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Implication of Mining to Health in Maiganga Coal Mine, Gombe State, Nigeria

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***Abstract:** Operations of mining are large industrial scale in nature, with significant environmental impacts. The mining industry generates and produces wastes containing high concentrations of metals and metalloids which are highly toxic and destructive to the immediate landscape and environment. In addition, the continued use of the traditional methods of mining intensifies the emission of toxic and products that are not friendly to the ecosystem.. Even regulated and controlled mining sites release toxins into the surrounding environment. While mining has prospects and benefits to the economy, both in terms of its own economic impact and the value to other industries of its product, it almost always has adverse environmental impacts and eventually health impacts. There are numerous ways in which mines impact the health of nearby environments and local communities. Mining involves some generally standard processes and practices. This paper considers the effects and harm done to living things around the mine location. By understanding mining's threats to health and long-term well-being and by taking precautions to reduce harm in all mines, miners and other people in mining communities can better protect their health and improve their lives. This research will address questions like: which are the toxic substances causing health problems in Maiganga Coal Mine? What is the challenging impact of toxic substances in Maiganga coal Mine?*

***Keywords:** Maiganga, Health, Mining, Toxic, Consequence, Reclamation*

I. INTRODUCTION

Mines have some positive impact, such as employment opportunity and infrastructural development but their impact on health is negative, which can occur through both environmental and occupational health channels. The people closure to the mine is associated with higher incidence of waterborne diseases, typhoid and fever – most likely associated with changes in water quality and distribution, whereas employment in the mines is clearly associated with acute respiratory infections as might be expected from working in dusty conditions with no protection (Priyambada P. and Dr. Sudhakar P., 2014). In North America, for example, the mining industry employs an estimated one million people and the industry in 1998 was estimated to be worth way more than $70 billion. In countries such as Peru and South Africa, mining activities contribute more than 11% and 27.4% of GDP respectively.

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Nonetheless, the mining sector has a lot of negative health and environmental impacts and sometimes the health cost of the mining activities can outweigh its benefits. Mining uses large amounts of energy requiring the transport and the combustion of high volumes of fossil fuels. Mining operations consume 7-10 percent of the world's energy production annually. Burning fossil fuels releases toxic substances such as mercury and polycyclic aromatic hydrocarbons (PAHs) into the atmosphere. Because of the remote nature of mining sites, the burning of fossil fuels typically takes place on site. In addition to significant energy needs, most mining requires massive amounts of water. Mining operations are also noisy and noise produced by human activities reduces the populations of animals nearby. Animals ranging from birds to deer are known to avoid areas with significant amounts of noise produced by people. The noise associated with mining operations could potentially have an adverse impact on subsistence hunting, making it more difficult for communities that rely on a subsistence diet to ensure livelihood. The EPA determined that noisy activity at the mine and transport road contributed to a decrease in farm harvest. According to Ademu, Obaje, Mohammed and Kumo (2020), there is no significant variation in ambient air quality parameters in the different locations worked on and the standards recommended by Federal Ministry of Environment. However, the values of particulate matter PM10 (coarse) at the coalmine and also at the Maiganga community, 359.00 µg/m3, and 358.00 µg/m3 respectively are higher than the value of 250µg/m3 set as safety limit by Federal Ministry of Environment which suggests pollution.

II. HEALTH EFFECT OF SOME MINERALS

A. TOXIC METALS AND ITS HEALTH CONSEQUENCES

Mining activities releases toxic substances from the earth. Ore deposits are often associated with arsenic, lead, mercury and other toxic metals. These toxic metals often find their way into the air, water and food chains once they are released from underground rock formations during mining.

Table 1: Some Toxic Metals Caused By Mining and their Health Consequences

S/NO.	TOXIC METALS	HEALTH CONSEQUENCES
1	Mercury	It affects the central and peripheral nervous systems and causes personality changes, deafness, changes in vision, loss of muscle coordination or tremors, loss of sensation, and difficulties with memory.
2	Arsenic	It causes cancer of the skin, liver, bladder and lungs; as well as birth defects and still births.
3	Lead	It destroys brain and nerve cells. It causes abnormal/reduced physical/mental growth and lower intelligence, as well as deficit hyperactivity disorder and antisocial behaviour.
4	Antimony	It causes pneumoconiosis (lung damage), lung cancer, alterations in pulmonary function, chronic bronchitis, chronic emphysema, pleural adhesions, increased blood pressure, altered EKG readings and heart muscle damage.
5	Cadmium	It causes kidney, lung, and intestinal damage, as well as abnormal foetal metabolism, low foetal weight and skeletal deformations, low birth weight and reduced sperm count
6	Cyanide	It causes breathing difficulties, chest pain, vomiting, blood changes, headaches, and enlargement of the thyroid gland and leads to coma and death.

Table 2: Effects of Mining on The Environment

S/No.		EFFECTS OF MINING ON THE ENVIRONMENT
1	Water Resources	It affects drinking water and pollutes surface and groundwater, especially in rural areas dependent on ground water wells or potable surface waters.
2	Society and Traditional Culture	B. It contaminates traditional food sources, its food gathering and local plants with heavy metals toxins (Causes and Effects of Mining on Human Health and the Environment. 2012).
3	Agriculture	Tailing dams and mine dumps become eroded and render farming or grazing land unproductive
4	Biodiversity	It deteriorate farming activities and causes animals to lose their habitats
5	Aquatic Animals	It causes poisoning of the marine animals and modifies the pH of the plants that the aquatic animals feed on.
6	Vegetation Cover	It causes deforestation, clogging of the leaf surfaces of plants by metallic-laden dust particles which modify their pH, hereby causing unavailability of nutrients.

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III. LITERATURE REVIEW

Maiganga Coal may be dull, dark brown to black, and soft and crumbly at the lower end of the range, to bright, black, hard, and relatively strong at the upper end (Onoduku, 2014).

Activated carbon is an amorphous form of carbon that has been specially treated to acquire

improved adsorptive properties such as surface area, pore volume, pore size and pore size

distribution (Umar et al, 2020). Maiganga coalfield which is currently receiving considerable attention from coal stakeholders has deposit which is also a prime target for power generation by the Nigerian government (Matthew et al, 2017).Resettlement takes place when major development projects, which are important elements of development, force people who have lived in a region for a long time to leave their homes, and their place in society, economic and agricultural activities, relationships and opportunities and any other immovable properties, to live in other places (Dogan et al, 1991). The problems caused by mining activities are land degradation, disposal of over burden, deforestation, washing rejects, subsidence, water pollution due to wash off, discharge of mine water, acid mine drainage, coal washing operation, air pollution due to release of gases and dust, noise pollution, mine fires, damage to forest flora and fauna, wildlife habitat destruction and occupational health hazards (Singh et. al,. 2011). By developing clean coal technologies, Nigeria will be able to use her considerable coal resources better and reduce the emissions of harmful substances associated with coal mining, thereby make a significant contribution to Nigeria's energy needs (Denloye and Akinola, 2017). Both the mineworkers and the Maiganga people that live in the area are daily exposed to hazardous materials with the resultant health and environmental risks and effects which are pneumoconiosis, silicosis, Acid Mine Drainage (AMD), water pollution , high ash and moisture contents (Chibuisi,2017). With the exception of Ni in Maiganga Coal Mine and farmland areas which exceeded the permissible limit value 15mg/kg, the other heavy metals levels were within permissible limit set by WHO in 2007 (Babayo, Santuraki and Adebayo, 2018). Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere (Tawari and Abowei, 2012). Mining of solid minerals from the earth's surface is another means in which air gets polluted through land site clearing, drilling, blasting, hauling, collection, and transportation (Abaje, Bello and Ahmad, 2020). The proven reserves of coal so far in the country are 639 million tonnes while the inferred reserves are about 2.75 billion tonnes,consisting approximately of 49% subbituminous, 39% bituminous, and 12% lignitic coals (The Presidency, 2003). According to the WHO's suggestion, the health risk of ^{226}Ra in drinking water is mainly concerned with the effective dose less than chemical radio-toxicity (World Health Organization,2004).

IV. MATERIAL AND METHODS

SCOPE OF THIS STUDY

This study targets the toxicity of some substances and their causes in Maiganga Coal Mine. It sought to establish and propose reclamation as best possible option using literature reviews of metallic particles in mining most like found in Maiganga Coal Mine.

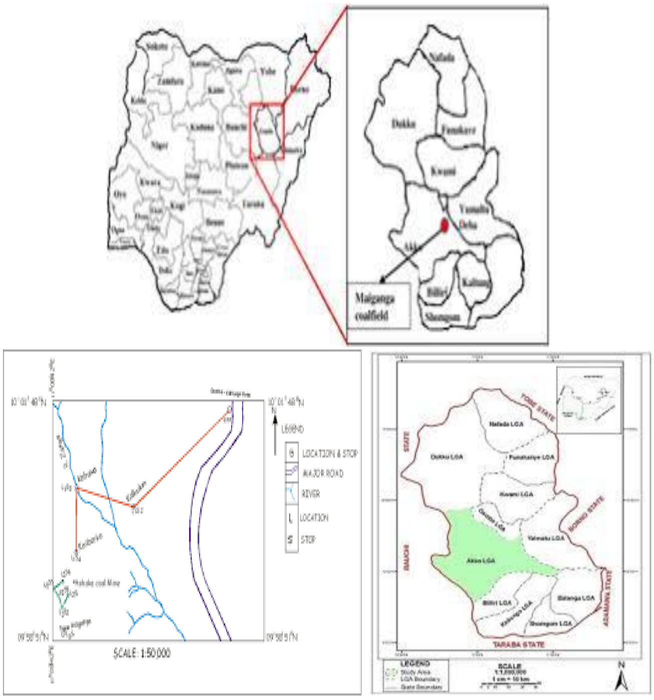

Figure 1: Locational Map of Maiganga Coal Mine (Source: Matthew et al, 2016, Chibuisi, 2017 and Oruonye, Iliya and Ahmed, 2016) - journals.plos.org and pubs.sciepub.com

GEOLOGY OF MAIGANGA COAL MINE

Maiganga is a community located between Latitude 10° 02' to 10°05° and Longitude 11°06' to 11°08' in Akko Local Government Area of Gombe state, North-East (Matthew et al, 2016).

It is situated at 8km off Gombe-Yola road immeeediately after Kumo town (Onoduku, 2014). The study area, Maiganga community covers an area of about 20,129.47 Acres (48.16

Km^2) (Oruonye et al., 2016). Rainfall ranges between 850 to 1000mm3 and the rainy season last between 5 to 6 months. Temperature is relatively high for most part of the year. Geologically the study area is developed on basement complex rocks. The vegetation consists of sparse trees, scrubs and open grasses. Some of the tree species in the area include butyrospermum, Mumparadoxum. Tamanrindus indica, Pakia biglobosa, Balanite aegyptiaca, Afzelia Africana, fabia, albida.

The population of the study area consists of ethnic groups such as Jukun, Fulani and Tangale the dominant group among others. The population of Maiganga village based on the 2006 population census is about 3,520 people. The economic activity of the study area is farming which includes the cultivation of different crops such as maize, millet, guinea corn, groundnut, sorghum and groundnut (**Abdulsalam M., Oruonye, E.D., Ahmed Y.M. and Mbaya L., 2016).** The maiganga coal is hosted within the Maastrichtian Gombe formation located at the Northern Benue Trough of North-East Nigeria. It is a low-rank subbituminous coal (Matthew etal, 2016).It lies within the Gombe sandstone, adjacent to and above the Pidiga formation (Obaje, 2009). It was laid down in non-marine possibly delta plane condition of upper continental sequenceof estuarine and deltaic sandstones, siltstone and iron stone which overlie the sediments of the Zambuk ridge and the Chad Basinin the western part of the region(Offodile, 1976). It was a mine owned by the management of Maiganga Coal Mining Company, but cultivated by individual; presently managed by Lafarge Africa Plc for tree planting. Maiganga Coal Mine has an estimated proven Coal reserve of 4.5 million tons at the site (Maina, Kachalla, and Comfort, 2016).

This study is helpful to reveal the causes of health challenges caused by mining and providing clues, especially reclamation and resettlement to sustain man and preserve his environment. Its significance is to address the health implication caused by metallic toxins in Maiganga Coal Mine. This will add its contribution to sustainable policy-making at the industry level. This work is however limited by resource constraints, proximity, time and insufficient information from the internet. Researchers chose to study implication of mining on health in Maiganga Coal as it impacts on man and his environment.

Figure 2: Gological Map of Maiganga Coal Mine (Source: pubs.sciepub.com, researchgate.net and semanticscholar.org)

DRAINAGE SYSTEM IN MAIGANGA

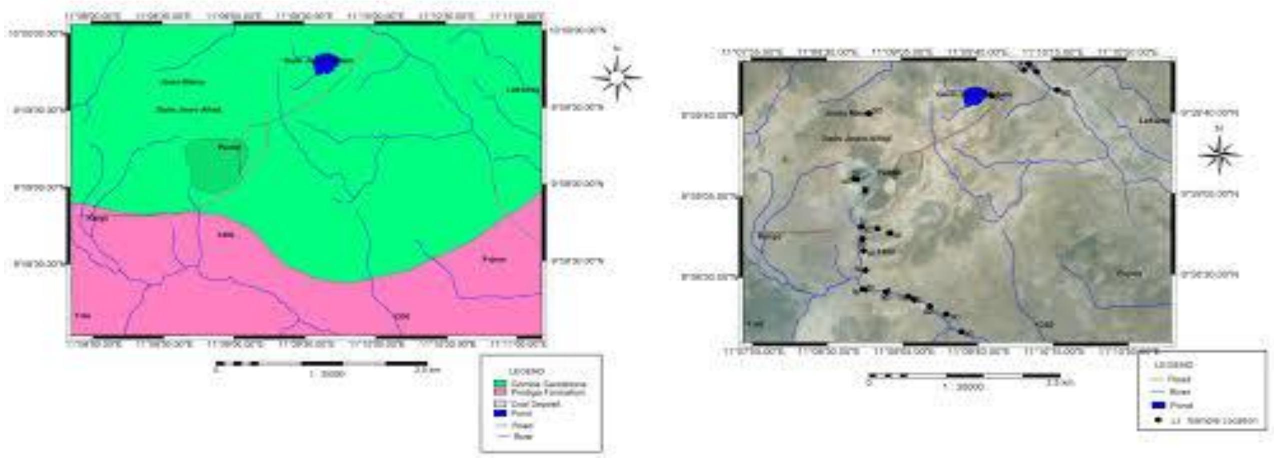

Fig. 3: Drainage in Maiganaga Coal Mine (Source: journals.indexcorpernicus.com)

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V. DATA AND METHODOLOGY

DATA REVIEW AND ANALYSIS

Table 3: Characteristics of Maiganga Coal Mine (Source: Nyakuma, 2015)

Carbon	Hydrogen	Nitrogen	Sulphur	Oxygen	Ash	Fixed Carbon	Volatile Matter	Mineral Matter	Moisture	Heating Value
61.69%	4.42%	1.07%	0.39%	32.16%	21.05%	22.52%	51.16%	22.95%	5.28%	23.7MJ/Kg

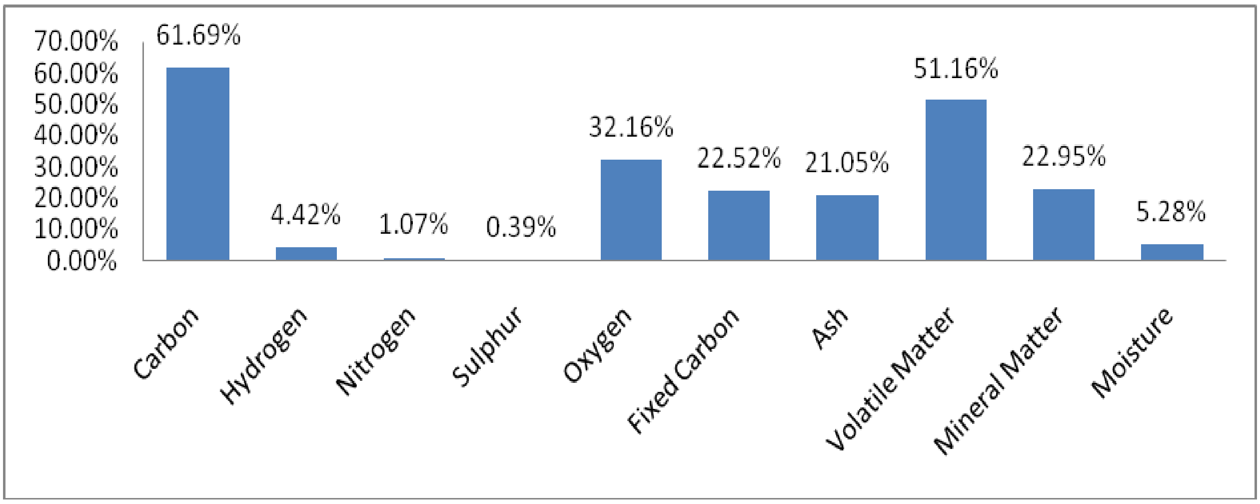

Figure 4: Bar Graph showing the property of Maiganga Coal Mine

On Maiganga, mean activity values of 11.90 ± 3.0, 17.72 ± 3.60 and 70.44 ± 20.4 Bq/Kg were obtained for Radon (^{226}Ra), Thorium (^{232}Th) and Potassium (^{40}K) respectively (Kolo, Amin, Khandaker and Abdullah, 2017).

Table 4: Representing radionuclide Metallic Concentration on Maiganga Coal Samples (Source: Kolo, Amin, Khandaker and Abdullah, 2017)

Radionuclide Concentration	
Radionuclide	**Mean Value of Concentration (Bq/Kg)**
Radon (^{226}Ra)	11.90 ± 3.0
Thorium (^{232}Th)	17.72 ± 3.60
Potassium (^{40}K)	70.44 ± 20.4

Table 5: Re-computing and re-organizing the radionuclide Concentration

Radionuclide Concentration		
Radionuclide	**Mean Value of Concentration (Bq/Kg)**	
Radon (^{226}Ra)	14.9	8.9
Thorium (^{232}Th)	21.32	50.04
Potassium (^{40}K)	90.84	50.04

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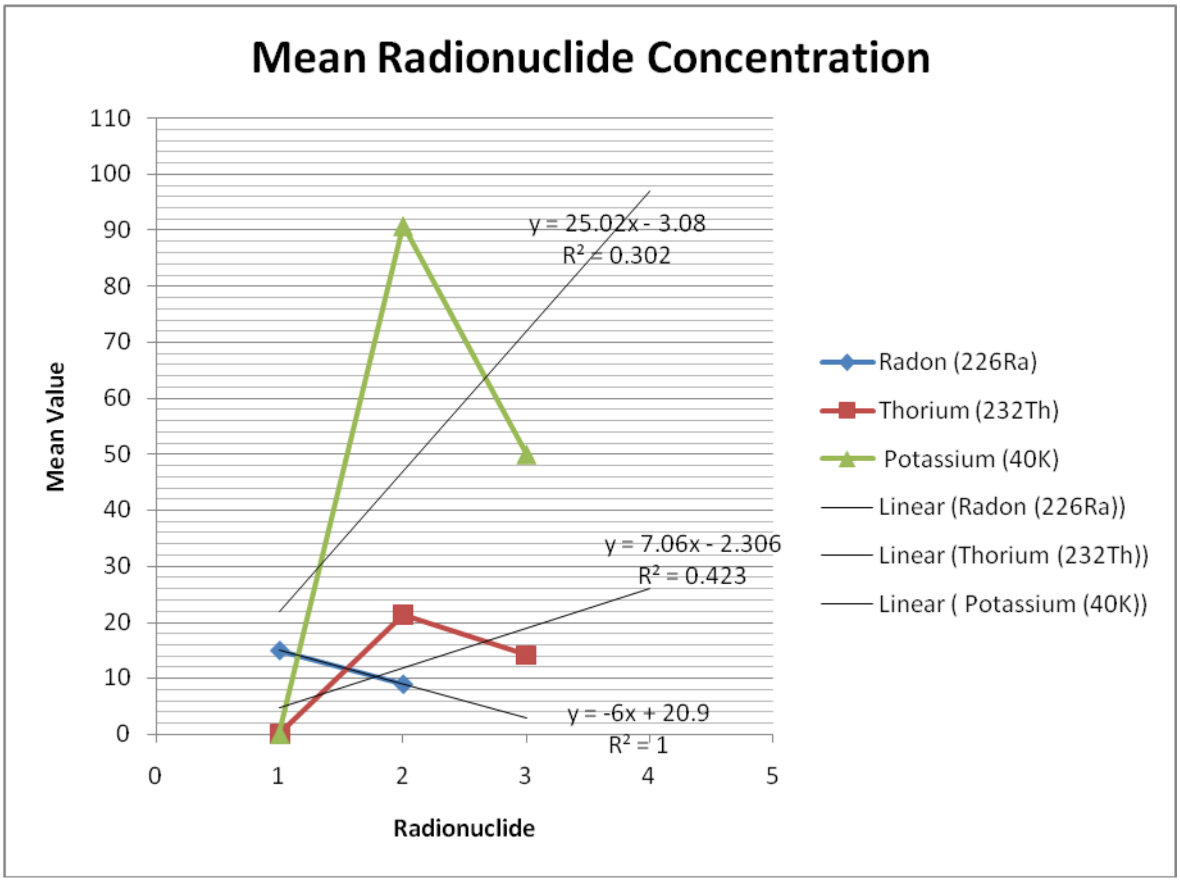

Figure 5: Graph from Re-computing and re-organizing the radionuclide Concentration

On Maiganga, Adamu, Mubarak, Mahmoud (2014) used Atomic Absorption Spectrophotometer (AAS) to read the heavy metals concentration in the water samples in borehole, hand dug well and the mine drain water around the coal mine area. This was juxtaposed with the expected standard of National Environmental Standards and Regulations Enforcement Agency - NESREA (2011).

Table 6: Adamu, Mubarak, Mahmoud (2014) comparison between Atomic Absorption Spectrophotometer (AAS) and Laboratory analysis (NESREA Standard 2011) of Maiganga Water Samples.

PARAMETERS/UNITS	WATER SAMPLES			NESREA STANDARD
	MINE DRAIN	BOREHOLE	HAND DUG WELL	
TEMPERATURE °C	26.5	26.4	26.5	-
pH	6.9	7	7.1	6.5-8.5
COLOUR, P.t Co	8	332	45	15
APPERANCE	Obj	Obj	Obj	Unobj
TASTE	Unobj	Unobj	Unobj	Unobj
ODOUR	Unobj	Unobj	Unobj	Unobj
TURBIDITY, NTU	23	33	12	5
ELECTRICAL CONDUCTIVITY, Us/cm	434	155	300	1000
TOTAL DISSOLVE SOLIDS, mg/l	217	76.9	149	500
T. HARDNESS, mg/l	248	50	120	150

(**Source:** NESREA Standard 2011 and laboratory analysis)

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Table 7: Chemical Analysis of the Water in Maiganga

PARAMETERS (mg/l)	WATER SAMPLES			NESREA STANDARD
	MINE DRAIN	BOREHOLE	HAND DUG WELL	
Calcium	143	32	74	70
Magnesium	21.04	1.45	2.23	0.20
Iron	4.30	12.02	1.4	0.03
Copper	0.06	0.12	0.12	1.0
Fluoride	0.21	1.42	1.02	1.0
Zinc	0.54	0.50	0.52	421
Nitrate	155	75	143	50
Nitrite	1.02	1.43	1.05	0.02
Manganese	0.00	1.24	0.00	0.05
Lead	0.513	0.502	0.511	164
Sulphate	50	20	36	100
Chloride	9	14	21	250
Chromium	0.00	5.33	0.00	0.05
Barium	0.00	0.54	0.00	0.005
Cadmium	0.45	0.299	0.011	3
Phosphate	0.00	0.00	0.00	10
Cyanide	0.032	0.73	0.004	0.001

(**Source:** NESREA standard for drinking water quality, 2011 and laboratory analysis)

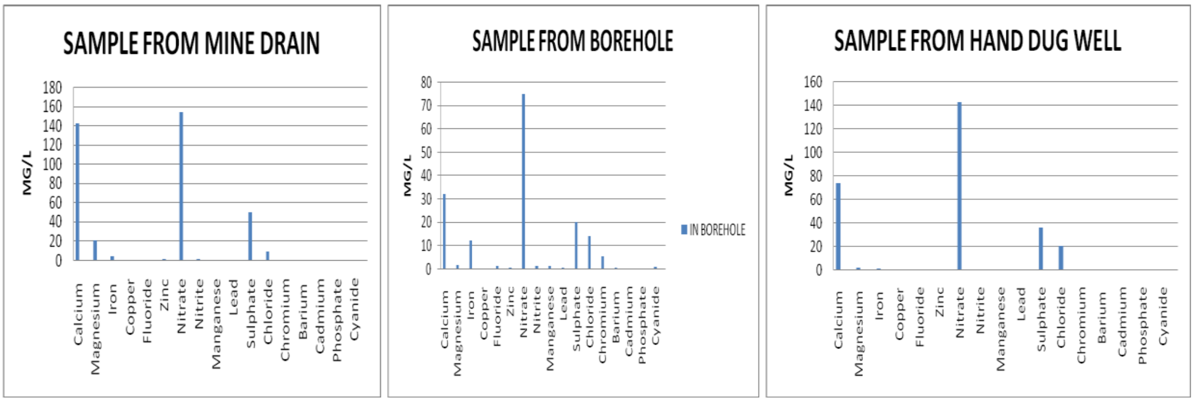

Figure 6: Graphs showing the chemical analysis of the samples from mine drain, borehole and dug well in Maiganaga

SOLUTIONS TO CHALLENGE CAUSED BY MINING IN MAIGANGA COAL MINE

The solution to the abandoned Maiganga Coal mine:

A. RECLAMATION IN MAIGANGA

Reclamation:

This is the recovery of bad or wasted land, and turning it into a useful or beneficial purpose, like residential, social, commercial and industrial.

Importance of Reclamation

- It increases land area
- It encourages agricultural and forestry activities
- It may be used for grazing by ruminant animals such as sheep, cattle, and goats.
- It enhances aesthetic value (Oruonye, Iliya and Ahmed, 2016).

Methods of Land Reclamation

- Re-vegetation: Is the planned process of planting several covers of vegetation over an abandoned mined area.

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- Landscaping: These involve constructing drainages; effective sediment control system, doing tilling, ploughing and harrowing operations; covering/burying lying wastes of rocks, tailings.
- Soil amelioration: It involves treatment of surface soil with mulches and the application of gypsum to neutralize alkalinity or lime to neutralize soil acidity.
- Soil Replacement or backfilling: This involves returning packed or stockpiled top-soil that was initially removed and separated before mining commenced its operation to abandoned mined area.

Figure 7: Reclamation in Maiganaga Coal Mine (Source: Oruonye, Iliya and Ahmed, 2016).

According to Oruonye, Iliya and Ahmed, (2016), findings show the following in table 8.

Table 8: Proportion of land under mining and reclamation in the area

S/No.	Status of land	Total area (hectares)	Percentage (%)
1	Land area under mining	78	13
2	Total land area for Mining	474	79
3	Total Land area under reclamation	48	8
4	**Total**	**600**	**100**

(**Source**: Oruonye, Iliya and Ahmed, 2016)

Table 9: Plant species identified in the Reclaimed area

S/No	Name of plant species	Number planted	Percentages
1	Azadirachta indica	1000	16
2	Anacardium occidentale	900	15
3	Acacia senegal	700	12
4	Eucalyptus camaldulensis	800	13
5	Jatropha curcas	500	08
6	Mangifera indica	1200	20
7	Tectona grandis	1000	16
8	**Total**	**6100**	**100**

(**Source:** Oruonye, Iliya and Ahmed, 2016)

B. RESETTLEMENT SCHEME IN MAIGANGA AND ITS ENVIRONS

(Abdulsalam, Oruonye, Ahmed and Mbaya, 2016) in their paper examined the socio-economic impact of Maiganga resettlement scheme for consisting 976 persons in three (3) communities in Akko LGA of Gombe State as seen in table 10. Their data was collected through field observation, questionnaire, interviews and other secondary materials.

Table 10: Resettlement Scheme of Maiganga Communities

S/No.	RESETTLEMENT VENTURE	QUANTITY
1	Houses	75
2	Boreholes	4
3	Primary school of three blocks of classroom	1
4	Skill acquisition centre	1
5	Primary health	1
6	Care/maternity	3
7	transformer with electricity	3
8	Mosques	1
9	Church	1

(**Source:** Abdulsalam, Oruonye, Ahmed and Mbaya, 2016**)**

Monetary compensations were paid to the farmers for loss of farm lands. The compensation ranges between ₦10,000 (USD 36) to ₦150,000 (USD 536) depending on the size of farm land lost.

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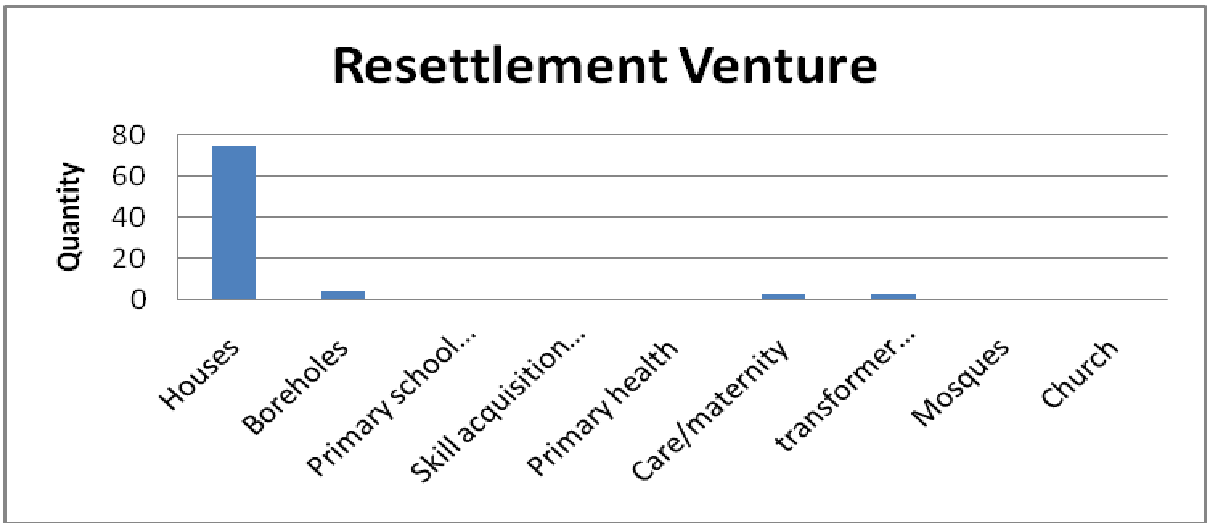


Figure 8: Graph showing resettlement programme in Maiganaga

Matthew, Mayeen, Yussof and Wan (2017) worked on samples of soil, coal and mine tailings from Maiganga coalfield (Nigeria coal) to obtain results of Mean activity concentrations of ^{40}K, ^{226}Ra and ^{232}Th in coal, tailings and soil when assessed using HPGe γ-ray spectrometry (Gamma ray spectrometric technique).

Table 11: Assessment of Matthew, Mayeen, Yussof and Wan (2017)

Samples	**Potassium,** ^{40}K (Bq/kg)	**Radon,**^{226}Ra(Bq /kg)	**Thorium,**^{232}Th (Bq/kg)
In Coal	17.8 ± 1.2	7.6 ± 0.5	5.5 ± 0.4
World Mean Values(In Coal)	50	20	20
In Mine Tailings	91.2 ± 4.3	20.2 ± 1.0	25.7 ± 1.3
In Soil	83.5 ± 4.0	17.7 ± 0.9	27.3 ± 1.3
World Mean Values(In Soil)	400	35	30

Table 12: Re-organizing the assessment of T. K., Mayeen U. K., Yusoff M. A. And Wan H. B.A. (2017)

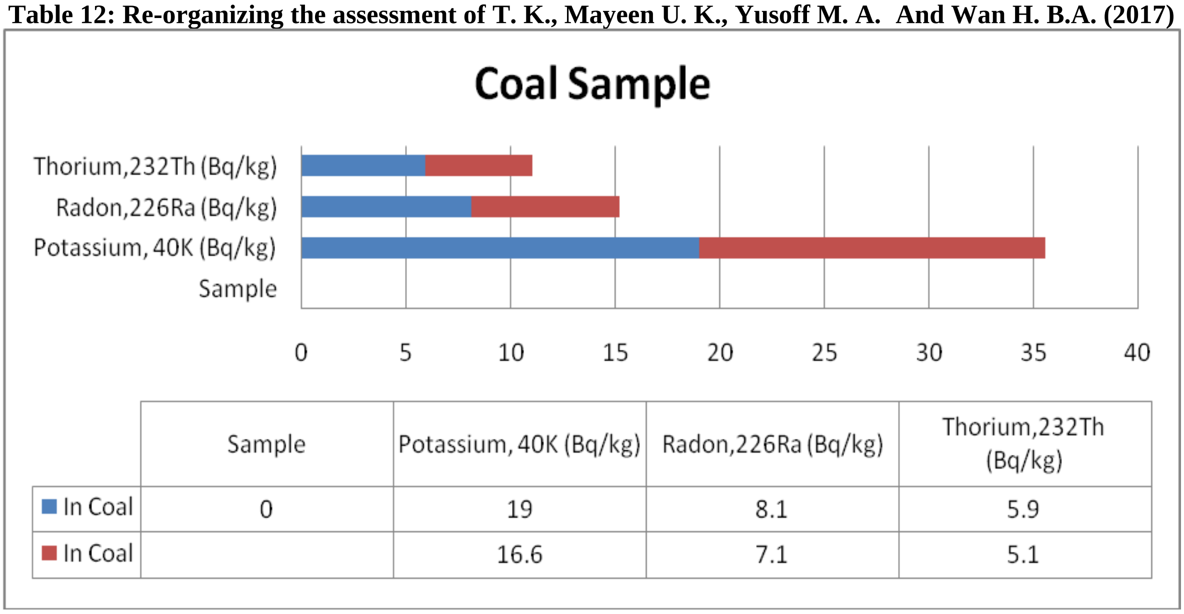
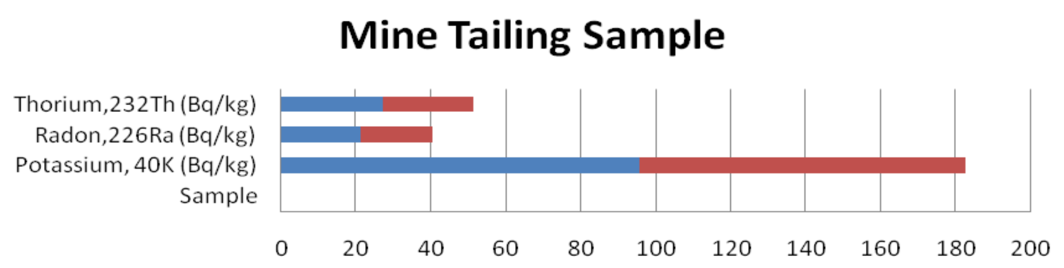
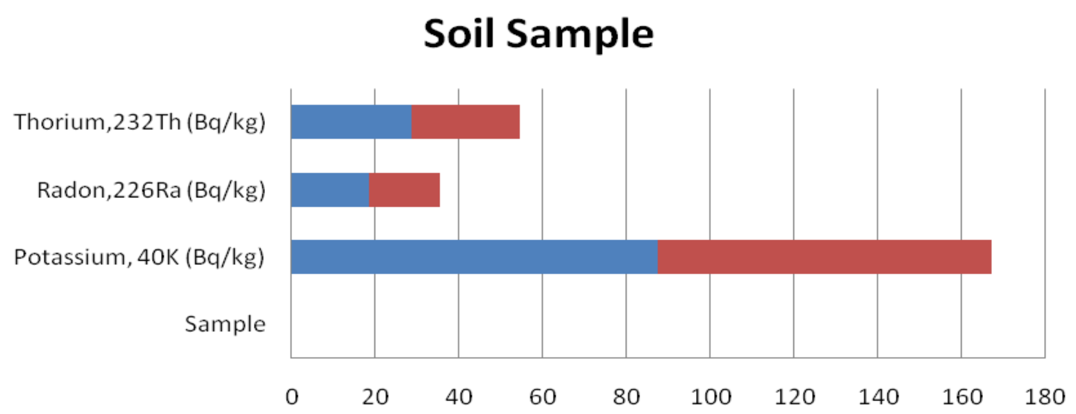


Figure 9: Metallic Concentrates In dust and in the soil



	Sample	Potassium, 40K (Bq/kg)	Radon,226Ra (Bq/kg)	Thorium,232Th (Bq/kg)
In Mine Tailing	0	95.5	21.2	27
In Mine Tailing		86.9	19.2	24.4

Figure 10: Metallic Concentrates In dust and in the soil



	Sample	Potassium, 40K (Bq/kg)	Radon,226Ra (Bq/kg)	Thorium,232Th (Bq/kg)
In Soil	0	87.5	18.6	28.6
In Soil		79.5	16.8	26

Figure 11: Metallic Concentrates In dust and in the soil

VI. RESULTS AND DISCUSSION

In figure 4, though, Maiganga coal has a high beneficial coal content of about 61.69%, it carries with it volatile matters of about 51.16%. In figure 5, the correlation coefficient for the graph showing radionuclide concentrations revealed Radon to be extremely high which may deduce the reason why Maiganga coal mine was abandoned. Same is confirmed in figure 9 to figure 11 which shows Thorium and Radon of high concentration, evidently present in the coal bed, coal tailings and in the soil of Maiganga coal mine.

In figure 6, samples collected from Maiganga mine drain, borehole and hand dug well vividly shows the extreme concentration of Nitrate as 155mg/l, 75mg/l and 143mg/l respectively. This values are too far from the NESREA standard of 50mg/l.

A proposed solution to the challenge of Maiganga coal Mine is reclamation from its abandoned state. Although about 92% has been exploited by mining, leaving 8% (see table 8) not mined, vigorous reclamation should be adopted, earnestly; and the best method of reclamation to apply is the agricultural/forestry activities which involves planting species that were in the mine before operation was kick-started (see table 9).

Other measures to help in giving a face-lift to Maiganga coal mine is the resettlement venture, as seen in table 10, with provision of houses as top priority, as shown in figure 8.

VII. CONCLUSION AND RECOMMENDATION

Mining activities generate and produce so much waste which is poisonous and destructive to aquatic animals, vegetation and man. These wastes include arsenic, lead, mercury, antimony, cyanide, cadmium, thorium, Radon. All these toxins affect health negatively during and after production. On Maiganga, Radon, thorium and Nitrate are in high concentration which is most likely reason for its abandonment. To resuscitate the land, reclamation and resettlement are suggested as best options.

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