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Assessment of Wetland Water Quality in Maiganga Coal Mining Area, Akko Local Government Area, Gombe State, Nigeria

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ABSTRACT

Mining activities significantly contribute to employment and economic growth but are often associated with severe environmental degradation, particularly affecting land, air, and water resources. In Maiganga, Gombe State, coal mining activities have led to considerable impacts on water quality. This study assessed the effectiveness of a constructed wetland system designed to treat mine wastewater before discharge into the environment. Water samples were collected and analyzed for physicochemical properties and heavy metal concentrations, then compared with World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) guidelines. Data analysis involved descriptive statistics and a paired sample t-test. Results revealed that both water sources remained acidic (pH ranging from 5.42 to 5.16) and exhibited elevated concentrations of total dissolved solids (TDS), total suspended solids (TSS), and heavy metals such as lead, cadmium, and chromium, exceeding permissible limits. Despite slight improvements after treatment, several parameters remained above acceptable thresholds, posing significant health risks. The results of the study indicates that the wetland water is less effective at moment. The study recommends enhancing sustainable mining practices, upgrading wetland treatment systems, improving community access to safer water sources and continuous monitoring of the wetland and public health surveillance.

Keywords: Coal mining, Heavy metal, Pollution, Water quality, Wetland

INTRODUCTION

Wetlands are among the most productive ecosystems globally, acting as critical interfaces between terrestrial and aquatic environments. They perform essential ecological functions, including flood control, sediment retention, and groundwater recharge, and provision of habitats for diverse flora and fauna. Additionally, wetlands offer vital ecosystem services such as water purification, food production, and raw materials supply, significantly supporting human livelihoods (Finlayson, D'Cruz, Davidson, 2005).

However, wetlands are increasingly threatened by anthropogenic activities, including agricultural expansion, resource overexploitation, and direct discharge of municipal and industrial effluents. These pressures often lead to ecosystem degradation, water pollution, eutrophication, and a decline in biodiversity, particularly in developing countries where waterborne diseases remain prevalent (Denny, 2007; Eneh, 2011)

Mining operations, especially coal mining, exert profound negative impacts on wetland environments. The extraction processes frequently lead to acid mine drainage, heavy metal contamination, soil erosion, and habitat loss (Adekoya, 2003; Arogunjo, 2007). In coal mining regions like Maiganga, Nigeria,

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contamination of surface and groundwater with toxic elements such as arsenic, cadmium, lead, and mercury has raised serious environmental and public health concerns (Baba & Tayfur, 2011).

Recognizing the escalating pollution threats, a constructed wetland system was established at the Maiganga coal mine in 2019 to mitigate wastewater discharge impacts. This study evaluates the performance of the wetland treatment system by assessing the physicochemical and heavy metal characteristics of water before and after treatment.

Due to their extraordinary ecosystem services and population growth, wetlands are often subjected to anthropogenic impact: agricultural land conversion, over-exploitation of their resources, and direct discharge of municipal, industrial and livestock wastewater. As a result of uncontrolled discharges of municipal and industrial effluents, a significant change in the ecosystem can occur, resulting in water pollution, eutrophication, pathogen development, and physicochemical changes in surface waters. At present, the threat of waterborne diseases and epidemics is still a serious problem for developing countries, including Nigeria. Besides, poor water qualiton harming aquatic life preservation. (De Troyer, Mereta, Goethals, & Boets, 2016).

The resilience of wetland ecosystems is provided by self-purification potential; however, this resilience can significantly change under extra anthropogenic load.

Water is important for several uses**.** Wetland water surface purification is essential to many human basic activities such as agriculture, forestry, industry, power generation, and recreation. As hydrologic science provides much of the knowledge and understanding on which the development and management of water for domestic uses are based, they are of fundamental importance, such as for industrial activities; animal drinking; irrigation activities, as well as washing (Baba & Tayfur, 2011). Mining is the extraction of valuable minerals or other geologia1 materials from the earth, usually from an ore body, vein or coal seam. The term also includes the removal of soil. Minerals recovered by mining include base metals, precious metals, iron, uranium, coal, diamond, limestone, oil shale, rock, salt and potash. Coal mining operations can negatively affect water quality, often with long-lasting effects. The fundamental issue involves contamination of nearby rivers, lakes, and aquifers by what comes out of a coal mine, usually highly acidic water containing heavy metals like arsenic, copper, lead, mercury and other elements that are toxic at low concentrations. It’s also believed to be true that most of those substances do not enter the environment, at least not in large quantities, until the coal is mined, burned, or otherwise tampered with (Vinod, Nitin, Temin & Pankaj, 2020).

There are significant environmental impacts associated with coal mining on water quality. It could require the removal of massive amounts of topsoil, leading to erosion, loss of habitat and pollution. Coal mining causes acid mine drainage, which causes heavy metals to dissolve and seep into the ground and surface water. It can negatively affect water quality, often with long-lasting effects. The fundamental issue involves the contamination of nearby rivers, lakes, and aquifers by what comes out of a coal mine, usually containing highly acidic water containing heavy metals like arsenic, copper, lead, mercury and other elements that are toxic at low concentrations.

Waste rocks generated from coal mining often constitute a source of heavy metals pollution, while tailing ponds or piles may give rise to pollution of water bodies (Adekoya, 2003).

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Runoff from coal mines can dissolve heavy metals, notably copper, lead, zinc, manganese, mercury, and molybdenum, into ground and surface water bodies, and some of the metals are carcinogenic to health and other health-related problems (Arogunjo, 2007).

However, soil and surface water contamination is prevalent in the Nigerian coal mine areas. The source of pollution to the water body (dam) often includes mine wastes, which are dumped along the bank of the stream channels, and water pumped out of mines into the surrounding stream, which affects the chemical quality of surface water (Baba & Tayfur, 2011).

Maiganga coal mine constructed a wetland reservoir in other to help in the treatment of mine waste, which has a strong tendency for water and soil pollution. Hence, Maiganga Wetland was constructed for wastewater treatment in 2019, which international recognition. The main wastewater sources in Maiganga are the excavation and mining of coal in the area. Different communities are situated along the wetland waterways, which include: Kwilapandi, Pandintai Komta in Billiri L.G.A Kwilapandi, Dongol, among other communities. The western zone of the wetland has an approximate population of over 1000 people, due to the absence of sewerage due to the presence of the wetland in 2019. The domestic wastewater is discharged through the channel (constructed locally along the mining site) into the surrounding communities.

The study area is Maiganga wetland reservoir. The study intends to evaluate the importance and effectiveness of wetland water treatment in Maiganga coal mining area. Therefore, the study aims to evaluate the water quality at wetlands in Maiganga coal mining area for human and animal uses, which was achieved through the following objectives: To determine the concentrations of physical and chemical properties of water in the study area; to determine the concentrations of heavy metals at the reservoir before and after treatment in the study area; to determine if there is any variation in the concentration of physio-chemical properties of water before and after treatment in the study area; to evaluate the suitability of the treated water in conformity to the expected regulatory standards in the study area.

Description of the Study Area

The study area, Maiganga is located in Akko Local Government Area of Gombe State. Its headquarters in Kumo on the A345. It has different tribes like Tangale, Fulani, Hausa, Jukun, Tula and minor tribes. Most of the People practice Christianity and Islam. It has a latitude $09^0 59^1$N and longitude $11^0 09^1$E. Maiganga covers a land area of about 48.16km^2 (fig.1). It has a population of about 3520 according to the National Population Commission the 2006 Census and projected using 3% growth rate to 39,881.6 people in 2017. The main economic activities of the people are small-scale farming; cultivation of crops like millet, maize, rice, beans, guinea corn, groundnut, and sorghum, among others. They also practice open grazing on a small scale because mining activities have affected the vegetation cover in the study area. It is an 8km drive west of Kumo-Yola Road. It covers 201, Acres (48.16 km2). It has wet and dry seasons with average annual rainfall ranging from 850mm to 1000 mm. The rainfall is concentrated between May to October, with a single maximum in July/August. Much of the rainfall, especially in July-August, is associated with storms of high intensity.

It has a mean maximum monthly temperature of 37 °c from March to May, with a temperature of 21^{O}C from December to February. Relative humidity has the same

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pattern, being 94% in August and dropping to less than 10% during (December/January) harmattan (Orunonye, Iliya & Ahmed, 2006).

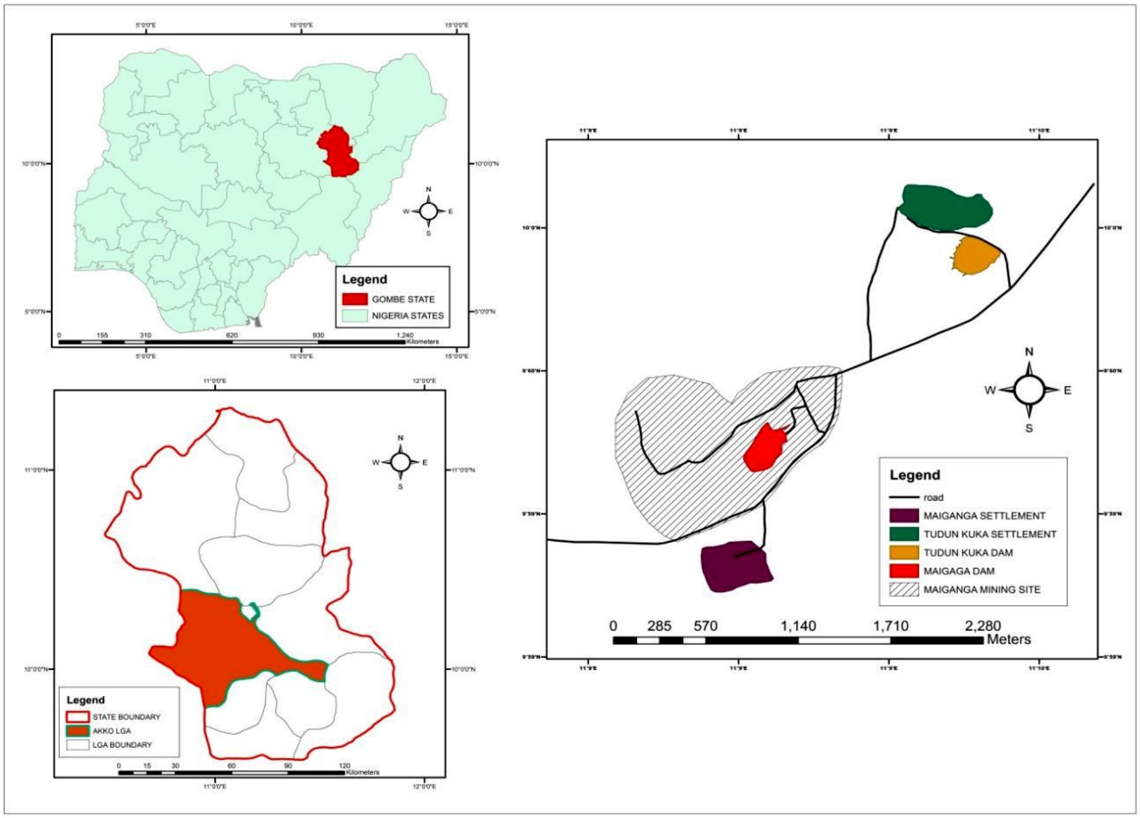

Figure 1: Map of the study area.

Source: Google Earth/Arcgis analysis 2024.

The geology is of discontinuous escapement rising in some places, particularly along Gombe-Kumo road to form sand storms and cliffs, which are over 150 meters above the surrounding plains. The Keri-Keri and Pindiga formation. The soil is typically ferruginous type; they are dark green in colour with a pH value of 4-6, depending on the location. (Orunonye, et al, 2006). The soil is intensively formed as a result of incomplete weathering of the basement complex rock. The vegetation comprises of a light canopy, with spindling of under shrubs and sparse growth of grasses to a more open grass of laser height, more spreading and stunted, slim and dense growth of grasses. Major trees in this area include *Butyrospermum mumparadoxum. Tamarind indoca, Parkia biglobosa, Balanite Agiftika Afzelia Africana, Fabia* among others (Orunonye, et al, 2006).

MATERIALS AND METHODS

The specific data is water samples in the study area and documented materials by World Health Organization (WHO) standard and other published and unpublished materials. The sources of data were obtained from both primary and secondary sources. The primary sources were collected from water samples from the wetland reservoir and surface water for comparison. The secondary source involved data on water quality standards for domestic uses from documentary materials. The water samples were collected each from

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the wetland reservoir and surface water (only 2 samples were collected) in the study area during the rainy season in 2024. Procedure for water samples collection: one water sample from wetland reservoir (mining pit) and one sample from surface water. The samples collected were filled into 2-litre of distilled separate plastic containers and labelled for laboratory analysis. The plastic containers for the collection of the water samples were thoroughly washed and distilled to avoid contamination. Thereafter 3 ml of nitric acid was added to each collected water sample to avoid biochemical reactions that may likely occur before laboratory analysis. The water samples were labelled for identification to avoid mix-up. At the point of water sampling, the locations were geo-referenced using a hand-held Global Positioning System (GPS).

Fast-changing physio-chemical parameters such as pH, temperature and Total Dissolved Solids (TDS) were measured in situ with a water analyzer. Water samples were preserved by storing them in ice-filled cooler boxes before transporting them to the laboratory, which enables us to determine whether the outline processes of water purification would reach the required standard or not (Nsi, 2007). Major water quality parameters analyzed were: Total Suspended Solids (TSS); Conductivity; Temperature (^{0} C); Total Dissolved Solids; pH; Dissolved Oxygen (DO); Biological Oxygen Demand (BOD); Chemical Oxygen Demand (COD); Copper(Cu); Cadmium(Cd); Iron(Fe); Manganese(Mn); Aluminum(Al); Lead(Pb); Zinc(Zn).

Data Analysis

The following standard analytical procedures for physical, chemical and heavy metals in water properties were analyzed as follows; Thermometer was used to measure temperature (Jackson, 1958); Turbidity was measured by the use of a Turbidity meter; Electrical Conductivity (EC) and Total Dissolved Solids (TDS) were determined by the use of Conductivity Meter (Wilcox,1950). Total Suspended Solid (TSS) and Total Solid (TS) were determined by the Gravimetric method (Black, 1965). Water pH was determined by pH Meter; Biological Oxygen Demand (BOD) was determined by the Track method; and lastly, the Chemical Oxygen Demand (COD) was determined by the photometric method (Jackson, 1958). Also, heavy metals like Iron (Fe), Manganese (Mn) and Chromium (Cr) were determined by the photometry method (Jackson, 1958). Copper (Cu), Total Arsenate (TAS), Cadmium (Cd) and Zinc (Zn) were determined using the Metalyser method (AOAC, 1950). However, a field sheet was used to record all information on the field, such as sampling points, coordinates, Geographical Positioning System (GPS), and so on. The data were summarized by descriptive statistics presented in the mean, tables and figures

RESULTS AND DISCUSION

Physicochemical Parameters

pH

The water pH recorded at the wetland reservoir before treatment was 5.42 and 5.16 at the surface water after treatment. While the permissible safety standard recommended by World Health Organization (WHO) and Nigeria's Standard for Drinking Water Quality (NSDWQ) is 6.5. This implies that the water is acidic and objectionable for consumption (Fan & Sreinberg, 2010)

Temperature (^{O}C)

The temperature at the wetland before treatment and at the surface water after treatment are 19.3^{O}C and 21.80 ^{O}C respectively, while the WHO recommended a range from 20^{O}C-35^{O}C but ambient, which means it is variable according to the NSDWQ

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standard. This implies that the temperature is commendable at both sources.

Conductivity (µS/cm)

Conductivity is the ability of a water medium to carry an electric current. The presence of dissolved metals such as calcium, chloride, and magnesium in water samples carries the electric current through water. The conductivity at the wetland reservoir before treatment and after treatment are 611.5 µS/cm and 464.00 µS/cm respectively, while the WHO and NSDWQ both have approved standards of 1000 µS/cm each. This implies that both water sources are not objectionable for human use because the results show that, they both have a concentration below the recommended values. A higher intake of water which has more concentration of conductivity is said to be harmful to man (Dandge & Patil, 2021).

Total Dissolve Solid (mg/l)

Based on the analysis, the TDS recorded at the reservoir and the surface water are 267.0 Mg/l and 226.0 mg/l respectively. While the minimum is 400 mg/l for WHO and 500 Mg/l for NSDWQ. This implies that both water sources before and after treatment are below the expected values, hence not objectionable for human consumption. TDS contain both inorganic and organic matter as a solution in water. The salinity in water indicates a high concentration of TDS, it also changes the color and properties of water (Fan & Sreinberg, 2010).

Turbidity (mg/l)

The Turbidity at the reservoir before treatment and after treatment are 340.5 mg/l and 111.0 mg/l respectively, while the expected safety standards recommended by WHO NSDWQ are 5mg/l each far below the expected value. This implies that the water is objectionable for human use and has the tendency to cause ill health. Turbidity is the cloudiness or haziness of a fluid caused by a large number of individual particles that are generally invisible to the naked eye (Fan & Sreinberg, 2010).

Total Suspended Solids (mg/l)

Total Suspended Solids (TSS), are fine particles which consist of microorganisms, algae, mineral particles and organic matter, suspended in water bodies. The TSS analysed before and after treatment are 133.05 mg/l and 58.85 mg/l, respectively, while the WHO and NSDWQ safety standards both have minimum expected values of 10 mg/l each, which are below the determined values. This implies that the TSS determined in both water sources before and after treatment are objectionable for human uses (Alex, 2008).

Heavy Metals

Cadmium (mg/l)

Cadmium occurs naturally in rocks and soils, and it enters water when there is contact with soft groundwater or surface water. Moreover, it may be introduced by paints, pigments, plastic stabilisers, mining and smelting operations, and other industrial operations such as electroplating and fossil fuel, fertiliser, and sewage sludge disposal. At the Maiganga reservoir before treatment, Cadmium has a concentration of 1.10 mg/l, and after treatment, the concentration reduces to 0.9 mg/l. Though both concentrations are above the expected recommended WHO and NSDWQ safety standards of 0.2 mg/l and 0.0 mg/l 1 respectively. This implies that the wetland treatment works, but not very well because the Cadmium level after treatment is still above the expected values; hence, the water is objectionable for human uses (Fan & Sreinberg, 2010).

Chromium (mg/l)

The chromium level at the reservoir before treatment was 0.1058 mg/l and 0.0413 mg/l

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after treatment. Both values are above the WHO (0.003 mg/l) and NSDWQ (0.05 mg/l). This implies that the water is objectionable for human uses. Chromium could be very dangerous and deadly if consumed in a large quantity (Alex, 2008).

Arsenic (mg/l)

The determined value of Arsenic at the reservoir before treatment was 0.0803 mg/l, but it reduced to 0.0171 mg/l after the wetland treatment. While the WHO and NSDWQ-approved standards are 0.003 mg/l and 0.05 mg/l, respectively. This implies that the water after treatment is not objectionable according to WHO safety standards but is slightly above the NSDWQ safety standards. Arsenic could be poisonous if consumed in excess water, and it is certain to cause liver and nervous system damage, vascular disease and skin cancer (Fan & Sreinberg, 2010).

Iron (mg/l)

Iron records 0.2504 mg/l at the reservoir and 0.1291 mg/l after treatment, while the WHO (0.01 mg/l) is below the determined value, hence, the water is permissible, but NSDWQ (0.30 mg/l) is above the determined values and objectionable for human uses. Iron is a very common element found in many rocks and soils of the Earth’s crust. It is also an essential trace element for animal growth if it is below the permissible approved standards (Eneh , 2011).

Lead (mg/l)

Lead is a heavy metal which is denser than most common metals. It is soft, malleable, and also has a relatively low melting point. Lead was determined to have 3.0519 mg/l before treatment and a value of 1.6160 mg/l after treatment. Whereas, the expected values for both WHO (0.01 mg/l) and NSDWQ (0.01 mg/l) are below the determined values. This implies that the water is not objectionable for human use because it is harmful to human health (Eneh, 2011).

Copper (mg/l)

Copper was detected in both water samples before the treatment (0.0794 mg/l) and after the treatment (0.0475 mg/l) with a reduction in volume by 0.0319 mg/l after treatment. The water treatment works well since the determined value was below the WHO safety standard; hence it is permissible. Although it is above the safety limit approved by NSDWQ (1.00 mg/l). This implies that the wetland water is objectionable for human uses according to NSDWQ safety standards. Copper is a soft malleable and ductile metal with very high thermal and electrical conductivity and is very harmful if consumed in excess (Baba & Tayfur, 2011).

Zinc (mg/l)

The determined values before treatment were 0.0428 mg/l and 0.0162 mg/l after treatment. Whereas, the expected WHO value is 0.05 mg/l and 3.0 mg/l for NSDWQ. This implies that the water is only objectionable by the NSDWQ standard because it is above both values. Zinc is an essential trace element. Very small amount of zinc is necessary for human health but it is harmful if consumed in large quantities (Baba & Tayfur, 2011).

Nikel (mg/l)

Nikel was determined before treatment to have a concentration of 0.9053 mg/l and 0.0464 mg/l, while the safety standard of WHO is 5.0 mg/l, above the determined value and 0.01 mg/l for NSDWQ which is below the determined values, hence, is not objectionable for human uses (Alex, 2008).

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Table 1: Results of Sample 1, Wetland Reservoir before treatment and sample surface water after treatment compared with WHO & NSDWQ safety limits.

S/N	Parameters	Unit	Sample 1 Wetland Reservoir Before Treatment	Sample 2 Surface Water After Treatment	WHO Permissible Limit	NSDWQ Nis
1	pH	Mg/l	5.42	5.16	6.5 – 8.5	6.5-8.5
2	Temp. ^{O}C	Mg/l	21.80	19.3	20 – 35	Ambiant
3	Conductivity	µS/cm	611.5	464.00	1000	1000
4	TDS	Mg/l	267.00	226.00	400 – 500	500
5	Turbidity	Mg/l	340.5	111.0	5 – 10	5.00
6	TSS	Mg/l	133.05	58.85	10	10
7	Cd	Mg/l	1.10	0.9	0.2 – 0.5	0.01
8	Cr	Mg/l	0.1058	0.0413	0.003	0.05
9	As	Mg/l	0.0803	0.0171	0.05	0.050
10	Fe	Mg/l	0.2504	0.1291	0.01	0.30
11	Pb	Mg/l	3.0519	1.6160	0.01	0.01
12	Cu	Mg/l	0.0794	0.0475	0.01	1.00
13	Zn	Mg/l	0.0428	0.0162	0.05 – 1.5	3.00
14	Ni	Mg/l	0.9053	0.0464	0.01	0.01
15	Mn	Mg/l	0.0813	0.0530	0.02 – 0.05	0.20
16	DO	Mg/l	2.1257	7.6529	4.00	4.00
17	BOD	Mg/l	2.36	13.20	6.00	6.00
18	COD	Mg/l	11.32	8.69	200 – 250	300

Manganese (mg/l)

The determined concentration of Manganese before treatment (0.0813 mg/l) and after treatment (0.0530 mg/l) were both above the expected values approved by WHO and NSDWQ 0.2 mg/l each. The determined values for both before and after treatment are above the expected standards. This implies that the water is objectionable for human uses even after treatment (Enoh & Abaraogu et al, 2014).

Dissolved Oxygen (mg/l)

The dissolved oxygen before treatment was 2.1257mg/l and after treatment was 7.6529 mg/l. While the WHO and NSDWQ have the same standards of 4.0 mg/l each. The results show that the determined value before water treatment was below the two safety standards, which signifies a high level of pollution which affect the expected DO level in the reservoir before treatment, hence it is objectionable for human use. After treatment, the value of DO, which rose to 7.6529mg/l, signifies less pollution with adequate DO in the treated water. Although the water was not objectionable for human uses after treatment. Any water which has less DO, means the oxygen content in the water has been affected, hence the water is polluted and unsuitable. Oxygen content in water is also affected by temperature. Increasing temperature renders the oxygen to flee from the medium (Eneh, 2011).

Biological Oxygen Demand (mg/l)

The determined values of Biological Oxygen Demand were 2.36 mg/l and 13.20 mg/l, respectively. The result signifies less value in the concentration of BOD before treatment due to the high content of pollutants. Whereas, the increase in the concentration of BOD after treatment is indicative of less content of pollutants, making the water not objectionable for human uses. Though the expected values for WHO and NSDWQ are 6.5mg/l -8.0mg/l

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mg/l and 6 mg/l, respectively. Oxygen content in water is also affected by temperature. Increase in temperature causes the oxygen to flee from the medium (Enoh & Abaraogu et el, 2014).

Chemical Oxygen Demand (mg/l)

Both the untreated and treated waters have less concentration of COD of 11.32mg/l and 8.69mg/l respectively, which are below the two expected safety standards as approved by WHO and NSDWQ with values of 200-250mg/l and 300 mg/l, respectively. The results indicate that both waters are objectionable for human uses because they are both below the approved safety standards. The lower the COD, the higher the level of pollution. High COD signifies less presence of pollution in the water. Oxygen content in water is also affected by temperature. Increase in temperature causes the oxygen to flee from the medium (Steele, 1989).

A t-Test Analysis

Here the student T-test was used as a tool to determine if there is any significant variation between the variables. This would help to achieve objective three. The concentration of physico-chemical parameters in water samples from Maiganga wetland reservoir before treatment and the surface water after treatment. The results show that the mean concentration in physiochemical parameters of water samples in the study area is 78.12 for Maiganga reservoir and 50.62 for Maiganaga surface water, with a standard deviation of 63.32. This implies that water samples in Maiganga reservoir have higher concentrations of heavy metals than the water samples from Maiganga surface water after treatment. Also, it is observed that there is no statistically significant difference in the concentration of physicochemical parameters of water samples in the study area ($t = 1.84$, $df = 17$, $p = 0.08$). This decision was based on the fact that the probability value of the t-test statistics ($p = 0.08$) is greater than the level of significance (0.05). This finding implies that the level of physio-chemical parameter concentration in water samples from the study area share similar characteristics, as well as, a common water quality status, with little or no variations.

To determine the suitability of water quality, table 2 explained the suitability of each parameter using WHO and NSDWQ-approved safety standards. Therefore, parameters like pH, Total Dissolved Solids (TDS); Zinc (Zn) and Chemical Oxygen Demand (COD) are all below the expected permissible safety standards before and even after treatment. This is an indication that the waters before and even after treatment have high contents of pollution, which affect the concentration as expected.

Whereas, temperature; conductivity; turbidity; Total Suspended Solids (TSS) Cadmium (Cd); Chromium (Cr); Iron (Fe); Lead (Pb); Copper (Cu); Nickel (Ni) and Manganese (Mn) are all above the permissible safety standard before and even after the treatment.

Though Arsenic (As) was above the permissible standard before treatment, it means the concentration of Arsenic (As) was reduced after treatment to an acceptable level. This implies the wetland was the effect at this point.

However, parameters like Dissolved Oxygen (DO); Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) indicate lower values, the lower the determined values, the higher and the concentration of pollutants. This is because pollution affects the availability of the said parameters as expected according to the approved safety standards.

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Table 2: Result of Permissibility between sample 1 Wetland Reservior before treatment and Sample 2 Surface water after treatment Compared with WHO and NSDWQ.

S/N	Parameters	Unit	Sample 1 Wetland Reservoir Before Treatment		Sample 2 Surface Water After Treatment		W.H.O Permissible Limit	NSDWQ NIS
	pH	Mg/l	5.42	BP	5.16	BP	6.5 – 8.5	6.5-8.5
	Temp. ^{O}C	Mg/l	21.80	AP	19.3	AP	20 – 35	Ambiant
	Conductivity	µS/cm	611.5	AP	464.00	AP	100	1000
	TDS	Mg/l	267.00	BP	226.00	BP	400 – 500	500
	Turbidity	Mg/l	340.5	AP	111.00	AP	5 – 10	5.00
	TSS	Mg/l	133.05	AP	58.85	AP	10	10
	Cd	Mg/l	1.10	AP	0.9	AP	0.2 – 0.5	0.01
	Cr	Mg/l	0.1058	AP	0.0413	AP	0.003	0.05
	As	Mg/l	0.0803	AP	0.0171	BP	0.05	0.05
	Fe	Mg/l	0.2504	AP	0.1291	AP	0.01	0.30
	Pb	Mg/l	3.0519	AP	1.6160	AP	0.01	0.01
	Cu	Mg/l	0.0794	AP	0.0475	AP	0.01	1.00
	Zn	Mg/l	0.0428	BP	0.0162	BP	0.05-1.5	3.00
	Ni	Mg/l	0.9053	AP	0.0464	AP	0.01	0.01
	Mn	Mg/l	0.0813	AP	0.0530	AP	0.02 – 0.05	0.20
	DO	Mg/l	2.1257	BP	7.6529	AP	4.00	4.00
	BOD	Mg/l	2.36	BP	13.20	AP	6.5-80	6.00
	COD	Mg/l	11.32	BP	8.69	BP	200 – 250	300

NOTE: AP=above permissible; BP=Below permissible

CONCLUSION

The environmental effect of coal mining in Maiganga and its environs cannot be over-emphasized especially as it affects land, water and air. Maiganga coal mining has a great effect on the environment especially as it affects soil and water in the settlements around the mine. The result shows that the water samples analyzed have lower pH below the WHO and NSDWQ which signifies water acidity. The water results show less concentration of Dissolved Oxygen; Biological Oxygen Demand and Chemical Oxygen Demand which signifies the presence of high concentration of dissolved metals like lead, copper, Chromium, Iron and Cadmium among others which has the potential to cause different health challenges in human such us kidney failure, skin rashes, lungs disease among others. However, the negative impact of the reservoir water is reduced, means the wetland treatment is not too effective but commendable.

Recommendations

The water samples before and after treatment show a high concentration of pH, which means there is a high concentration of heavy metals in both water samples. Hence, the study recommends as following:

i. It would be very important to introduce sustainable measures in coal mining activities.

ii. There is a need to modify the wetland water treatment through the advice of expertise in other to achieve the purpose for which it was constructed.

iii. There is a need to link up the area with the state water board in order to have an adequate water supply for the populace.

iv. There is a need to provide more boreholes and dug wells as other sources

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of water supply to the communities so as to reduce pressure on the use of the wetland water source.

v. There is a need to provide more earth dams as water reservoirs for animal consumption.

vi. There is need for continuous monitoring of the wetland and public health surveillance

REFERENCES

Adekoya, J. A. (2003). Environmental Effects of Solid Minerals Mining, Journal of Physical Science, pp. 625-640.

Aigbedion, I. & Iyayi, S. E., (2007) Environmental Effects of Mineral Exploitation in Nigeria. International Journal of Physical Sciences 2 (2), 033-038.

Alex, G. (2008). "Coal combustion: Nuclear Resource or Danger" Oak Ridge National Laboratory.

Arias Ordonez P.J. RUDN Journal of Ecology and Life Safety. 2020;28(2):172-182, 180 ECOLOGIES https://doi.org/10.22363/2313-2310-2020-28-2-172-182.

Association of Official Agricultural Chemists (AOAC) (1950). Official and tentative methods of analysis of the association of official agriculture, chemical Ed.7; Washington.

Atli, G. &d Canli, M. (2006). Responses of metallothionein and reduced glutathione in a freshwater fish American Lung Association, pneumoconiosis, http:/www.lung.org/lung-healthand-diseases/lung-disease-lookup/pneumoconiosis/ (Accessed on 18 April).

Baba, A., & Tayfur, G. (2011). Groundwater contamination and its effect on health in Turkey. *Environmental Monitoring and Assessment*, *183*(1–4), 77–94. https://doi.org/10.1007/s10661-011-1907-z

De Troyer, N., Mereta, S., Goethals, P., & Boets, P. (2016). Water quality assessment of streams and wetlands in a fast-growing East African city. *Water*, *8*(4), 123. https://doi.org/10.3390/w8040123

Dandge, K. P., & Patil, S. S. (2021). Spatial distribution of ground water quality index using remote sensing and GIS techniques. *Applied Water Science*, *12*(1). https://doi.org/10.1007/s13201-021-01546-7

Denny P. (1997) Implementation of constructed wetlands in developing countries. Water Sci. Technol. (1997); 35(5):27-34.https://doi.org/10.2166/wst.1997.0157.

Efe (2007) assessment of surface and groundwater Quality in Ganaja. Lokoja, North Central Nigeria

Eneh O.C. (2011), Effects of Water and Sanitation Crisis on Infants and under-five children in Africa. J. Environ. Sci. Technol. 4(2): 103- III https://doi.org/10.3923/jest.2011.103.111.

DOI: 10.56892/bima.v9i1B.1301

Enoh C. UI and Abaraogu U (2014) Comparative analysis of water quality from hand-dug wells and boreholes in Uyo, Akwa Ibom state, Nigeria.

Eziashi (2005) assessment of Well Water Quality in selected locations in Jos, Plateau State, Nigeria

Fan,A..M & Sreinberg V.E (2010) Health implications of nitrate and nitrite in drinking water: an update on methemoglobinemia occurrence and reproductive and developmental toxicity. Regul. Toxicol. Pharmacol 23:35-43 https://doi.org/10.1006/rtph.1996.0006.

Federal Republic of Nigeria (2004) National water policy Abuja, available at Federal Republic of Nigeria, 2004, at 5, available at http//www.wsssrp.Org.

Finlayson M, D'Cruz R, Davidson N. Ecosystems and Human Well-Being Wetlands and Water: Synthesis. Washington: Island Press; 2005.

Konnerup D, Koottatep T, Brix H. Treatment of domestic wastewater in tropical, subsurface flow constructed wetlands planted with Canna and Heliconia. Ecol. Eng. 2009; 35(2):248-257. https://doi.org/10.1016/j.ecoleng.2008.04.018.

Ramsar (2011) Sites Information Service. Ramsar Information Sheet (RIS): FichaInformativa de losHumedales de Ramsar (FIR) - Versión 2009-2012. Updated December 2011. (In Spanish.) Available from: https://rsis.ramsar.org/RISapp/files/RISrep/EC1991RIS.pdf (accessed: 25.05.2020).

Reyes Quevedo P.E. (2017) Evaluación de la calidad de aguaen el humedal La Tembladerautilizandoíndices de contaminación (Dissertation). Quito: Universidad Internacional SEK.

Tembladera El Oro-Santa Rosa: Guayaquil, Ecuador. 2009, November. (In Spanish.) Available from: http://suia.ambiente.gob.ec/documents/783967/890928/

Vinod Kumar, Nitin Kamboj, Temin Payum & Pankaj Kumar (2020). Advances in environmental pollution management: wastewater impacts and treatment technologies. In *Agro Environ Media - Agriculture and Ennvironmental Science Academy, Haridwar, India eBooks* (pp. 1–244). https://doi.org/10.26832/aesa-2020-aepm

Zhou L, Guan D, Huang X, et al.(2020) Evaluation of the cultural ecosystem services of wetland park. Ecol. Indic. (2020).;114.https://doi.org/10.1016/j.ecolind..106286 .