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Review Article

Agro - Economic Damages and Health Risk Assessment of Dirty Gold Mining in Ife/Ijesa Land, Osun State

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Abstract

Practicing agriculture in a more sustainable way that enhances productivity and natural ecosystem is a task to feed the growing population. People and environment are the core aspects of sustainable production system that promote agro-ecosystem health. The practices of gold miners are extractive in nature and have enormous environmental implication, that bring about reduction in agricultural productivity due to damages done to the nature. The focus of this study is on destruction to natural ecosystem that affects agriculture and public health due to biogeochemical components of soil that is contaminated with heavy metals. Soil samples were taken purposively from eight vulnerable communities due to noticeable degradation level, analyzed for the contaminants present in the soil water with standard laboratory procedures. The results revealed wider variations in the concentration of heavy metals and other toxicants between the degraded and non-degraded forestland as control. Values of 1.07, 8.52, 42.77 and 118.71 (mg/kg) respectively for Hg, Cd, Ar, Pb in Idoijesa/Campus area. 0.64, 8.33, 32.74, 295.72 (mg/kg) for Isua while 1.33, 10.47, 21.78, 115.64 (mg/kg) obtained for Iperindo/Imogara/Odoijesa, and 2.06, 6.74, 35.75, 85.74 (mg/kg) for Ore/Iregun community. Also in Idoijesa/Campus area, Cyanide contents in degraded site has 89.64 mg/kg against 25.50 mg/kg non-degraded site, in Isua, 102.51mg/kg against 22.68 mg/kg, and 92.68 mg/kg against 21.65 mg/kg obtained for Iperindo/Imogbara/Odoijesa. The index geo-accumulation of heavy metal in the soil is significantly higher in degraded forestland. The high level of toxicants and contaminants present in the soil water is detrimental to crop yield and human food safety. A low crop growth, yield and poor health challenges are characterized with the cyanidation that takes place in grossly degraded areas for gold mining, the consequence which is high susceptibility to health challenges. However, many inhabitants in Osun state may not be saved from chronic outbreak of water born diseases if the menace continues unchecked.

Key Words: anthropogenic; biodiversity; cyanidation; ecosystem; degradation; epidemic; extractive; livelihood; mining and pollution

Introduction

Trading has been an indigenous trade mark of Ijesa people among the Yorubas in Southwest Nigeria. Though farming, still regarded as predominant occupation of Ife and Ijesa people. The fertile alluvia soil and topography of Ife/Ijesa agricultural Zone of Osun state has distinguishable quality for a sustainable production of a good number of cash crops; Cocoa, Kola nut, Oil palm, Banana and Plantain, Timber, food and vegetable crops. Others are food and arable crops such as Rice, Maize, Cocoyam, Cassava and Yam that are known for the high turn - over rate in production. Unfortunately, the available arable lands are being continually depleted by the ever increasingly human population and dirty gold mining operations that ravaged every nooks and crannies of Ife/Ijesa land. The current crisis standout clearly as the magnified impact of aggressiveness in the forest degradation becomes most important challenge of many rural communities in the study area. According to Mohammed (2022), environmental degradation is a process by which the natural environment is compromised in ways that reduce biological diversity and the general health of the environment. Sustainable land management practices coupled with land use planning is good to protect livelihoods and food security. In Ife/Ijesa environs, sources of livelihood to man have been directly and indirectly affected by environmental degradation that has left farmland and water body severely affected. Over half of available arable land in the study area is degraded from mere observation. The continuous destruction of the forest in the study area induced by aggressive gold miners has lead to migration of farmers and allows resettlement of a multitude of northern (Hausa) youths, making most vulnerable communities proliferated. This influx of expatriates and non-yoruba tribes in the zone may ignite tribal clashes in the nearest future due to massive displacement of farmers, as well as massive destruction of farmland. All the environmental factors (land, water, air and man) are depended on one another and the degradation of one factor leads to the breakdown of the other factors in nature (Ansumant, 2019). A notable river named 'Osun' in the state spanning 213km (132 miles) flows across five states in Southwest Nigeria, including Ekiti, Osun, Ogun, Oyo and Lagos.

Impact Assessment of Dirty Gold Mining Operations

Agriculture is one of the largest contributors to climate change and current agricultural practices are extractive in nature and have enormous environmental impact. The operations of both the controlled and uncontrolled gold mining across the study area is most destructive by human activities despite the fact that, gold mining is identified as booming business in Ife/Ijesa land. The dirty practices of gold miners are known to accelerate destruction of forestland and ecosystem with serious effect on global warming. Land degradation is one of the biggest threats to the livelihoods and food security of smallholder farmers in Nigeria. However, the gradual degradation of the environment as a result of dirty mining makes livelihood more susceptible to health hazard (Majekodunmi, 2014 and Emunze, 2021). The process of tearing down the forest to access rich gold deposit beneath the Earth crust pose extensive detrimental effect on the ecosystem. The result of relationship of human beings with the environment is attributed to atmospheric pollution and contamination, degradation of landscape, contamination of ground and surface water body, polluting surrounding water and streams with heavy metals such as Cadmium (Cd), Mercury (Hg), Arsenic (As), Lead (Pb), and Iron (Fe) that are dangerous to human health, these elements are potential risk to environment and public health. Olasunkanmi (2022) asserted that, many pollutants are capable of damaging genetic materials (DNA) or interfering with normal cell division that resulting to birth defects in children, cancer in adult humans as well as sperm cell deformities. Many international organizations recognized environmental degradation as one of the major threats facing the planets, since humans have no other Earth to work with, and if the environment becomes irreparably compromised it could mean the end of human existence (General Multilingual Environmental Thesaurus GMET, 2021). Cyanide (CN), Mercury (Hg), and other toxicants are freely released into the environment during dirty mining operations. It is obvious that in most places, the destruction of landscape/forestland is not only limited to one or two communities but heavily noticed in several places of Ife/Ijesa that includes: Isaobi, Ido Ijesa, Odo Ijesa, Omo Ijesa, Igangan, Isua, Igila, Ipole, Ibodi, Epe, Igbade, Ore Ijesa, Idoka, Muroko, Ijana, Mongbara, Igbogi, Igun, Itagun, Iregun, Osu, Iloba communities, Kajola, Ifewara and Opa axis of Ife community. Mining sites that spread across these communities pose more risk than the control and the children are more exposed than the adults (Bwede et al., 2021). A statement credited to Hon. Commissioner for Health, according to Daily Trust 12th August, 2022 who admitted that, Osun river have been heavily contaminated with Mercury, Lead, Cyanide and other injurious elements that are poisonous to human health. Transforming our food system and helping smallholder farmers through decisive actions of stakeholders in protecting our environment is essential if we want to end poverty in our land.

Dirty Gold Mining and Health Implications

We knew we had challenges that had to be dealt with, we are losing biodiversity faster than it can regenerate, our fertile farmland is depleting faster, we are contributing to climate change, and one in every three people may likely has water born diseases due to the high rate of contamination of water body that often used domestically. Gold mining as a destructive industry, can displace community and grossly affected food production and sustainability, contaminate natural rivers or streams with Mercury (Hg), Lead (Pb), Iron (Fe) and Cyanide endangering the health of people and ecosystem (Olasunkanmi, 2022). Ozah et al. (2021) opted that gold formation involves amalgamation and Cyanidation through the use of chemical which pose expensive detrimental effect on the ecosystem and public health. Cyanide is highly toxic, and substantially harmed agriculture land and public health risk if released into environment. During the processes, the forest is completely degraded and the underground rock is exposed to new air and water which makes the Iron (Fe) and ferrous present in the rock to undergo some chemical reactions that involves oxygen (O_2) to form Acid. However, acidic water as waste from mine site can easily seeped/spilled into soil and underground water. Acidic water is toxic to living organism just like oil spillage experienced over time in the Niger Delta states of Nigeria. Rivers and streams being the major source of water for domestic uses, become contaminated with heavy metals such as Cadmium (Cd) which causes liver disease, Arsenic (As) causes skin cancer and tumors, while Lead (Pb) and Lead poison cause disability in learning and impaired development in children. Iron makes river or streams smell of rotten egg. These metals endangering school age children and pregnancy mother. Running water are caused to carries sediments containing nutrient and heavy metal contaminants to a new location which result to eutrophication and pollution of delicate ecosystems (Bing et al. 2013). According to Olasunkanmi (2022), in March 2010 an epidemic of lead poisoning was discovered in Zamfara state, and by April 2010 death and illness became prevalent, and hundreds of children under the age of 5 years were at the risk of death. Genotoxicants are products of certain chemical reactions just like heavy metals, resulting to birth defect where children with different kinds of malfunctions and abnormalities are born. The high rate of malfunctions in children's parts of Northern particularly Zamfara state according to Olasunkanmi (2022) is suspected to be the effect of over 10% lead content introduced into the processing Stream in 2010. Also in 2011, an estimated 400 children in Zamfara state died from lead poisoning in Bagega community and thousands more were found to have excess lead in their blood stream. The most health dangerous of heavy metal toxic is that once spillage occurs it becomes very difficult to stop leading to an increase level of acidity in the water body and can easily destroy aquatic life for generations. The constant released of cyanide into environment as a result of environmental degradation will push more than 2 million people in Osun state into poverty and serious health challenge because the process of cyanidation resulted in major fish kills, contaminated drinking water supplies and harmed agriculture land.

Statement of the Problem

In recent years, gold mining activities across Ife/Ijesa zone has been deploring, given that both controlled and uncontrolled miners and the general public has not consider the danger of this anti-environment and indiscriminate tearing of forestland. This unfriendly act has rather exposed inhabitants of the areas to series of health challenges. Is there any company with all applicable environmental laws, regulations and other obligations as established in the certified environmental impact assessment? In spite of the challenges, only one company has been identified in Osun state to have devoted appropriate concern on management of waste from mine site. The acidic water and other heavy metals as waste from mine sites can easily seeped/spilled into soil and underground water which is toxic to living organisms just like oil spillage experienced overtime in Ogoni land, where families were found drinking water from benzene contaminated well water (Olasunkanmi, 2022). Therefore, many dirty gold miners are out there handling the issue of gold ore and their waste products unprofessionally which makes not only many vulnerable communities highly susceptible to health hazards but the entire citizens of Osun state in the future. In the consequence, there is likelihood of forest destructive outstrip the existence food supply in the study area, which have negative implications on the entire population. A statement credited to the Executive Director of a Civil Society Organization (Urban Alert) Anthony Adejuwon revealed that, Geographical Information Analysis and Laboratory tests carried out by the Organization established the cause of Osun river pollution and affirmed the presence of heavy metals in the water. He further blamed the harmful contaminated of Osun river on the activities of gold mining which has put the lives of over 2 million residents of Osun state in danger (Adejuwon, 2022). (Olasunkanmi, 2022) attributed Osun river pollution to the activities of artisanal gold miners and other sources such as agricultural land use, anthropogenic activities, and industrialization. An assessment into mining activities across Ife/Ijesa zone has revealed serious threats to human health by contamination of water body, air and soil, aquatic ecosystem in the vulnerable communities is equally threatened and the resultant effects of all these, is poor and low agricultural production. It is therefore envisaged that gold mining activities in Osun state will increase geometrically while food production (Farming) increases arithmetically in progression. Who is guilty of this? There is insinuation that, most small-scale gold miners and their dirty gold practices have been common along the banks of rivers in the vulnerable communities and as a result, a wide range of rivers and hectares of rain forest are destroyed leading to a reduced level of individual participation in agriculture and food production (Adeoye, 2016). Heavy metal excessive levels are detrimental to plant growth just like Hg, Cd and Pb were reported to reduce plant growth in maize crop (Ghani, 2010). Though gold mining is booming in this part of the country; due to high gold deposit and the involvement of people in gold trading, makes agricultural labour more expensive for agricultural activities. The magnified effect on food and agricultural production is very devastating as agricultural produce from Ife/Ijesa zone would be continually reduced.

Methodology

To ascertain chemical elements responsible for contamination of soil water body as a result of continual forest degradation that affects agricultural land use, bulk soil sample were collected purposively from eight vulnerable communities. Eight soil samples from 8 communities under different degrees of forestland degradation were collected at a depth of 0 - 30 cm for degraded and non-degraded as control forestland respectively from vulnerable communities that includes: Idoijesa/Campus area, Isua, Iperindo/Imogbara/Odoijesa, and Ore/Iregun communities. The heavy metals in the samples responsible for contamination were determined by atomic absorption Spectrophotometer such as lead, mercury, arsenic, iron and cadmium, as well as cyanide (mg/kg). These were derived from each soil sampled from the laboratory analysis.

Quantification and Sample Digest

$$\text{Concentration (mg/kg)} = \frac{\text{Concentration (mg/L)} \times V}{W}$$

where V = Final volume (50 ml) of solution, and M = Initial weight (0.5 g) of sample measured.

Wet digestion method was used for digestion of the soil samples. About 0.5 g of each sample was ground and accurately weighed into digestion tube. 6 ml aqua regia and 1.5 ml H_2O_2 added into the digestion tube which was then placed on digestive furnance (model: KDN - 20c, China) and heated at temperature of 180^{o}c for 3 hours. All the digests were cooled and filtered through Whateman No. 24 filter paper and diluted to 50 ml by double distilled water. Each sample was digested in replicates of five and transferred to acid - washed stoppered glass bottle. The digested samples were determined for the concentrations of heavy metals using flam atomic absorption spectrophotometer. Final concentrations of the metals in the soil samples were calculated adopted (Uwah et al, 2012).

Sampling and Analysis of Cyanide

Whaeman No. 1 paper (8 x 1 cm) each were dipped into alkaline picrate solution and drained free of excess liquid. The filter paper strips were prepared under identical conditions. The samples (10 g/sample) were loaded into glass bottles and acidified with 5 ml of hot 20 % HCL solution and heated at 80^{o}c. The bottles were sealed with 3 picrate impreginated strips suspended above the acidified samples and incubated at room temperature (28 ± 2^{o}c) for 24 hours. The red coloured picrate paper strips were removed and rinsed in 5 ml of 50 % ethanol solution for 30 minutes, and absorbance of the solution measured at 510 nm using spectrumlab (23A Spectrophotometer). Cyanide levels of the samples were extrapolated from the standard curve (Nwokoro et al, 2009). According to Enurotu and Onianwa (2017), the extent of each heavy metal in the soil and contamination level was measured using the index of geo - accumulation (I_{geo}) of metals in soil.

$$I_{geo} = \log_2 \left[\frac{Cn}{1.5 \times \beta n} \right]$$

Where: Cn = Concentration of the examined metal in the soil, βn = geochemical background of the same metal 1.5 = is the background matrix correction factor.

Results

Heavy metal contents of soil sample of the degraded and non-degraded forestland shown in the Tables 1 and 2. The result in Table 1 revealed the concentration levels of the heavy metals in degraded forestland in order of magnitude of concentration:

Idoijesa/Campus area - Hg (1.07mg/kg) > Cd (8.52mg/kg) > Ar (42.77mg/kg) > Pb (118.71mg/kg) > Fe (2391.26mg/kg)

Isua- Hg (0.64mg/kg) > Cd (8.33mg/kg) > Ar (32.74mg/kg) > Pb (295.72mg/kg) > Fe (2103.93mg/kg)

Iperindo/Imogbara/Odoijesa - Hg (1.33mg/kg) > Cd (10.47mg/kg) > Ar (21.78mg/kg) > Pb (115.64mg/kg) > Fe (1755.23mg/kg)

Ore/Iregun - Hg (2.06mg/kg) > Cd (6.74mg/kg) > Ar (35.75mg/kg) > Pb (85.74mg/kg) > Fe (1505.83mg/kg)

Communities	Pb	Ar	Hg	Fe	Cd	CN
Idoijesa/Campus area	118.94	42.94	1.05	2394.31	8.54	89.84
	118.44	42.44	1.11	2391.24	8.55	89.55
	118.75	42.94	1.04	2388.23	8.48	89.53
$\bar{x}$	118.71	42.77	1.07	2391.26	8.52	89.64
I_{geo}	(0.94)	(1.03)	(0.33)	(0.96)	(0.88)	
Isua	295.99	32.85	0.64	2104.31	8.24	102.55
	295.42	32.55	0.62	2105.14	8.31	102.43
	295.74	32.83	0.67	2102.33	8.44	102.54
$\bar{x}$	295.72	32.74	0.64	2103.93	8.33	102.51
I_{geo}	(0.88)	(1.28)	(0.31)	(0.85)	(0.66)	
Iperindo/Imogbara/Odoijesa						
	115.94	21.94	1.34	1754.24	10.44	92.85
	115.75	21.77	1.32	1755.13	10.43	92.55
	115.22	21.64	1.32	1756.33	10.55	92.65
$\bar{x}$	115.64	21.78	1.33	1755.23	10.47	92.68
I_{geo}	(1.04)	(1.21)	(0.64)	(0.88)	(0.75)	
Ore/Iregun	85.93	35.85	2.03	1500.95	6.84	114.55
	85.44	35.55	2.09	1505.33	6.44	114.38
	85.84	35.84	2.05	1511.19	6.94	114.39
$\bar{x}$	85.74	35.75	2.06	1505.83	6.74	114.44
I_{geo}	(0.94)	(0.75)	(0.56)	(0.66)	(0.92)	

Table 1: Biogeochemical Contents of Soil (mg/kg) in the Degraded Forestland

Communities	Pb	Ar	Hg	Fe	Cd	CN
Idoijesa/Campus area	29.84	2.84	0.54	1004.83	1.65	25.56
	29.44	2.35	0.58	1004.99	1.72	25.44
	29.64	2.65	0.55	1002.54	1.62	25.49
$\bar{x}$	29.64	2.61	0.56	1004.12	1.66	25.50
I_{geo}	(0.94)	(1.03)	(0.33)	(0.96)	(0.88)	
Isua	103.94	4.82	0.31	1235.84	2.84	22.95
	103.44	4.33	0.34	1238.44	2.44	22.56
	103.73	4.83	0.33	123.83	2.95	22.52
$\bar{x}$	103.70	4.66	0.33	1235.37	2.74	22.68
I_{geo}	(0.03)	(0.13)	(0.11)	(0.44)	(0.12)	
Iperindo/Imogbara/Odoijesa						
	74.83	1.94	0.85	895.44	2.45	21.95
	74.33	1.88	0.82	895.72	2.44	21.44
	74.63	1.92	0.83	891.88	2.41	21.56
$\bar{x}$	74.60	1.91	0.83	894.35	2.43	21.65
I_{geo}	(0.21)	(0.25)	(0.09)	(0.17)	(0.31)	
Ore/Iregun	26.94	2.10	1.04	238.45	0.54	41.55
	26.55	2.11	1.01	235.22	0.66	41.04
	26.84	2.16	0.99	231.95	0.62	40.95
$\bar{x}$	26.78	2.12	1.01	235.21	0.61	41.18
I_{geo}	(0.11)	(0.11)	(0.18)	(0.13)	(0.12)	

CN = Cyanide

Table 2: Biogeochemical Contents (mg/kg) of the Non-degraded Forestland

Figures in parentheses are Index of Geo-accumulation (I_{geo}) of metals in soil

The maximum value for each metal followed in the same order and the results indicated that all the heavy metals are high in contents, meaning that the soil in the study area contained heavy metal contents (mg/kg) which brings about dangerous pollution of soil to justify (Makino et al. 2010).

However, the heavy metal contents of soil collected from non-degraded sites shown in Table 2 and the findings are:

Idoijesa/Campus area - Hg (0.56mg/kg) > Cd (1.66mg/kg) > Ar (2.61mg/kg) > Pb (29.64mg/kg) > Fe (1004.12mg/kg)

Isua- Hg (0.33mg/kg) > Cd (2.74mg/kg) > Ar (4.66mg/kg) > Pb (103.70mg/kg) > Fe (1235.37mg/kg)

Iperindo/Imogbara/Odoijesa - Hg (0.83mg/kg) > Cd (2.43mg/kg) > Ar (1.91mg/kg) > Pb (74.60mg/kg) > Fe (894.35mg/kg)

Ore/Iregun - Ca (0.61mg/kg) > Hg (1.01mg/kg) > Ar (2.12mg/kg) > Pb (26.78mg/kg) > Fe (235.21mg/kg)

The maximum value of each metal followed in the same order of magnitude of concentration except only for Ore/Iregun communities where Hg (0.68mg/kg) has a higher maximum value than Cd (1.01mg/kg). The findings indicated that all geochemical components of metals were far lower when compare with values in degraded forestland. Values of metals in degraded site were outrageous and may not likely to fall within the United States Environmental Protection Agency (USEPA) regulated limits, for the application of industrial waste to agriculture. Heavy concentration of metals especially Pb and Cd can result to phytotoxic, erosion and death of human being through crop consumption. An increase in contents of Cd in food crops could be of health concern if such crops are ingested.

Discussion

Geometrically, increase in heavy metal content (mg/kg) was observed between the degraded and non-degraded forestland meaning that if the pace of increment continues it may lead to high toxicity of heavy metals. However, the accumulation of toxicants in farmland could lead to contamination of agricultural soil. Once the soil is contaminated it will not only affect the rapid growth of crops and yields, but poses a severe threat to living organisms. Considering the baseline, a contaminant can be regarded as a pollutant when the observed content of the contaminant is high enough to harm living organisms. The baseline of the United States Environmental Protection Agency (USEPA, 1993); is adopted for the interpretation for acceptable limits, Arsenic (0.11mg/kg), Cadmium (0.48mg/kg), Mercury (1.00mg/kg), Lead (200mg/kg) and Cyanide (10mg/kg). In order of magnitude concentration of heavy metals (mg/kg) in degraded forestland is too high and an indication that agricultural production will suffer from poor plant growth and crop yield. There is every tendency that excessive levels of heavy metals in the study areas is dentrimental to plant growth just like Hg, Cd, and Pb were proved to have reduced plant growth in maize farm (Ghani, 2110). According to Moustakes et al. (1994) high concentration of heavy metals in farmland, brings oxidative stress, damage cell tissues, and hamper photosynthetic activities in plants. Cyanide is highly toxic and can result to substantial environmental impacts and public health risk if released into environment. Specifically, cyanide spillage affects biological, physical and chemical status of the soil by inhibiting plant respiration, nutrition absorption, reducing soil pH, bacteria and fungi count in the soil (Smah et al, 2021). The presence of heavy metals, cyanide and anthropogenic wastes in the study areas will definitely bring about poor and low agricultural productivities, and the health of inhabitants is in serious danger.

Conclusion

Based on the spot observation and laboratory test analysis, this paper concludes that gold mining is a destructive industry which grossly impaired human health and retard agricultural activities leading to a poor and low food production system. Hence, environmental degradation is an indictment to everyone without exception in the study area.

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Ido-Ijesa

Iregun/Ore-Ijesa axis

Imogbara /Odo/Iperindo axis

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