakdown of law and order. The government, therefore, need to be proactive so as not to be confronted with another ugly situation that might be worse than Boko-haram and banditry.

Conclusion

This study focused on the effect of ASM activities on River Kpapi and the adjoining settlements, it also the fact that unemployment and poverty is push factor, while the sustenance of livelihood from the sales of gold is the pull into ASM. Nigerian's artisanal and small-scale gold mining sector has development potential as observed in the year2017 when these mines in Niger State employed about 600 000 people and created opportunities for local infrastructural development.

But this prospect notwithstanding, the environmental degradation and pollution that characterise the sector is a major challenge apart from the criminals who profit from the sector at the expense of vulnerable populations. The release of heavy metal into the surface waters is inimical to human existence. The government's ban on artisanal gold mining in Zamfara State and across the region, and the deployment of soldiers to enforce the ban since April 2019 have yielded little or no results as illegal mining and its associated conflicts continue regardless. This lends credence to the existence of a powerful network of organised criminals involving local collaborators and foreign nationals in Nigeria's mining and extractive sector.

The operations of the policymakers suggest a lack of knowledge of the nexus among unemployment, poverty, mining, and disaster dynamics in artisanal mining communities across sub-Saharan Africa. Cholera outbreak is very common in state capitals that are struggling to provide wholesome water to the urbanites. There is, therefore, the need to carry out indebt research on this nexus and disseminate such result to the policymakers for a resilient national development. To address these ever increasing challenges associated with ASM in Minna and in other parts of the world, the following are hereby recommended:

The mining act should be amended to place ownership and control of mineral resources on state governments rather than the federal government. The government also need to diplomatically address the involvement of foreign nationals and corporations in organised crime through ASM in the country.

The riparian law under the Nigerian Inland Waterways authority (NIWA) should be strengthen so as to effectively manage the encroachments into the drainage basins in the country.

The government should fully embrace inclusive planning at all levels so as to secure the cooperation and commitment of the local communities in sustainable environmental development.

There is the need for more statistical data, attention, and investment in the sector so as to achieve the SDGs and develop springboard for decent work in ASM, productive employment, and economic growth.Conduct qualitative mapping exercises to identify actors in the local mining ecosystem; and design behaviour change programs on decent work which engage social actors outside the immediate mineral value chain.

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Conflict of Interest

We will like state that none of the author of this paper has any conflicting interest whatsoever, it was unanimously agreed to publish the research work.

Authors' Contributions

JJ initiated the manuscript, undertook literature reference collection, and developed the manuscript. B. supplied the secondary data on NEMA and made editorial comments on the draft manuscript.

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Data Availability Statement

The data base for the findings of this study is available from the corresponding author upon request.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official position of any affiliated agency of the authors.

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