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DETERMINATION OF SOME ESSENTIAL NUTRIENT ELEMENTS OF TUDUN KUKA DAM FOR IRRIGATION IN MAIGANGA COAL MINING AREA, AKKO LGA, GOMBE STATE, NIGERIA.

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Abstract

The study examined concentration of some essential elements for irrigation in Tudun Kuka dam in Maiganga coal mining area. Water samples were collected at two points; the downstream and the up-stream. The collected water samples were analyzed for the following essential nutrients: (PO_{-4}, K, Mg, Mn, Fe, Ca, Cu and Zn) and the concentration of each element was determined. The values were compared with the permissible limits provided by Food and Agricultural Organization (FAO) standard. The results showed that Phosphate was detected both at the downstream (0.80 mg/l) and at up-stream of the dam (0.52 mg/l). Both were below the permissible standard of FAO (3.5 mg/l) standard. Potassium (K) was detected at both downstream (5.20 mg/l) and up-stream (3.60 mg/l), was both below the FAO permissible standard of (50 mg/l). Magnesium (Mg) was detected both at downstream (7.05 mg/l) and at up-stream (6.68 mg/l), but far below the expected FAO standard value of (40 mg/l). Manganese (Mn) was detected at both the downstream (0.094 mg/l) and the up-stream (0.15 mg/l) and was below the FAO expected standard of (0.20 mg/l), though permissible for crop production. Iron (Fe) was detected at both the downstream (1.74 mg/l) and up-stream (1.91 mg/l) of the dam with concentration above the FAO standard (0.50 mg/l) for crop production, hence not healthy for sustainable crop production. Copper (Cu) was not detected at both the downstream and up-stream of the dam and was below the expected FAO standard is 0.01, hence permissible for crop production. Calcium (Ca) was detected at both the downstream (6.80 mg/l) and up-stream (7.40 mg/l) of the dam but was below the FAO expected standard (180 mg/l) and is permissible for crop production. Zinc (Zn) was only detected in trace amount at the up-stream of the dam (0.005 mg/l) and was far below the FAO (0.02 mg/l) permissible standard for crop production. However, since all elements; except Fe, were below the expected FAO standard. All other elements were either far below or within the FAO permissible limits, implying that the expected nutrients are at the risk of water pollution at the moment. The study recommended the need for enlightenment to the irrigation farmers on the present nutrient status and the need for fertilizer application at appropriate rates on the irrigated farmlands in the area.

Keywords: Coal mining, heavy metals, Maiganga, permissible limit and water pollution**,**

1. Introduction

Nutrients are generally absorbed by roots as cations and anions from the water in soils, or the soil solution. Cations and heavy metals are among some of the essential nutrients elements found in irrigation water. Cations are any ions that are positively charged. The following cations; Ca++, Mg++, Na+ and K+, are the important cations present in irrigation water whilst Cu++ and Zn++ are the heavy metal cations which can also be found in small amounts (traces elements) in irrigation water. Calcium (Ca++) an element widespread in nature, in particular in calcareous rocks in the form of carbonates (CaCO3). Calcium contributes to the hardness of water and it is the fifth most common element found in most natural waters. The sources of calcium in ground water especially in sedimentary rocks are calcite, aragonite, gypsum and anhydrite. Magnesium (Mg++): Magnesium is one of the most widespread elements in nature (2.1% of the earth's crust). Most of the magnesium salts are water-soluble. This element is present in the forms of carbonates and hydrogen carbonates. Like calcium, it constitutes a significant element in water hardness (Quevauviller, 2002). Potassium (K+): Although potassium is a relatively abundant element, its concentration in natural fresh waters is usually less than 20 mg/L. Brines and seawater, however, may contain as much as 400 mg/L of potassium or more. Potassium generally constitutes a small fraction of cation in irrigation water.

Copper and zinc are among the long chain of trace elements or heavy metals, which are encountered in natural water in small amounts. These elements may be toxic to sensitive crops if highly concentrated. Toxic trace elements concentrations in some irrigation water samples are undesirably high, and hence it becomes necessary sometime to estimate their qualities in an irrigation water sample (Moshood, 2009). Zinc is found in some natural waters, most frequently in areas where it is mined. It is not considered detrimental to health unless it occurs in very high concentrations. It imparts an undesirable taste to drinking water (Obropta and Goodrow, 2005). Copper is an essential nutrient, but at high doses has been shown to cause stomach and intestinal distress, liver and kidney damage, and anemia (Obropta and Goodrow, 2005). Water quality is important for water and land resources managers in assessing the effects of human activities such as land use, on water resources (Emamgholizadeh, 2008**)**. Water quality is in the world deteriorating fast due to increasing population pressure, rapid urbanization and industrialization, and inadequate sanitation facilities, with water resources being contaminated by a variety of hazardous chemicals and virulent pathogens. These pollutants are mainly untreated human and animal waste, garbage and industrial waste (Choi *et al.*, 2007). Coal mining is often associated with a lot of environmental problems which include erosion, formation of sinkholes, loss of biodiversity and contamination of ground and surface water by chemicals from mining processes which in turn create safety and health challenges to the people living within and around the mining communities (Buba, Samaila and Marcus, 2019a).

Dam is one of the major sources of water for irrigation farming. The quality of the dam water is very important in terms of the productivity, quality and quantity of the production. Dam close to mining site may be affected in terms of the water quality for irrigation. It's a well-known fact that the Mining sector worldwide is greatly important for income generation, employment, economic development but also poses major threats and hazards that can degrade the natural environment in terms of water, soil/land, vegetation and air (Oelovfse*et al.*, 2008). Waste rocks generated from coal mining often constitute source of heavy metals pollution, while tailing pond or piles may give rise to pollution of water bodies (Adekoya *et al.*, 2003). Runoff from coal mines can dissolve heavy metals; notably, copper, lead, zinc, manganese, mercury and molybdenum into ground and surface water bodies and can affect soil nutrients even in Dam water for irrigation (Arogunjo, 2007). Tudun kuka dam reservoirs in Maiganga coal mining areas provide water for irrigation of various crops. However, not much is known on its quality particularly for irrigation agricultural practices in the area. Therefore, the need for such a study to determine the level of the essential nutrients of Tudun Kuka dam based on some selected water quality parameters.

2. Materials and Methods

2.1 Study area

Tudun Kuka dam located at Tudun Kuka settlement in Maiganga village of Akko Local Government Area, Gombe State**.** It is lies between longitude 09^0 59'N and 11 09' N and latitude of 11^O 8E and 11^O9' E. Maiganga covers a land area of about 48.16 km^2**.** (Fig.1). It is bounded to the south by Billiri and to the west by Kumo town, the headquarters of Akko Local Government Area. Maiganga lies within the tropical continental type of climate. It has both wet and dry seasons. Rainfall ranges from 850 mm to 1000 mm annually. Temperature in the study area is relatively high for most part of the year (Oruoye, Iliya, and Ahmed, 2016).The mean maximum monthly temperature is 37^OC from March to October, but reduces to 21^OC in December to February. Tangale, Fulani and Jukun Tribes majorly dominate Maiganga community. Maiganga has a population of about 3,520 according to 2006 National Population Commission census and when projected using 3% growth rate, 39,881.6 people in 2017. The main economic activities of the people is peasant farming with the cultivation of crops such as maize, millet, rice, beans, sorghum, soya beans, groundnut, and guinea corn and they also practice small scale open grazing.

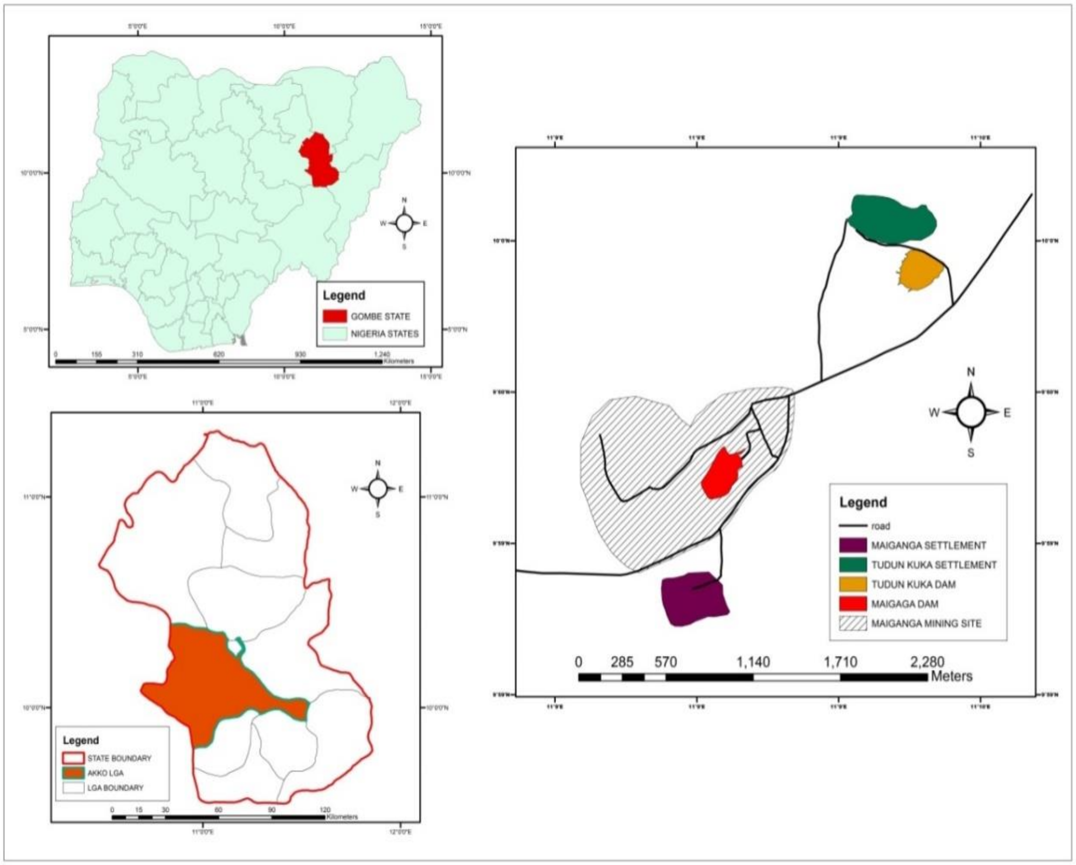

Fig 1: Map of the Study Area
Source: Google Earth/ArcGIS analysis (2019).

2.2 Water sampling and Laboratory procedures

Water samples were collected at two different points inside the Tudun Kuka dam. The first sample was collected at the upstream and the second sample was collected at the downstream of the Dam. This gave two samples at different locations. The water samples were collected in two (2) different plastic containers each two liters and well labeled for identification and taken to the laboratory for analysis. The plastic containers for the collection of the water samples were thoroughly washed with distilled water to avoid contamination. Then three (3) mls nitric acid were added into each collected water sample to avoid biochemical reaction that may likely occur before laboratory analysis. The water sampling points were recorded using a hand held Geographical Positioning System (GPS). The water samples were taken to the laboratory for the determination of the considered essential nutrients; Phosphate, Potassium, Magnesium, Manganese, Iron, Copper, Calcium and Zinc using standard analytical procedures for the chemical parameters. The laboratory analysis was conducted at the Federal Ministry of Water Resources, Department of Water Quality Control and

Sanitation, National Water Quality Reference Laboratory Gombe, Gombe State.

3. Results and Discussion

This section presents findings of the study for both down-stream and up-streams surface water in Tudun Kuka Dam investigated for each nutrient compared with the Food and Agricultural Organization standard/safety limit (FAO, 2014) is presented in Table 1.

3.1 Essential Nutrients Elements Investigated at Tudun Kuka Dam Irrigation

Phosphate (PO_4): Table 1 reveals that Phosphate was detected in both down-stream (0.08 mg/l) and up-stream (0.52 mg/l). Both results were within permissible limit of Food and Agricultural Organization (FAO). It also, reveals that the concentration of Phosphate in the dam water samples were lower than the expected permissible limit of 3.5 mg/l FAO for crop production. It might be possible that the lower concentrations could be attributed to the coal mining activities in the area. Since the dam is not too far from the mining site as observed by Sharma (2007) who assert that dissolved metals from mining activities can affect soil and water quality. Therefore, irrigation farmers need to apply fertilizers rich in Phosphate for better productivity.

Table 1: Concentration of nutrients at Tudun Kuka dam compared with permissible standards for irrigation

Parameters (mg/l)	Downstream		Upstream		FAO Standard
	Results	Remark	Results	Remark	limits
Phosphate	0.80	BP	0.52	BP	3.5
Potassium	5.20	BP	3.60	BP	50
Magnesium	7.05	BP	6.68	BP	40.00
Manganese	0.94	BP	0.15	BP	0.20
Iron	1.74	AP	1.91	AP	0.50
Copper	0.00	BP	0.00	BP	0.01
Calcium	6.80	BP	7.40	BP	180
Zinc	0.00	BP	0.005	BP	0.02

Source: Field survey and laboratory Analysis (2019). **NB**: (AP = Above Permissible and BP = Below permissible)

Potassium (K): From Table 1, the result reveals that Potassium was detected at both down-stream (5.20 mg/l) and up-stream (3.60 mg/l). Both results were within the FAO. The results indicate that the concentration of Potassium was far below the expected FAO standard limit of (50 mg/l). This could be attributed to the mining activities in the area. Guala, Vega and Covelo (2010) argue that Sodium, Potassium and Nitrate are useful elements which help plants grow but can be affected by heavy metals. Hence, Potassium could be limiting for sustainable crop production in the area.

Magnesium (Mg): The result reveals that Magnesium was detected in both the down-stream (7.05 mg/l) and up-stream (6.68 mg/l) and both were below the FAO standard of 40.0 mg/l as could be seen in Table 1. The result indicates that the concentration of Magnesium was permissible for irrigation use. This could be likely attributed to the mining activities (Guala, Vega and Covelo, 2010). Hence, it is not objectionable for irrigation uses**.**

Manganese (Mn): Manganese was detected at both the down-stream (0.094 mg/l) and the up-stream (0.15 mg/l) both were below the permissible standard of FAO in Table 1. The result reveals that the concentration of Manganese was below expectation. This could be due to the coal mining activities in the environment. Buba, Samaila and Marcus (2019b) observed that heavy metals from Maiganga Coal mining activities have polluted the quality of water around the mining area. Therefore, it is permissible for irrigation since Manganese is a micronutrient, which is required in small quantity.

Iron (Fe): Iron was detected at both the down-stream (1.74 mg/l) and up-stream (1.91 mg/l) of the dam but they are both above the FAO permissible standard of 0.50 mg/l as could be seen on Table 1. The result has shown that the concentration of Iron was above the permissible limit. This is likely due to the effect of the dissolved heavy metals from the mining environment into the dam. NT Shakoor (2015) observed that heavy metals have the potentials to affect soil nutrients for plants growth.

Copper (Cu): From Table 1, Copper was not detected at both the down-stream and up-stream of the dam. While the FAO standard or permissible limit is 0.01 mg/l, hence the copper concentration is said to be below permissible standard required for crop production. The result has shown that the concentration of copper has no negative effect on crop production; hence the dam water is not objectionable for irrigation. Ayers and Westcot (1985) observed that heavy metals in water can affect the water quality.

Calcium (Ca): Table 1 shows that Calcium was detected both at the down-stream (6.80 mg/l) and at up-stream (7.40 mg/l) at permissible limit but below the FAO standard of 180 mg/l for irrigation purpose. It is permissible for irrigation purpose in the area.

Zinc (Zn): In Table 1, it reveals that Zinc was only been detected at the up-stream (0.005 mg/l) of the dam and it is below the FAO permissible standard of 0.02 mg/l. The result has shown that concentration of Zinc is below the FAO standard for crop production, implying that the coal mining activities has not polluted the water with Zinc at the moment of this study. Hence dam water it not objectionable for irrigation purposes.

4. Conclusion

From result of the study, it is an evident that coal mining activities at Maiganga coal mine has impact on the nutrients concentration of the Tudun Kuka Dam water for irrigation. The concentrations of all the considered nutrients were below permissible standard at both downstream and up-stream of the dam.

5. Recommendations

Based on results of the study, the following recommendations were suggested; there is need for routine monitoring of the dam water quality to ascertain its status for optimal irrigation agriculture in the area. Also, very important is a follow-up on soil quality assessment in the irrigated fields to enhance soil management and the type and rate of fertilizer application.

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