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Assessment of Underground Water Contamination Due to Early Coal Mining Activities in Nigeria

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Abstract

This paper examines the level of mining activities impairment on underground water quality. Five samples whose major water sources is underground water were obtained. The samples obtained were analyzed using Physical, Biological and Chemical Parameters. The result shows most of high concentration of chemical elements impairing on water quality as a result of mining activities such as Nitrate, Chloride, Phosphate, Cyanide, Fluoride, Iron, Manganese etc. Additionally the bacteriological analysis of these water samples revealed the concentration off *e coli* bacteria in the most boreholes, well, and the stream. The paper concluded that even though borehole were provided to augment the water supply for communities consumption but consideration was not given to streams where waste water from the mining site are normally drained into because it is use by plant and animals. There is therefore the need to treat the water before discharge into the stream.

Key words: Contamination, Mining, Parameters, Samples, Underground water

1 Introduction

All life depends on land, for people construct homes on land, food is cultivated on land, and when people ultimately die their remains are committed to land. Usually, life's basic needs are expressed to be food, clothing and shelter but it is true to assert that there is only one essential or basic need of life and that is land because food, clothing and shelter are entirely derived from land. (Mohammed 2004 and Ladan 1997). Water is an essential commodity to living things and non living things and it is important in all aspect of human life. Water is used for domestic, industrial and other purposes. Chemically, the combination of oxygen and hydrogen forms water. As water penetrates through the ground surface to the subsurface as groundwater, impurities get into it. The public most especially the rural dwellers consume well water without due consideration of its chemical and biological composition. Perhaps this may be due to severe water problems in parts of the rural area. The quantities of water are just as important as its quality Todd, (1959). History revealed the inception of ground water investigation by the geological survey of Nigeria started in 1926, the quality of portable water was not taken seriously until Dufreez and Barber's 1965 investigation of ground water quality in the northern parts of Nigeria

The exploitation of the mineral resources results in the environmental degradation with large scale consequences. Although mining activities directly affects a relatively limited area of terrestrial land, its impacts on the environment, as well as on public health, may be found at greater distances from the source and for a long period Ahanger *et. al,.* (2014) Boni *et. al,.* 1999 and Balistrieri., *et. al,.* 1999.

Coal consists of more than 50% by weight and more than 70% by volume of carbonaceous material (including inherent moisture) (James, 2005). It is used primarily as a solid fuel to produce heat by burning. Coal exists, or is classified, as various types, and each type has distinctly different properties from the other types. Anthracite, the highest rank of coal, is used primarily for residential and commercial space heating. It is hard, brittle and black lustrous coal, often referred to as hard coal, containing a high percentage of fixed carbon and a low percentage of volatile matter. Bituminous coal is a dense coal, usually black, sometime dark brown, often with well-defined bands of bright and dull material used primarily as fuel in steam electric power generation, with substantial quantities also used for heat and power application in manufacturing and to make coke.

Coal mining has disastrous impacts on the Environment. Compared to the high price of oil and natural gas, coal even though very cheap but appearances may be deceiving. The true costs of conventional coal extraction and use are significant. The conventional coal fuel cycle is among the most destructive activities on earth, threatening our health, fouling our air and water, harming our land, and contributing to global warming.

Mining is a common practice in Nigeria, the problem with mining activities in the country, however, is the

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inattention of the miners and the government to proper mining practices which makes life difficult for the people. And many people because of their low level of education do not know their environmental obligations under the Minerals and Mining Act, and that the adherence to best global practices in mining is a vital tool for the promotion of sustainable growth in the industry Ifeanyi 2010, Although mining provides a variety of socio-economic benefits but its environmental costs, if not well handled can be massive in terms of land conversion and degradation, habitat alteration, water and air pollution Adekoya, 2003. In Africa, the mining sector is thought to be the second largest source of pollution after agriculture; the sector is resource intensive and generates high concentrations of waste and effluents (Babagana, et. al. 2012 and Aigbedion, and Iyayi, 2007). Mining from exploration to the closing stage has a serious impact on the environment. This impact can be direct through the value chain activities, prospecting exploration, site development, ore extraction, mineral dressing, smelting, refining/metallurgy, transportation, post mining activities and indirectly through the impact of the degradation on the socio-cultural development of communities. In general, degradation arising from mining includes; air pollution, water pollution, land and forest degradation, noise pollution, solid and liquid waste disposal of toxic substances, as well as socio-cultural problems such as health complication, conflicts, alcoholism, communal clash and inequality (Babagana, *et. al*. 2012 and Twerefou, 2009)

2 Impact of Mining Activities on the environment

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 Ahanger *et. al*,. 2011) their studies analyze 18 water samples for physic chemical parameter and discover that

3 Study Area

Nigeria's coal reserves are in excess of 1.2 billion tones of proven, indicated and inferred categories (Usman Shehu Onoduku 2014 and Famuboni, 1996). Despite the reserves, not much of the county's coal has been used as a domestic fuel for coking..

The Maiganga Coal deposit is located at Maiganga village in Akko Local Government Area of Gombe state. The Maiganga coal mine is located at 8 km off Gombe-Yola road immediately after Kumo town (Figure 1). The study area is located within the Maiganga coal mine, near Kumo in Akko LGA.

Mining is achieved through several activities from exploration through exploitation to processing and finally to the consumer (Ogezi, 1998). The open cast mining method was generally used in predominantly flat plains of the Plateau, as tin and columbite were concentrated in old stream beds (alluvial), having been washed down from the younger granite outcropping units (Falconer 1921). The maiganga coal mining site also use open cast mining method.

Fig. 1: Mining activities at the Maiganga mining Sites

4 Methodology

Using stratified random sampling techniques five samples were collected from water bodies whose major sources of water is underground water the sample site include borehole, open well and stream. To avoid the ingestion of foreign contaminants by fetchers in the morning, The samples were collected very early in the morning using sterilized 50ml properly labeled plastic bottles. The samples were tested for colour and temperature on the field thereafter they were taken to the laboratory where they were kept at room temperature prior to the analysis.

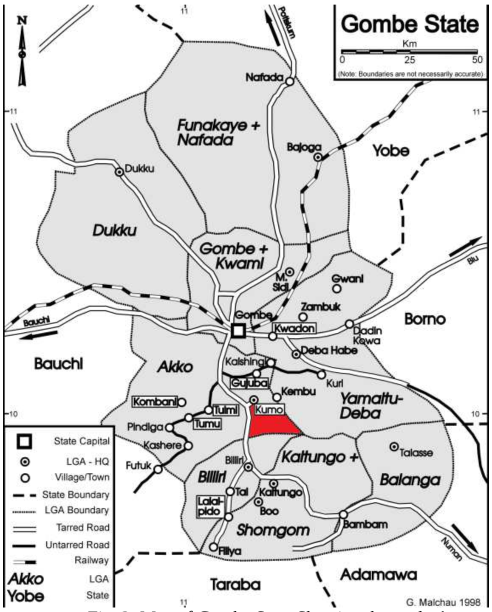


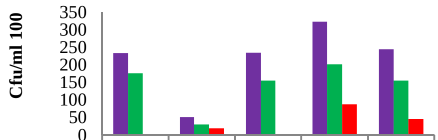
Fig. 2: Map of Gombe State Showing the study Area

The samples were then analyzed using spectrophotometer, titration methods, Orion Model 520 Ph Meter, Pocket conductivity meter etc to estimate; total hardness Ph Bio oxygen demand (BOD), chemical Oxygen demand (COD), total hardness. Nitrate, Nitrite, Total Dissolve Solid (TDS), e-coli and total coli form count (TCC).

The mean of the three analyses was taken and is tabulated in table 1 and 2 for physical and chemical parameters while figure 3 is the mean result of the microbial parameter. The mean of the samples was calculated and a deviation from the WHO standard was calculated and tabulated in column remarks so as to find out the parameter that exceed thresh hold limits.

5 Results

The sample were analyze three times at three weeks interval to ensure check of the analyses result. The mean results of the analysis for the parameters were given in the tables and figure below.



	Borehole 1	Borehole 2	Borehole 3	Open Well	Stream
coli form	233	50	234	322	244
Feacal Coli Form	176	30	154	201	154
E. Coli	0	18	0	87	45

Fig. 3: Mean Result of Microbial Parameter

6 Discussions

From the assessment of physical parameter in table 1 it shows that color and turbidity of the underground water was greatly alter which is above the thresh hold limit by the WHO standard. The color for instance has exceeded the WHO thresh hold limit by 137.2this indicated that of the adverse effect of mining activities on the physical appearance off the water bodies in the area. The chemical analysis of the samples shows that the major element resulting from mining activities has also impaired into the water. The result of the analysis also indicated there is high concentration of calcium, magnesium, iron, fe^{2+}, Nitrate, No_3, Nitrite, No_2, and Cyanide CN in the water samples. The result shows very low concentration of Copper, Cu^{2+}, Zinc, Zn^{2+}, Sulphate, So_4 and Chloride, Cl. But in fluoride and Chromium, Cr^{6+} Barium, Ba^{2+} is concentrated is also slightly above thresh hold limit of WHO.

From the result of analysis, the low concentration of chlorides perhaps gives rise to high concentration microbial contaminants that is *coli form* and *feacal coli form* count in the water samples.

Table 1*:* Mean Result of Physical Parameter

Parameter	Units	Samples					Mean	WHO	Remarks
		1	2	3	4	5			
Temperature (^{0}C)	Mg/l	26.6	26.5	26.5	26.5	26.5	26.5	27	-0.5
Colour	Pt. co	332	322	54	45	8	152.2	15	137.2
Turbidity	NTU	33	98	32	12	23	39.6	5	34.6
Electrical Conductivity	Us/ cm	155	93.3	200	300	434	236.5	1000	-763.5
Total hardness	Mg/l	50	120	65	120	248	120.6	150	-29.4
TSD	Mg/l	76.9	46.5	100	149	217	117.9	500	-382.1

Table 2: Mean Result of Chemical Parameter

Parameters	Unit	Water Samples					Mean	WHO	Remarks
		1	2	3	4	5			
Calcium ca2+	Mg/l	32	87	67	74	143	80.6	70	10.6
Magnesium mg2+	Mg/l	1.45	2.11	0.32	2.23	21.04	5.43	0.2	5.23
Total iron, fe2+	Mg/l	12.02	10.8	20.2	1.4	4.3	9.744	0.3	9.444
Copper, cu^{2+}	Mg/l	0.2	0.54	0	0.12	0.06	0.184	1	-0.816
Fluoride,	Mg/l	1.42	0.35	0.43	1.02	0.21	0.686	1	-0.314
Total alkalinity	Mg/l	40	55	52	50	75	54.4	100	-45.6
Zinc, zn^{2+}	Mg/l	1.2	1.3	0.05	2.37	0.02	0.988	3	-2.012
Nitrate, No_3	Mg/l	75	87	89	13	155	83.8	50	33.8
Nitrite, No_2	Mg/l	1.43	0.11	32	1.05	1.02	7.122	0.02	7.102
Manganese, Mn^{2+}	Mg/l	1.24	0.54	0	0	0	0.356	0.05	0.306
Lead, pb^{2+}	Mg/l	0	0	0	0	0	0	0.001	-0.001
Sulphate, So_4	Mg/l	20	65	40	36	50	42.2	100	-57.8
Chlorine, Cl	Mg/l	14	16	32	21	9	18.4	250	-231.6
Chromium, Cr^{6+}	Mg/l	5.33	3.23	0	0	0	1.712	0.05	1.662
Barium, Ba^{2+}	Mg/l	0.54	0.07	3.04	0	0	0.73	0.005	0.725
Phosphate	Mg/l	0	2.8	0	0	0	0.56	10	-9.44
Cyanide	Mg/l	0.73	0.24	0.008	0.004	0.032	0.2028	0.001	0.2018
pH		7.7	7	7.1	7.1	6.9	7.16	7	7.16

7 Conclusion

The Result of the analysis clearly shows that the major mining contaminants such as Nitrate, Chloride, Phosphate, Cyanide, Fluoride, Iron, and Manganese impair with the underground water regiments in the study area and therefore not safe. Although bore hole were provided to arguments water supply to the local communities effort should therefore be made by Local Administration and the company to sensitize the local communities on the need to locally treat drinking water before consumption. At best the Policy makers should provide alternative source of water for domestic consumption whose major source is not the underground water within the mining area.

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