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Analysing the State of Water Quality Indicators of the Afram River in Ghana: Implication for Water Resources Management

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Abstract

The Afram River has suffered significant degradation and pollution due to the massive amount of domestic wastewater, premix oil and fertiliser runoff from agricultural activities entering the river. At three sites, ten physicochemical and heavy metal parameters were measured along the river. This research aimed to characterise water quality variations in space and time. Water samples were collected and analysed using Atomic Absorption Spectrometry (AAS) at the University of Ghana and the results were analysed using descriptive and inferential statistics and presented in tables. The field results were in comparison to Standards thresholds set out by the Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO). Findings of the research indicated that the lead, cadmium and manganese levels tested were over the maximum acceptable and desirable range. This indicates an increase in local residential trash, agrochemicals and premix oil entering the Afram River. The studied Arsenic, Copper and other heavy metal levels were less than the maximum permitted levels set by the WHO. The paper contends that the National Community Water and Sanitation Program Policy be vigorously implemented, particularly in the interior of the river's 100-meter zones, to protect them from anthropogenic activities and to organise and champion educational and sensitisation programs in the community to raise public awareness about the consequences of their actions.

Keywords: Heavy metals • Physico-chemical • Water quality • Afram river • Ghana

Introduction

Human activities such as waste disposal, the use of poisonous chemicals for fishing, pesticides and fertilisers for agricultural activities in the vicinity of most of these rivers have caused them to deteriorate, causing a decline in water quality and biodiversity in these rivers [1,2]. In accordance with WHO [3], evaluation of water quality stands critical in the direction of ensuring the resources long-term safe use for drinking, agricultural and industrial purposes. Poor drinking water and hygienic conditions cause 80% of all diseases in the developing world. Water and sanitation are in the spotlight more than ever thanks to Long-Term Development Goal 6, which ensures that everyone has access to water and sanitation (U.N., 2015). Freshwater pollution is expanding over the globe in various areas [4]. United Nations said Ghana is among developing countries that suffer from water quality issues, such as loss of pristine water bodies, changes in hydromorphology, growing pollution and invasive species spread. Water shortage affects all continents, thwarts sustainability and inhibits social and economic progress [4].

As a result, everyone must make maintaining water quality a priority. Excess toxic chemicals and biologically available nutrients can cause a variety of issues, including harmful algal bet allooms, oxygen depletion, fish kills and biodiversity loss [5]. According to Ackah M, et al. [6], rural communities in Ghana are well known to depend solely on rivers and other water bodies for survival. Still, the unwholesome nature of these water sources is a question with a limited answer. Ghana aims to have an efficient and effective water resource management system in place by 2030 in order to ensure that all current and potential generations would gain socioeconomically. Management of resources such as water continues to be a major concern in developing countries because anthropogenic activities have contributed in diminishing water sources, steadily increasing pollution load and significantly decreasing environmental stability, which along with climate change pose a serious danger to long-term development [7]. When population grows, it needs a lot of water for domestic and economic purposes, water is now becoming increasingly rare. Precipitation has become uncertain as a result of variability in climate [8-10]. Because it affects soils, crop yields and the surroundings, in addition to human survival, water quality is vital for human wellbeing [11].

However, rivers are incredibly vulnerable to physical and chemical factors that could compromise their quality compared to other water sources [12]. Environmental variables are said to impact water quality-environment relationships [13,14], together with temporary variations in rivers [15]. Poor-quality water can lead to epidemics or water-related health problems, which can make a significant contribution to disease prevalence usually manifests themselves on different time scales. Safe water approaches benefit public health even while promoting socio-economic growth and people's well-being [3]. Measuring the quality of water by juxtaposing water's physicochemical and other related metrics to a set of acceptable level of parameters is used to identify the suitability of water for the feasting of man as well as safe for the surrounding neighbourhoods. The Afram River cannot be ruled out in this study context since it provides significant grounds for fishing operations and fresh water for those residing along the portion of the river's full length. With regards to the aforementioned it becomes paramount for the physico-chemical properties of Afram River to be tested to see how safe it is for inhabitant consumption and how it affects the flora and fauna because most of the inhabitants rely on aquatic organisms for survival. Surface water contamination by toxic substances is increasing at an alarming rate, causing primary concerns among users and stakeholders.

Contaminants are constantly introduced into the water habitats in a variety of forms, primarily due to the steadily increasing anthropogenic and natural

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activity. Heavy metals are one of the worst toxins due to their toxicity, duration, tendency to build up in organisms and strengthen the food chain and difficulty in decomposing. Heavy metals with adverse health effects on metabolic reactions (which include lead, mercury, cadmium, as well as arsenic) pose significant issues resulting from their enduring presence in the environmental factors as well as their propensity for adverse health effects. The lungs, kidneys, liver, endocrine glands, bones and the central nervous system can all suffer damage from symptomatic heavy metal poisoning. It is hard to entirely protect yourself from hazardous toxins. Individuals who aren't heavily vulnerable nonetheless have some metals in their bodies because of other exposure sources including food, drinks, or the air. On the other hand, reducing the likelihood of hazardous heavy metal absorption by lifestyle choices such dietary changes that support the safe metabolism or efflux of absorbed heavy metals can help minimize the risk of metal poisoning [16].

There are actually more than 20 heavy metal; however five of them are particularly hazardous both to the environment and to people's health. There are several different elements which cannot be over emphasized: Magnesium, Copper, Cadmium, Lead, Cadmium as well as Arsenic. (ATSDR, 2011). They seem to be poisonous and can be harmful in low concentrations. This research again took into account physico-chemical metrics include Conductivity, Total Dissolved Solids, pH and water temperature. After already being released into the natural environment, numerous dangerous chemical components accrue in the deposits of water bodies [17]. Among the most damaging activities to the Afram River's quality of water is the sale of pre-mixed oil along the river, as well as waste disposal and agricultural practices. According to Hein CJ and Ashton AD [18], many wetlands areas around the world face problems caused by both anthropogenic and natural factors. Afram communities that don't have access to treated water are forced to rely on this water, which really is harmful to their health and may disrupt the breeding of fish on which inhabitants with in basin rely for a living. This means there is every possibility of these heavy metals to bio-accumulate in fishes, which can eventually be consumed by humans, which may lead to severe diseases. A study that Agyare A, et al. [19] conducted to assessed the Afram river's aquifer systems susceptibility Evans V [20] also analysed groundwater abstraction scenarios using numerical groundwater flow modelling technique in the Kwahu Afram plains.

Again, Boadi KO and Kuitunen M [21] conducted a study on the Davis WM [22] carried out a study on tracking the setup of a series of water system boreholes in Ghana and assessed the quality of certain timber trees derived from the Afram arm of the Volta Lake: Ghana's Afram plains. It is known that the main water supply for Afram plains and its surroundings comes from the Afram River. As a consequence, there is a requirement for factual data on the Afram river to advance water quality understanding and establish as a base for creating, besides implementing an improved strategies to ensure the quality of water that is why this study was conducted. This study also will encourage stakeholders to rethink actions that jeopardize the natural conditions of such an important water resource. Moreover, if the polices and recommendations are followed, they will help to restore the ecosystem to its previous state. The study will also offer data to stakeholders for proactive interventions to safeguard natural water quality. People in the Afram Plains will also be warned about the risks of river pollution. Finally, the study will contribute to existing knowledge on water management.

Materials and Methods

Study area

With Kwahu East to the north, the Kwahu South Municipality has shared borders. Akim South is located to the west, East Akim District and Kwahu West Municipality are located to the south and Fanteakwa District is located to the east. The approximate location of Kwahu South Municipality is between latitudes 6°35" and 6°45" north and longitudes 0°55" and 0°20" west. It is possible that the municipalities include the communities of Nketepa, Adawso and Pitiko. (Ghana Statistical service, 2021). The geographical coordinates of the river are 6°26'40"N, 0°48'0"W; 6°32'0"N, 0°42'40"W; 6°37'20"N, 0°37'20"W and 6° 42'40"N, 0°32'0"W, 6°48'0"N, 0°26'40"W; 6°53'20"N, 0°21'20"W. The site was selected based on the orientation and predominant activities that generally occurs along the Afram River as shown in Figure 1. The selected communities are; Nketepa, Adawso and Pitiko (Figures 1 and 2).

Sampling procedure

The Afram River was sampled in the field from January 2021 to December 2021. The wetlands and fresh water quality survey methods suggested by the governments of Australia and New Zealand in 2000 and the American Public

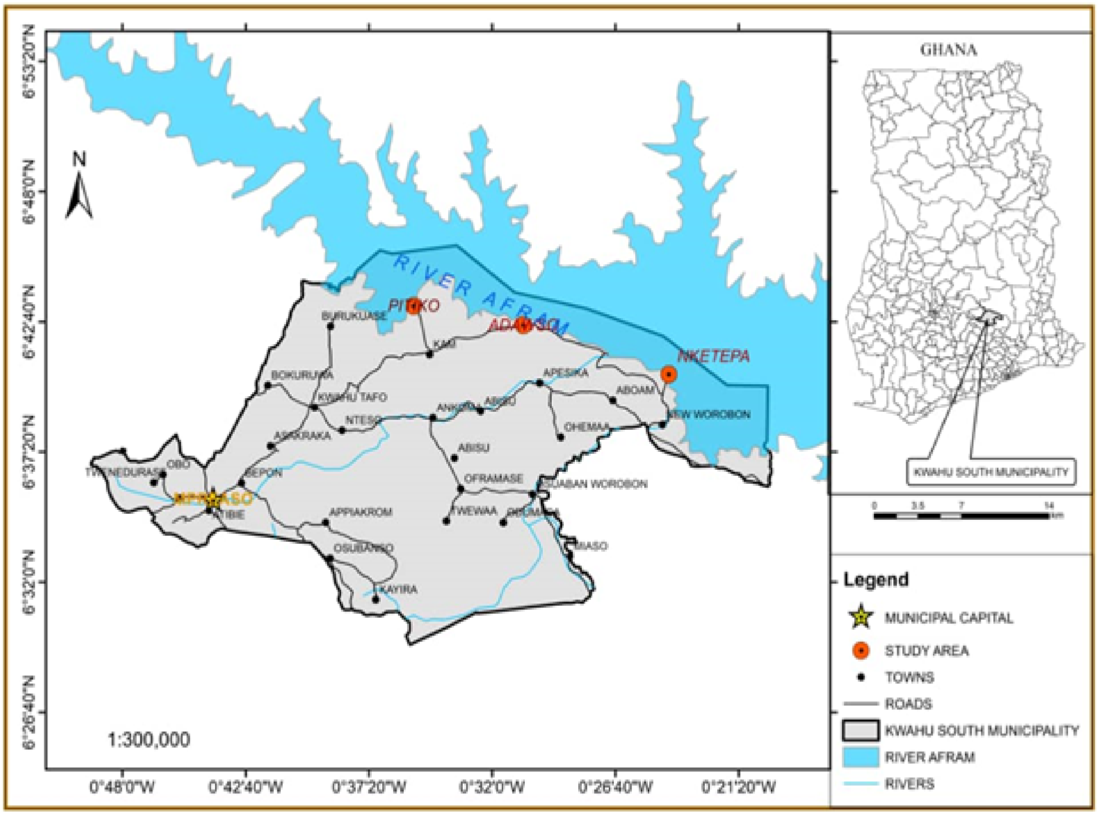

Figure 1. Area of study in regional and national context.

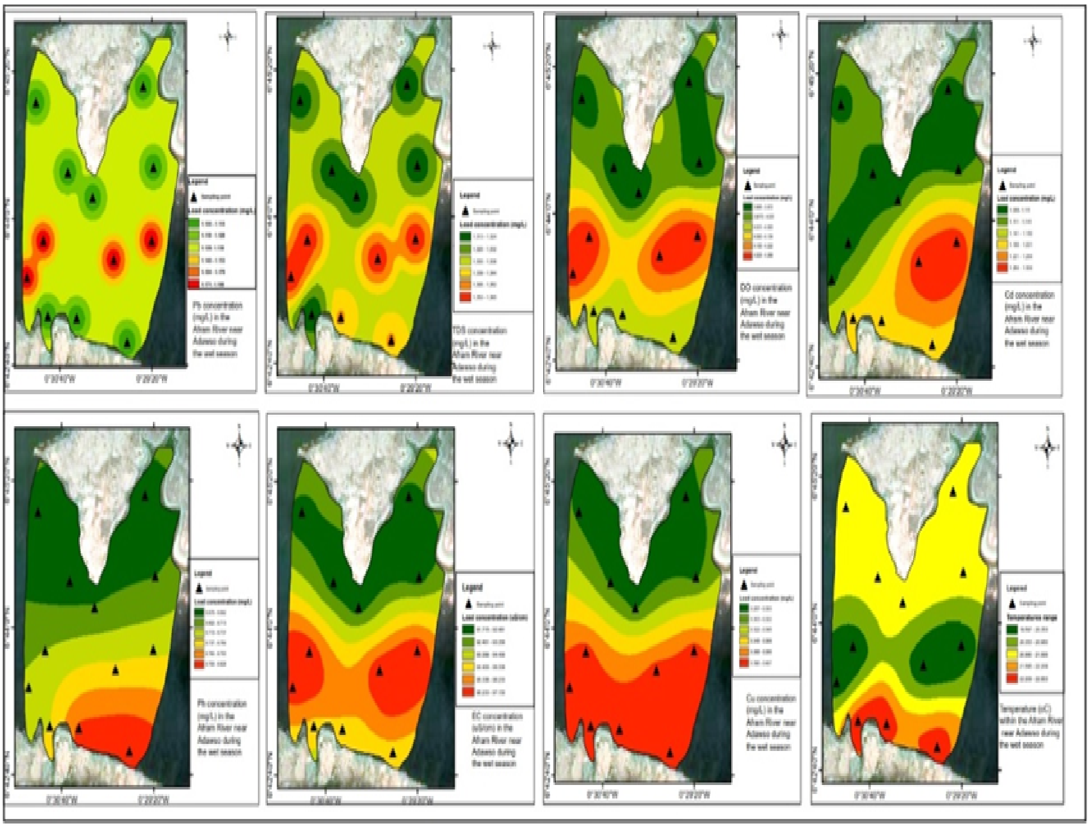

Figure 2. Physicochemical and heavy metals parameters sample points of the river Afram during the wet season.

Health Association (APHA) in 1998 were correctly applied. The samples were obtained between January 2021, which represents the dry season and June/ July 2021, which represents the wet season. Three distinct places had their water samples taken which includes Pitiko, Nketepa and Adawso. Proximity to Afram River and their constant interaction, water sources in these three villages were sampled for analysis.

The places were chosen after taking into account vantage points and activities along the River Afram shoreline, as well as the site's topography and anthropogenic activities. Site A, for example, was selected because it is where the pontoon berths and we assumed that the water quality would change there. Site B is approximately 70 meters from site A, where premix oil is usually sold. Site C is 56 meters from Site B, which depicts the location of the community football pitch and extends to the transitional point where the Late President Jerry John Rowling opened electricity to the Ekye Amanfrom and the Donkorkrom, as well as their diaspora. These sample points were located using the Etrex global positioning system (GPS) (Figure 3).

Sample collection

Water samples were collected using 1.5-liter plastic stoppered bottles. Bottles were cleansed with two drops of Nitric Acid. The Nitric Acid was used to clean the bottle, removing any dirt or particles that might have influenced the study's results. In addition, in compliance with the standards of the World Health Organization and the United Nations Environment Programme, the bottle was cleansed three times with distilled water. The bottles were washed three times in order to prevent contamination of the samples that were taken. After the bottles were filled and sealed, there was no air space or leakage. With appropriate precautions taken to avoid suspended or floating debris. The sample container was carefully lowered into the river at a depth of 10 cm and the mouth was directed upstream to collect water. The name and date of sample were properly labelled on each container. Every precaution was taken to prevent personnel from accessing the body of water. At every sampled point, 500 mL amount of water was collected and stored dry in an ice chest in properly labeled plastic bottles. This method lowers adsorption on container surfaces, which may have an impact on the outcomes [23,24].

After collection of water sample it was then sent to the Ecological Laboratory of the University of Ghana's, Institute for Environmental and Sanitation Studies in Legon, Accra, water samples were collected and examined. Handheld portable pH, thermometers, D.O. sensors, electrical conductivity and total dissolved solids (TDS) meters were used in the lab to measure pH, temperature, dissolved oxygen (D.O.). These water factors were prioritized over others since they are common in specific places like this. Water quality monitoring can help researchers forecast and learn from natural environmental processes, as well as assess human impacts on the environment. These measures can also help with restoration projects or assure compliance with environmental rules.

Quality control, quality assurance and quality assessment

Chapman, 2016 asserts that quality assurance/quality control guarantees that measurements are made to establish a study's accuracy (how close you are to the real result) and precision (how repeatable your results are). To guarantee the integrity of the data, field and laboratory procedures were improved. Before field measurement, sampling vials were thoroughly cleansed in the laboratory with diluted hydrochloric and nitric acid and then rinsed by using de-ionized water. Water collected at each sample point was used to wash the bottles and eliminate any pollutants that may have been introduced. In order to avoid the superficial colloidal layer from influencing the concentration of certain parameters, all water samples were collected at the subsurface. Samples were stored in storage containers with ice cubes to slow down chemical and biological reactions. This technique was employed to prevent water changes brought on by atmospheric gas loss or absorption, especially for dissolved oxygen [25].

Laboratory examination

American Public Health Association's "Standard Methods for the Examination of Water and Wastewater," 1998 Edition, as well as the recommendations for fresh and wetlands water quality, were followed in all laboratory testing. For each season's relevant physical and chemical criteria, samples were gathered and independently assessed. A refrigerator set to 4°C or below was used to preserve water samples that weren't immediately inspected in the lab. The physical and chemical properties of the water samples were examined at the Ecological Laboratory of the University of Ghana in Accra.

Heavy metals analysis

After preparing adequate calibration standards and homogenising the samples, they were filtered and acid-digested before being analysed for trace/

heavy metals content using a Shimadzu model 6401F normally termed as the Flame Atomic Absorption Spectrophotometer (FAAS). Manganese was assessed using cold vapour atomic absorption spectrometry. After that, the water samples were digested by being heated for 30 minutes on a hot plate with 5 ml of 11.1 M HNO_3. The solution was digested until it was light brown or colorless after adding 10 ml of 16.3 M Hcl. In an ETHOS 900 microwave digester, the samples were left for a minutes of 30 before being accepted to cool to ambient temperature. After receiving 5 ml of distilled water, each sample was filtered using a Whatman No. 41 filter paper and a funnel into a 20 ml Teflon tube. After that, distilled water was used to dilute the solution to 20 mL. Using the instrument settings of the VARIAN AA240FS Fast Sequential Atomic Absorption Spectrometer indicated that, liquid extract was used to determine Arsenic, Lead, cadmium, copper and manganese.

The recovery percentage of Arsenic, Lead, Cadmium, Copper and Manganese includes 80.6%, 84.40%, 84%, 86% and 82%, respectively. While considering the energy consumption and volatility of the heavy metals, the following can be regarded as an appropriate temperature for recovery for heavy metals. Arsenate is readily generated if the dust ash is burned beyond 890°C, which hinders the recovery of arsenic. When the dust is heated to between 390 and 890°C, arsenic is easily volatilized and collected, to improve the processing of Cd, vacuum is used at 800°C, Copper recovery was enhanced by the increasing temperature at 120°C, A manganese recovered at a temperature of 80°C and finally, considering the lead recovery rate and energy consumption, the process temperature was 1200°C.

Water quality metrics

The WHO and FEPA water quality indices and the levels of heavy metals in the water samples are compared, as shown in table 1. The Water Quality Index is the most practical method for assessing water quality. On the basis of numerous measures of water quality, the index gives a standardised variable that calculates the average water quality for a certain location and period (Table 1).

Statistical analysis

Atomic Absorption Spectrophotometer (AAS) heavy metal concentrations were analyzed using the Statistical Package for Social Science (SPSS) V. 26 after being coded. The average levels of heavy metals and their standard deviations were calculated using descriptive and inferential statistics. The significant two-tailed Pearson correlation was used to calculate the seasonal concentrations, with a 95% confidence level. Finally, seasonal changes in physicochemical and heavy metal parameters were determined by the application of a sample t-test pairing. The results are presented in the following tables.

Results and Discussion

Assessment of quality metrics of river Afram

The seasonal concentrations and fluctuations in physicochemical characteristics for Afram River samples obtained throughout the two seasons shown. As the results depicts during raining season, mean pH recorded 6.7633 pH units and during the dry season, it was 8.267 pH units. PH readings changed dramatically as shown in table 1 in the two seasons. All over the season of rainfall, however, the pH reported was frequently low. The variation can be attributed to the amount of rainwater that is added to the river, it is lower, higher pH was recorded in the dry season because rainfall decreases during such periods, causing the river to reduce its volume, confirming the findings of Atobatele OE and O. Alex Ugwumba [26] that pH decreases with increased rainfall. With increased rainfall, pH decreases. Carbon dioxide saturation in groundwater may cause lower pH levels. The pH levels of all River Afram sample sites ranged between 6.89 and 8.2, implying that the river Afram is not polluted in terms of acid and alkaline because the pH was within the WHO permissible limits of 6.5-8.5 for pure water and thus it is not capable of producing serious health concerns such as gastro-intestinal irritation or dental and skeletal fluorosis [3].

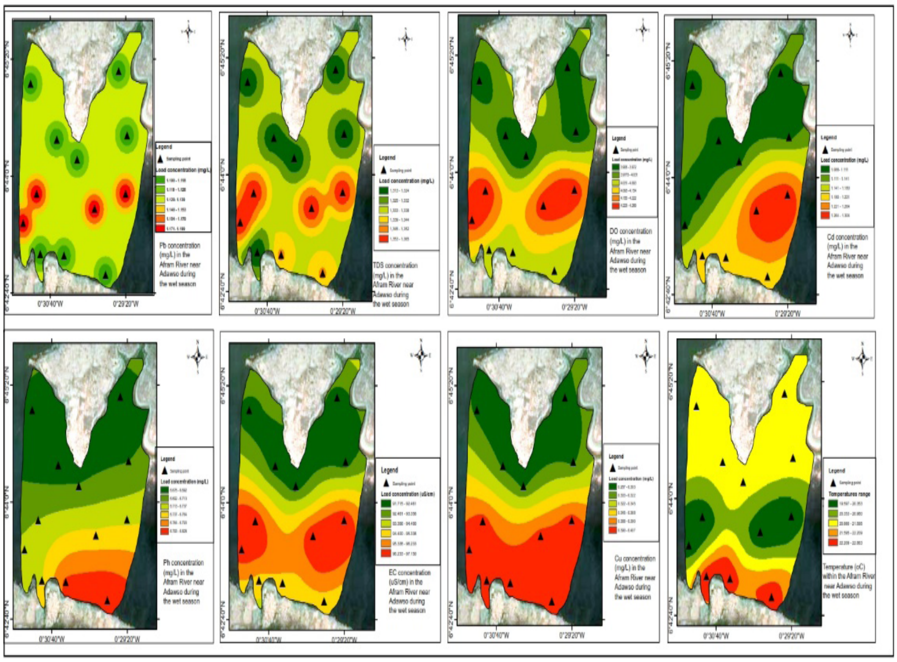

Figure 3. Physicochemical and heavy metals parameters of the river Afram during the dry season.

Table 1. Seasonal mean concentrations and variations in physicochemical parameters.

	Wet season		Dry season		
	Mean	**Std.**	**Mean**	**Std.**	**WHO Standard 2011**
Physico-chemical metrics	concentration (mg/L)	Deviation	concentration (mg/L)	Deviation	6.5-8.5
pH	6.7633	0.1115	8.267	0.0577	22-29°C
TEMP(°C)	21.3	1.5524	32.367	0.8737	>5
DO (mg/L)	4.0867	0.1914	4.3167	0.28711	1000
TDS (mg/L)	1341.67	26.407	618.67	24.786	1500
CON. (µS/cm)	94.67	2.517	152.33	9.452	WHO Standard 2011

The usual water temperature of the Afram River varied during at the raining time. Again, average temperature during the dry season was 32.367°C; it was 21.3°C during the wet season. All sample locations saw high temperatures throughout the dry season, which may have been caused by the higher air temperatures seen during that time (Harmattan). According to the statement in, sunlight rays may enter the water, causing it to be quickly heated to high temperatures. The effects of temperature on many biological and chemical processes might have a bearing on quality of water [27]. Afram River's temperature rose over the permitted level during the dryness period. In a like manner the effect of temperature on human health is indirect.

Records of maximum mean dissolved oxygen value was 4.3167 mg/L, while the lowest mean dissolved oxygen reading was 4.0867 mg/L. To survive, fish and other aquatic creatures require oxygen. Rivers, in general, cannot have too much oxygen. If oxygen levels in the water are too low, fish and other aquatic species may suffocate and die. Hypoxia occurs when the dissolved oxygen level in a river falls below 2.8 mg/L. Hypoxia can cause stress and mass death in fish and aquatic creatures, resulting in decreased fisheries productivity and definition of benthic populations [28]. The Afram River's dissolved oxygen concentration was significantly within WHO-allowable level of >5.0 mg/l (WHO, 2011) and thus was not capable of causing severe health concerns in aquatic life. The Afram River's mean Total Dissolved Solids show some extreme variation. The mean TDS during the wet season was 1341.67mg/L and 618.67mg/L during the dry season. Geology, drainage, atmospheric precipitation and water balance all have an impact on the amount and composition of TDS in natural water [29]. TDS has a WHO standard or acceptable value of 1000 mg/L. (WHO 2011). River Afram had fewer than 1000 mg/L of total dissolved solids.

During the rainy season, the River Afram's TDS was over the limit. The seasonal variation could be ascribed to groundwater leaching, as evidenced by the works of Agbaire PO and I. P. Oyibo [30]. Finally, one of the physicochemical parameters of water, conductivity, was not overemphasised. During the rainy season, the Afram River's mean conductance was 94.67 S/cm and 152.33 S/cm during dryness period. Electrical conductivity is the capacity of any medium, in circumstances like water, to convey an electric current. Calcium, chloride and magnesium are examples of dissolved particles that cause an electric current to flow in water samples. According to World Health Organization [3], the maximum permissible quantity of conductivity is 1000 S/cm, indicating that River Afram is not polluted by electric conductance because the mean value for the two seasons was within the allowable thresholds. Conductivity does not affect human health. It is estimated for a variety of reasons, including determining the rate of mineralisation (existence of minerals such as potassium, calcium and sodium). High conductivity may detract from its visual appeal by imparting a mineral taste to water.

In the water of the Afram River during two separate seasons, tables 2 and 3 display the Pearson Correlation Coefficient that was applied to evaluate the inter-physicochemical Correlation between pairs of physicochemical measures (dry and rainy). The table below displays many notable positive and negative relationships between the physicochemical properties of the water and the seasons. Correlation analysis was done on the Physico-chemical parameters tested. Reasons for the correlation analysis were meant to ascertain the linkage that exist amid each physico-chemical parameter with the others for the two seasons that the samples were taken and their implication. Table 3 shows the correlational values between the physico-chemical metrics for the two seasons (Tables 2 and 3).

From table 3, the Power of Hydrogen (pH) of wet and dry seasons exhibited a strong positive correlation, whiles TEM, D.O., TDS and CON has a moderate positive relationship for the two distinct seasons. However, manganese depicted a moderate positive correlation in the wet season, but manganese has a strong positive relationship in the dry season (r value 1.000) at a significant level of 0.01. Again, the Power of Hydrogen (pH) showed a moderate significant increase in concentration from the rainy to the dry season that is from 0.500 to 0.866, respectively as at a significant level of 0.03 whiles Dissolved Oxygen (D.O.) exhibited a decrease in Correlation from 1.000 at significant level 0.01 in the wet season to -1.000 at a significant level of 0.01 in the season of dryness. Dissolved Oxygen (D.O.) and Dissolved Oxygen have a strong positive association both throughout the dry and rainy seasons. There is a weakly negative correlation between TDS and the rainy season compared to the dry season.

According to table 4, the Afram River's mean arsenic content was 0.001(S/cm) when it's dry out and 0.2673(S/cm) when it's wet out. Arsenic, one of the most dangerous heavy metals, has a significant impact on both environmental and human health. It is abundantly available as sulfides, oxides, or salts of iron, sodium, calcium, copper and other metals. Some elements seem semi-metallic, are extremely hazardous and carcinogenic and contain these metals in large quantities. Because it primarily affects the sulfhydryl group of cells, arsenic is categorized as a protoplasmic toxin, disrupting cell respiration, enzymes and

Table 2. Seasonal differences in physico-chemical parameters.

		Paired differences			95% Confidence interval of the difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	df	Sig. (2-tailed)
Pair 1	pH^W-pH^D	44.86	0.72547	0.41885	43.05784	46.66216	107.103	2	0
Pair 2	DO^W-DO^D	-44.86	0.72547	0.41885	-46.6622	-43.0578	-107.1	2	0
Pair 3	TDS^W-TDS^D	1713.333	56.862	32.83	1572.079	1854.587	52.189	2	0
Pair 4	CON^W-CON^D	-1713.33	56.862	32.83	-1854.59	-1572.08	- 52.189	2	0
Pair 5	$TEMP^W$-$TEMP^D$	-1907.09	51.06837	29.48434	-2033.95	-1780.23	-64.681	2	0

Table 3. Correlation matrix of physico-chemical parameters concentration in the wet and dry seasons.

		Wet Season					Dry Season				
		pH	TEM	DO	TDS	CON	pH	TEM	DO	TDS	CON
Ph	Pearson Correlation	1.000	-	-	-	-	1.000	-	-	-	-
	Sig. (2-tailed)	-	-	-	-	-	-	-	-	-	-
	N	3	-	-	-	-	3	-	-	-	-
TEM	Pearson Correlation	.500	1.000	-	-	-	.866	1.000	-	-	-
	Sig. (2-tailed)	.667	-	-	--	-	.333	-	-	-	-
	N	3	3	-	-	-	3	3	-	-	-
DO	Pearson Correlation	.500	-.500	1.000	-	-	.866	500	1.000	-	-
	Sig. (2-tailed)	.667	.667	-	-	--	.333	.6673	-		-
	N	3	3	3	-	-	3	3	3		-
TDS	Pearson Correlation	.500	-.500	1.000**	1.000	-	.866	-1.000*	-.500	1.00	-
	Sig. (2-tailed)	.667	.667	-	-	-	.333	-	.667	-	-
	N	3	3	3	3	-	3	3	3	3	-
CON	Pearson Correlation	.500	-.500	1.000**	1.000**	1.000	-.866	-500	-1.000***	-.500	1.000
	Sig. (2-tailed)	667	.667	-	-	-	.333	. 667	-	.667	-
	N	3	3	3	3	3	3	3	3	3	3

mitosis. Compared to the other metals studied in the Afram River, arsenic concentrations were the lowest at all test sites. Because the results fell below the acceptable or permitted threshold of 10 μS/cm set by (WHO, 2011), River Afram could be justified as being arsenic-free. The amount of Arsenic in the River Afram may not have any health consequences, such as cell respiration malfunction in the inhabitants and so on (Table 4).

Copper was one of the heavy metals considered for testing in the Afram River. Copper (Cu) mean values were 0.367μg/L in the season of dryness and 0.377μg/L in the raining season. Copper is a trace element required for metabolic processes. Copper levels in the Afram River varied with the seasons. In comparison to the WHO drinking water regulation of 2.0 g/L of Cu, these values are relatively low and may cause little or no danger to consumer health. Furthermore, these small quantities have little to no environmental impact [31]. Manganese Mn (mg/l) mean concentration in all samples in the dryness period was 0.512mg/L, also the manganese average concentration in the raining season was 0.4867mg/L. Concentration levels reported in the River Afram during both seasons could indicate that anthropogenic activities along the river are leaking metal contaminants into the river, one of which is Mn. However, it was recorded that, at the time of raining season, concentrations are somewhat lower than the WHO heavy metal concentration thresholds. In the River Afram, manganese concentrations were 0.53 mg/L, 0.43 mg/L and 0.5 mg/L, respectively. Sites A, B and C; levels above the WHO-permitted level may be hazardous to the environment.

During the investigation, it was discovered that the source of manganese in the river was agricultural operations along the river's banks. As a result, agriculturalists must be trained on how to reduce pollution and encouraged to use pesticides in limited quantities to reduce waste water leaching. In terms of lead (Pb) concentration (mg/L), the mean value for both seasons was 1.133 mg/L. Pb was geographically dispersed, with similar mean values in the waters. The Pb content of the River Afram exceeds the WHO's permitted drinking water guideline. Because it uses fuel, the piston-engine pontoon operating on the Afram River is the lead lead source (Pb). Other sources include waste incinerators, utilities and lead-acid batteries dumped into the river by residents. Because the population depends on the River Afram for survival, if the source of Lead in the river is not controlled, it may negatively harm the residents. Lead is a hazardous metal that can cause harm to man's survival even in trace levels.

Numerous routes exist for lead to enter the human body. Many foods, most especially seafood that has been heavily contaminated by industry, contain it in trace amounts. Even while our urine removes the majority of the lead we absorb, lead build-up is still a possibility, especially in children. Lead poisoning may results to death or irreparable weakening to the kidneys, brain and central nervous system [4]. In addition to behavioural and learning issues (such as hyperactivity), this damage frequently results in memory and attention issues, high blood pressure, hearing issues, headaches, delayed development, issues with both men's and women's reproductive systems, digestive problems and muscle and joint discomfort. Children's exposure to lead poses the greatest health risk due to its long-term effects. A child's development is hampered by lead poisoning, which also harms the neurological system and impairs learning [16], hence it must be monitored.

The Afram River had an average content of 1.2 mg/L of cadmium (Cd) during the dryness period and 1.433 mg/L during wet season. One of the most harmful heavy metals that may damage people's health is cadmium. According to the research, the Cd concentration in the Afram River varied from 1.2 mg/L to 1.6 mg/L. The World Health Organization's 0.003mg/L drinking water standard may not apply to the Afram River because of the level of Cd there. Concentration trend could indicate that anthropogenic cadmium input into River Afram is increasing due to increased wastewater and chemicals deposited in the river. Cd is considered a significant harmful environmental pollutant due

Table 4. Heavy metals mean seasonal concentrations and variations.

Dry Season Heavy	Mean Concentration (mg/L)	Std. Deviation	Wet Season Mean Concentration (mg/L)	Std. Deviation	WHO Standard
As (μS/cm)	0.001	0	0.267333	0.4613029	10.1(μS/cm)
Cu (μg/L)	0.367	0.0577	0.377	0.3525011	2.0 μg/L
Mn (mg/L)	0.512	0.0702	0.4867	0.05132	0.4(mg/L)
Cd (mg/L)	1.2	0.1	1.433	0.1528	0.003(mg/L)

Table 5. Heavy metal concentration variations seasonally.

				Paired Differences		95% Confidence Interval of the Difference			
	Mean	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	Df	Sig. (2-tailed)
Pair 1	As^d-As^w	-0.3657	0.0577	0.0333	-0.5091	-0.2222	-10.97	2	0.008
Pair 2	Mn^d-Mn^w	-1.0333	0.0577	0.0333	-1.1768	-0.8899	-31	2	0.001
Pair 3	Cd^d-Cd^w	1.199	0.1	0.0577	0.9506	1.4474	20.767	2	0.002
Pair 4	Cu^d-Cu^w	0.24667	0.04041	0.02333	0.14627	0.34706	10.571	2	0.009
Pair 5	Pb^d-Pb^w	0.0333	0.1155	0.0667	-0.2535	0.3202	0.5	2	0.667

Table 6. Heavy metal concentration correlation matrix in the wet and dry seasons.

		Wet Season					Dry Season				
		As	Cu	Mn	Pb	Cd	As	Cu	Mn	Pb	Cd
As	Pearson Correlation	-	-	-	-	-	-	-	-	-	-
	Sig. (2-tailed)	-	-	-	-	-	-	-	-	-	-
	N	3	-	-	-	-	3	-	-	-	-
Cu	Pearson Correlation	-	1	-	-	-	-	1.000	-	-	-
	Sig. (2-tailed)	-	-	-	-	-	-	-	-	-	-
	N	3	3	-	-	-	3	3	-	-	-
Mn	Pearson Correlation	-	-	-	--	-	-	.866	1.000	-	-
	Sig. (2-tailed)	-	-	-	-	-	-	.333	--	-	-
	N	3	3	3	-	-	3	3	3	-	-
Pb	Pearson Correlation	-	0.5	-	1.00	-	-	-1.000**	-.866	1.000	-
	Sig. (2-tailed)	-	0.667	-	-	-	-	-	.333	-	-
	N	3	3	3	3	-	3	3	3	3	-
Cd	Pearson Correlation	-	0.866	-	0.866	1.000	-	-866	-.5000	.866	1.000
	Sig. (2-tailed)	-	0.333	-	0.333	-	-	.333	.667	.333	-
	N	3	3	3	3	3	3	3	3	3	3

to its environmental persistence and proclivity to accumulate throughout being considered an essential harmful ecological pollutant due to its environmental diligence and proclivity to accumulate over human life [31].

Anthropogenic activities such as farming in the River Afram's vicinity steadily add to the toxins in the river. Cd concentrations were found to be higher in the area surrounding the Pontoon station. Therefore, it may be inferred that the main causes of Cd contamination in the Afram River include discharge from discarded batteries, deterioration of natural and other sediments, rusting of galvanized pipes on canoes, premix lubricants and fertilisers and detergents from settlements and other locations. Cadmium may also be found in phosphate fertilizers, detergents and refined petroleum products as an impurity [32]. To compare heavy metal concentrations throughout the seasons, a paired sample t-test was use. Cu, Cd and Pb concentrations differed significantly between wet and dry seasons, according to table 5. Mn concentrations, declined dramatically from the raining period to the dry season, whereas Cu and Cd concentrations increased. In contrast, there was no noticeable difference in Pb concentrations (Table 5).

This gives statistical support for the idea that Pb concentrations in the Afram are not seasonally variable. Because the mean concentration of Cu during the dry season is higher than the mean concentration during the wet season, the flow of Cu to the Afram River decreased during the rainy season, according to an examination of the association between Pb and Cu. The researchers explained the variations in evaporation and precipitation as the cause of the increased heavy metal content levels seen during the dry season. With the exception of Pb, the seasonal fluctuation in the distribution and concentration of the analyzed heavy metals may therefore be established. This backs with the findings of Adu-Boahen K and Isaac Boateng [31] on seasonal mapping fluctuation in heavy metal distribution and concentration. Correlation analysis was performed on the heavy metals that were tested during the inquiry.

It was done to establish the relationship of each parameter to the others for the two seasons in which the samples were taken (dry and wet seasons), as well as their implications. Table 6 displays the correlational values for the heavy metal parameters for the dry and wet seasons. Heavy metals found in water samples have varying degrees of correlation with one another. Table 6 shows a favourable link between the wet season, arsenic and copper, as well as lead and cadmium. Cu, Pb, As and Cd showed a similar link to both seasons. Manganese showed a modest positive association at the period of raining but a strong positive relationship at the period of dryness (r value 1.000) at a significant level of 0.01. Again, lead (Pb) has a substantial positive connection with lead (Pb) with respect to the season of dryness of 0.866 (significant at 0.03). Manganese has a very slight negative connection with Lead (Pb) during the dry season (Table 6).

Furthermore, during the dry season, Cupper exhibits very modest negative association of -1.000 (significant at 0.01) with Lead (Pb). Finally, Manganese (Mn) concentration increased moderately from wet to dry season, although Copper (Cu) and Manganese (Mn) correlation levels decreased. A strong correlation coefficient between the examined heavy metals indicates that the metals have a shared origin, mutual dependence and comparable transport behavior. The lack of metal correlation shows that metals are regulated by a combination of geochemical support and relationships rather than by a single element. This suggests that as the seasons change from wet to dry, a frequent source of pollution that releases Pb, Mn and Cd into the Afram River ceases to operate. Negative correlation coefficients show how the amount of heavy metals and its distribution in the Afram river are influenced by a variety of mechanisms, including the interaction or combination of these mechanisms and the varying dependence on the sources of pollution [32-38].

Conclusion

The study discovered that Temperature, Manganese, Lead and Cadmium levels were above the normal thresholds in the season of dryness and this is ascribed to the evaporation rate. When water sample mean concentrations were equated to World Health Organization acceptable standard of water for man consumption, pH, Dissolved Oxygen, Total Dissolved Solids and Electric Conductance showed no variation concerning the season of sampling. Again, it concluded that Afram River is contaminated with Cadmium, Manganese and Lead compared to the WHO allowable drinking water standard. This reflects increased waste entering the river due to fewer environmental regulations. It is evident that the leachate released caused this water body's heavy metal toxicity. Furthermore, it was revealed that agriculture inputs (the application of fertilisers to farms along the river channel), the sale of premix oil at the shore, the key elements influencing the quality of the Afram River were identified as the area's geology (soluble rocks), soil and sewage. Finally, the analyses and evaluation of Arsenic and copper disclose water in the study area is commonly free from such heavy metals; hence, the water cannot cause deterioration to the brain, kidneys, or kidneys of consumers.

Policy Recommendation

To begin with, water quality monitoring is crucial for ensuring that treatment operations are effective and that consumers obtain safe water. With this, the To safeguard water ecosystems from anthropogenic activities and to help with the rehabilitation and restoration of water quality, the National Community Aquatic and Sanitation Program Policy and the Water Resource Commission, which was formed by an Act of Parliament (Act 522 of 1996), should be implemented, particularly within the 100m buffer zones surrounding water ecosystems. Public awareness campaigns are once again required in the research region to inform locals of the risks that human activity poses to water quality. Community Water and Sanitation Agency (CWSA), one of the divisions under the Ministry of Sanitation and Water Resources, may plan and fund such educational projects in the neighborhood.

The Ghana Water Company Limited's Water Quality Assurance Department, in collaboration with district assemblies, should be urged to conduct regular water testing to ensure the quality of their waters and to make disinfectants available. Also, the Water resources commission should regularly educate the surrounding communities about the dangers of dumping solid waste, selling premix oil, bathing and washing into the river. These are unsightly and have an impact on the water quality. Finally, public-private partnerships to be precise Community Water and Sanitation Agency (CWSA), under Ghana Water Company, in collaboration with additional private stakeholders such as Universal Aqua Ghana Ltd, Aqua safe Water care Ltd, H_2O Solutions, Ghana, should be promoted to determine the quality of various water source for inhabitants . In order to prevent wastewater leaching, farmers must also be urged to use a minimal amount of pesticides and instructed on how to reduce contamination. Fields apart from polluted areas and industrial areas should be used for cultivation.

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