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ASSESSMENT OF WATER QUALITY OF THE KWAMAN RIVER IN THE WASSA AMENFI WEST DISTRICT OF GHANA

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ABSTRACT

Access to potable water remains a critical issue in the developing world to protect communities from waterborne diseases. However, more than 2.2 billion people still lack access to safely managed drinking water services. This is particularly true in the Sub-Saharan Africa and South East Asia regions. The study sought to assess the water quality of Kwama River in the Wassa Amenfi West District of Ghana. The river was stratified into three zones namely; upstream, midstream and downstream and samples of water were collected. Monthly water samples were collected from these sampling points of the river and analyzed for physicochemical and microbial parameters. In situ measurements of pH and temperature were performed using a Wagtech International portable meter. Besides, an assessment of sanitation was also conducted in relation to anthropogenic activities close to the river. Distance of 100 m was measured between the river and human activity. pH value of 0.9 was recorded which was highly acidic as compared with Ghana EPA standards of pH 6.5 -8.5 suitable for growth and survival of aquatic organisms, turbidity (0.34 NTU), conductivity (0.19 μs/cm), total dissolved solids (0.19 mg/L), Dissolved oxygen (0.58 mg/L), total suspended solids (0.50 mg/L), chemical parameters; phosphate (0.02 mg/L) , indicates that there was statistical significant difference of mean concentration of phosphate of water samples collected, and nitrate (0.72 mg/L) showed no significant difference of mean concentration for nitrate at the sampling sites. The bacteriological analysis, however, showed that the water was contaminated with total coliforms (4.86-83.9 cfu/100ml), faecal coliforms (15.3- 98.50 cfu/100ml) and E. coli (3.01-67.9 cfu/100ml) as compared with Ghana EPA. Levels of some heavy metals were determined; Iron (0.25 mg/L), Cadmium (0.14 mg/L), Lead (062 mg/L), Mercury (0.52 mg/L), and Oil and Grease (0.39 mg/L) comparing Ghana EPA of 0.001 mg/L and WHO standards, there was no significant difference of mean concentration among all the heavy metals analysed. The high numbers of these biological indicators in the water samples could be attributed to the presence of open defecation, waste discharge and improper sanitation around the river as well as the use of agrochemicals and bad farming practices. The presence of these biological indicators indicates that the water is potentially harmful to human health if consumed untreated. The supply of adequate pipe-borne water must be pursued by the government as a way of improving water availability. Residents need to be sensitised to take up proper sanitation practices and as well treat the water by boiling or properly filtering the water before using it. Succinctly, the residents need to be educated on how to construct, locate and maintain manually dug wells.

Keywords: Rivers, water quality, water-related diseases, sanitation

INTRODUCTION

Protected and satisfactory freshwater is fundamental to the survival of every single living life form and the smooth working of the biological communities, groups and economy. Declining water quality has turned into a worldwide issue of worry as human populations grow, mechanical and farming exercises extend, and environmental change to make real adjustments of the hydrological cycle. It is evaluated that over 2.2 billion people still lack access to safely managed drinking water services (WHO, 2020). Therefore, water quality issues and its administration choices should be given more noteworthy consideration in creating nations. Serious agrarian exercises have expanded the request on groundwater assets in Ghana. Water quality is affected by regular and anthropogenic impacts including nearby atmosphere, geography and water system rehearses (Deshpande *et al*., 2012). Human activities impact the nature of both surface waters and groundwater. Water normally contains disintegrated substances, non-broke up particulates and living life forms; such materials and creatures are fundamental segments of good-quality water, as they help keep up indispensable biochemical cycles (US.EPA, 2004a). There are few exceptions where naturally occurring substances trigger water quality challenges, causing negative effects to human health. In a developing countries like Ghana where nearly 90 % of the population uses groundwater as its primary source of freshwater, up to 15 million people have been at risk of exposure to arsenic in recent decades (Smith *et al*., 2000).

Mining, industrial production, electric power generation, forestry practices, domestic use, agricultural production, and other factors can alter the chemical, biological and physical characteristics of water can threaten the integrity of the ecosystem and human health (Zaporozec *et al.,* 2002).The main sources of water pollution emanates from human settlements, industrial and agricultural activities. Negative factors associated with these activities include unhygienic disposal and inadequate treatment of human and animal wastes, poor management and treatment of industrial residues, inappropriate agricultural practices and unsafe solid waste discharge. WHO 2008 reported that over 80 % of sewage in developing countries is untreated and discharged directly into water bodies.

Mahvi *et al.* (2005) reported that nitrate from agriculture is the most common contaminant in the world's groundwater aquifers. In the United States of America, manure and fertilizer run-off from agriculture is the single greatest source of water pollution, with crop lands along, accounting for nearly 40 % of the nitrogen pollution and 30 % of the phosphorus pollution (Revenga *et al*., 2005). The World Health Organization, (2000) revealed that, contaminated drinking water caused seventy-five percent (75 %) of all sicknesses in developing nations. The absence of access to water likewise restrains good sanitation and cleanliness practices in numerous family units in the light of the priority given for drinking and cooking purposes. Measuring access to enhanced water sources is mostly based on the quality of water concerns.

Satisfactory quality demonstrates the security of consuming water in terms of its physical, chemical and bacteriological parameters (WHO, 2004).

More importantly, individuals can distinguish varieties of water in terms of changes in pH, mineral and natural substance of drinking water (Dietrich, 2006). The change in pH is distinguished in an ambiguous way; with more noteworthy corrosiveness expanding destructively that can degrade the quality of the water, and which infers an alteration in the taste of water. Further, water quality issues are complex and diverse, and deserve urgent global attention and action. This research seeks to outline the main challenges, drivers and impacts related to water quality on rural water resources and strategies adopted to find lasting solution (USEPA 2004c).

Asankrangwa is a fast-growing community and faces challenges with inadequate and unreliable pipe-borne water supply; mostly in new sites due to lack of expansion of the pipe-born water system by the District Assembly. Residents in these communities mainly depend on shallow dug wells, pipe-borne water and River Kwama as their main sources of water for consumption and for other domestic purposes. Provision of sanitation facilities in the community is inadequate as compared to other peri-urban areas which are supported by different agencies and institutions. Open defecation into nearby water bodies as a custom, washing cars bay, oil machines installation, saw mills and block moulding in the nearby vicinity to the water sources and growth in the number of dwellers in the locality of the water sources are some of the challenges that render water sources prone to water contamination in the area

MATERIALS AND METHODS

Study Area

The study was carried out within some selected communities upstream midstream and downstream of the Kwaman River in the Wassa Amenfi West District of Ghana. Asankrangwa is the district capital located in Wassa Amenfi West District of the Western Region of Ghana. Asankrangwa is approximately 250 kilometres west from the capital of the region, Takoradi. The location of the district is located between longitudes 1^{o} 45’W and 2^{o} 11’W and latitudes 5^{o} 30’N and 6^{o} 15’N. The entire land size or land coverage is 3,464.61 km^{2}. This constitutes around 14.5% of the entire land coverage of the Region. The district is surrounded southward by Jomoro and Nzema East, westward by some districts namely, Sefwi-Wiawso and Aowin - Suaman districts, to the north by Bibiani-Anhwiaso-Bekwai and to north-east by Wassa Amenfi East, Wassa Akropong. The district has some projected residents of 235,000 with a normal population concentration of about 78 per sq. km. The district is mainly rural with a population growth rate of 3.2%. (Wassa Amenfi West District Assembly, 2006). Thus, many people enclaved in the district grieve acute water scarcity throughout the dry period. The District lies in the wettest parts of the country with typical yearly rainfall between 1400 mm –1730 mm. There exist two rainfall patterns which are the ones from March to July and then the one from September to December. These two rainfall seasons are separated by two seasons of harmattan. The harmattan covers from December to February and then from August until the rains come. Temperatures are typically high, ranging between 24 0C – 29 0C. Most extreme temperatures are in March and least temperatures in August (Anon 2006). The semi-deciduous woods are situated in the northern side of the equator while the tropical rainforest is at the southern part with the most noteworthy rainfall design. There is a transitional zone between the two regions. The region has wood holds which covers an aggregate range of 413.94 square kilometres. The forests protect different water bodies, for example, Tano, Samre and Ankobra and Kwama waterways (Anon, 2006).

Figure 1: The Amenfi West District, Asankrangwa being depicted in the Map of Ghana.

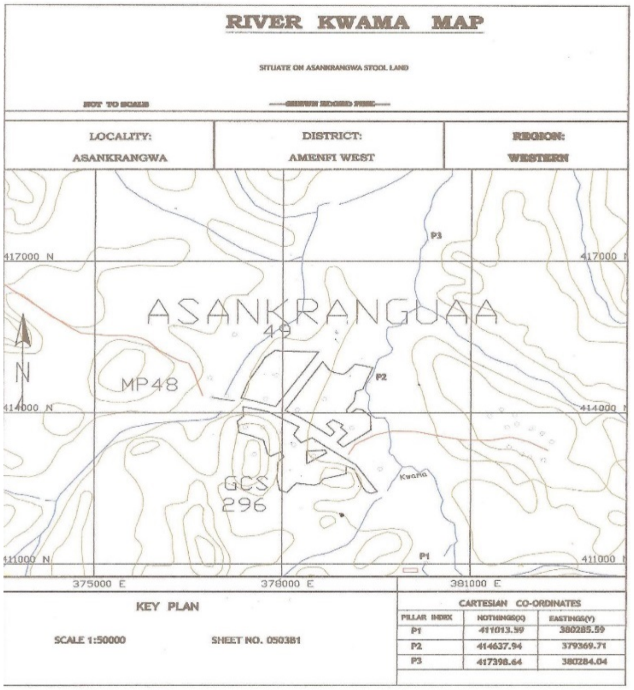

Figure 2: Map of Asankrangwa showing River Kwama indicating sampling sites (P_1, P_2, P_3)

Study Design

Preliminary field investigation was conducted in the Kwama river basin to observe the land use and socio-economic activities near the river. Based on that the river was stratified into three zones namely; downstream, midstream and upstream. Monthly water samples were collected from these sites from November 2017 to March 2018. Three water samples were taken from each sampling point near the right and left banks and in the middle of the river. Triplicate water samples were collected from each point. Water samples were collected in specific bottles according to APHA (2003). Samples were stored in sterile glass flasks and sterilized plastic bottles, cooled, transported to the Ashanti Regional Water quality laboratory for analysis and processed within 24 hours of collection. Temperature, dissolved oxygen (DO), electrical conductivity (EC), and pH were measured insitu using PC 300 Waterproof Handheld pH while Total Dissolved Solids (TDS), Oil and Grease, turbidity, Phosphate (PO_4^{3-}), Nitrate (NO_3^-), and total coliform, faecal coliform (FC) were analysed in the laboratory. Additionally, total dissolved solids (TDS), oil and grease (O&G) were determined at 103–105°C by partition-gravimetric methods (APHA, 2003). Moreover, phosphate was analysed by Ascorbic Acid method and nitrate by Cadmium Reduction method (that is, reduction of nitrate to nitrite). Eventually, faecal coliform was determined based on the membrane filter technique (APHA, 2003). The equipment was calibrated prior to use based on the manufacturer's directions.

Physico-chemical Analysis

pH

The determination of pH for all the samples was made by employing the PC 300 Waterproof Handheld pH meter. Of each sample, a hundred (100 ml) was taken into a plastic beaker of size 500 ml. A digital reading appears upon inserting the probes into the sample indicating first the values of pH. The sample was stirred and the digital reading allowed to tabilize before recording. This was needed to ascertain a reliable reading of the meter employed.

Total Dissolved Solid (TDS)

Total dissolved solid was determined using a Hanna instrument Sension 16 Portable Conductivity Meter. It has an accuracy of ±1%. It automatically compensates for temperature. The electrode rinsed in deionised water and put in the water sample to record the total dissolved solid. The total dissolved solid value was noted and recorded.

Nitrate

The Palin test Nitrate was used to measure the levels of nitric acid in the sampled water. Twenty (20) millilitres of the sampled water was used to fill the nitrate tubes. A levelled spoonful of Nitratest Powder was added to a Nitratest tablet for each water sample. The cap on the screw was replaced and then the test tube was shaken for a minute after which the tube was turned up carefully thrice to ensure flocculation. To ensure that the contents of the tube settled well, the process was followed by allowing the tube to stand for two minutes. The tube was uncapped and the tube's end wiped carefully with a clean tissue. The clear solution formed was transferred into a round bottom test tube and filled up to 10 ml. This was followed by adding a crushed Nitricol tablet which was mixed and allowed to dissolve. The solution made to stand for 10 minutes so that the colour development would be completed. From the Palin test Photometer, 570.0 nm wavelength was selected. Based on knowledge drawn from Suthar *et al.,* (2009), the Nitratest calibration table was then used to ascertain the values.

Dissolved Oxygen (DO)

Dissolved Oxygen was measured using an oxygen-membrane electrode. An YSI Model 55 handheld dissolved oxygen meter was used. It has an accuracy of ± 0.3 mg/L for concentration and ± 2.0% for percentage saturation. The sample was poured into a container containing a stirrer bar such that the depth was at least 2 cm. The same size beaker and approximately the same volume were used for all measurements. The stirrer was turned on and its speed was same for all samples and standards. The DO electrode was removed from the solution bottle. The sponge inside the bottle was determined for any moist. Small air bubbles were acceptable in the electrode but larger air bubbles were removed. The electrode was connected to the meter and allowed for a 15-minute polarization. The tip of the electrode was rinsed with water (using a wash bottle). The DO reading was recorded after the read out had been stabilised (WHO, 1997).

Phosphate

Up to 10ml of the sampled water was transferred into a test tube. One tablet high in phosphate was broken and combined to disintegrate. Normal range of phosphate lies between 2.7-4.5 mg/L. for full colour development, the mixture was allowed to stand for ten minutes. From the photometer, a wavelength of 490 nm was read and recorded.

Oil and Grease

The level of oil and grease in the samples was determined using Partition-Gravimetric method. A 200 ml of sample was measured into a flask and acidified with Hydrochloric acid to pH 2 and transferred into a separating funnel. The sampling bottle was carefully rinsed with 30 ml petroleum ether and solvent washings were added into a separation funnel. The separation funnel was shaken vigorously for 2 minutes and corked. The separation funnel was inverted and the pressure was released through the bottom. The shaking was repeated and the pressure was released until there was no more pressure built up in the separatory funnel. The separation funnel opened and hanged upright thereby allowing solvent to separate from the water sample. The layer of the solvent was separated from the water layer using a funnel which contained filter paper that was moistened with a clean-tarred evaporating dish. The extraction repeated twice more with 30 ml each. Extracts were combined in a tarred flask and the filter paper washed with additional 20 ml solvent. The solvent was distilled using a distillation flask on a water bath at 70°C till the flask was due to oil and grease (Erickson, 2001).

Calculation

$$\text{Oil \& Grease (mg/ L)} = \frac{(A-B)X\ 1000}{Volume\ \ of\ \ sample}$$

Where, A= total gain in weight of the flask in grams, B = solvent blank.

Microbiological Analysis

Total Coliform and Faecal Coliform

In order to ascertain the total coliforms and faecal coliforms as well as *E. coli*, the Plate Count technique was adopted. Of all the water samples, 100 ml each was measured and transferred into a petri dish. In order to obtain complete coliform and faecal coliform pasteurised nutrient agar up to an amount of 10 ml was added. To obtain the *E. coli,* a 10 ml measure of *Escherichia coli* mixture was combined with the 100 ml water samples taken. The mixture is then churned to obtain a proper blend of all inputs and allowed for 10 minutes to settle. The samples selected were kept warm at various temperatures. The total coliforms were heated at 37^{o} C, the faecal coliforms and *E. coli* were both heated at 44^{o}C for 24 hours (Mallin *et al*., 2000).

After this, growth was counted with colony counter. Alternative method included Most Probable Number (MPN) employing tubes or microlitre trays (Asbolt *et al*., 2001).

Heavy metals

An aliquot of 100 ml of water sample for metal determination is transferred into 125 ml conical flask. 5 ml of concentrated HNO_3 was added and evaporated on a hot plate to the lowest volume before precipitation occurred. Digestion was completed by the appearance of a light-coloured clear solution. The solution was then filtered through 0.45 μm filter paper and transferred into a 100-ml volumetric flask, cooled, top to the mark for analysis at the laboratory. A blank was also prepared through the same procedure (APHA, 1998). The concentration iron (Fe), cadmium (Cd), and lead (Pb) were determined using Agilent 240 FS Atomic Absorption Spectrometer by direct aspiration of the water samples into air acetylene flame. Mercury (Hg) was also determined using Atomic Absorption Spectrometer (AAS) cold Vapour.

Gathering Data from the Field

A steel measuring tape was used to determine the distance that existed between the river and the closest human activity. For identifying geographic locations of the river and their closeness to anthropogenic activities, a GPS device was employed. Observation with the eye was made of how hygienic the water body, the sanitation systems and its situations. Also, the surroundings of the water bodies and human activities around the study areas were also considered.

Data Analysis

The results were statistically examined by the use of Microsoft Excel and a one-way ANOVA with the use of STATA (2010) statistical tools. All statistical tests were estimated at 95 % level of confidence and a p-value of 0.05 was considered significant.

Results and Discussion

Physico-Chemical Parameters

Drinking water is all around regarded as one having satisfactory qualities as far as its physical, chemical, and bacteriological parameters to such an extent that it can be used to drink and for other local uses (WHO, 2004). According to WHO (2012), ensuring the use of good quality water is the appropriate way of avoiding and managing water related illnesses. The focus of this research was to understand the physical, chemical and the natural limits of the river under study at the Wassa Amenfi district.

Table 1: Mean and standard deviations of Physico-chemical parameters of different sampling sites.

Parameter	Upstream	Midstream	Downstream	*p - value	WHO guideline
pH	6.4 ± 0.1	6.4 ± 0.3	6.5± 0.2	0.9	-
Temperature (^{0}C)	25.3 ± 0.4	23.2±0.5	28.1 ± 0.2	-	0-30
Turbidity (NTU)	101.9 ± 42.9	78.54 ± 45.59	66.32 ± 16.77	0.34	-
Conductivity (μs/cm)	121.7 ± 23.53	148.7 ± 35.6	178.8 ± 67.18	0.19	500
TDS (mg/L)	61.28 ± 10.88	74.38 ± 17.99	89.38 ± 33.62	0.19	-
DO(mg/L)	3.77 ± 0.07	3.75 ± 0.06	3.80 ± 0.09	0.58	-

TSS (mg/L)	18.20 ± 6.30	55.20 ± 87.40	25.80 ± 14.99	0.50	50.00
Phosphate (mg/L)	1.41 ± 0.58	1.69 ± 0.62	2.87 ± 0.95	0.02	-
Nitrate (mg/L)	1.04 ± 0.96	1.40 ± 1.29	0.87 ± 0.95	0.72	50.00

*p is significant at $p \leq 0.05$

pH

WHO optimum limits of pH levels in drinking water ranges from 6.5-8.5 (W.H.O, 1993). The pH level of water below 7 (that is $p < 7$) the water is acidic but with $pH < 7$, the water is basic. This implied that all the samples of water taken from all the locations in the Kwama River were acidic. That is to say all the values obtained for the ranges fell below 7.0. The average values obtained from the water samples taken makes them desired to be considered as fit to drink water. This is because, using their pH as the criterion for the judgment, all the water samples were potable because they fell within the acceptable parameter of 6.5 to 8.5 which is the required value range for water that is fit to be drank.

Furthermore, pH range recorded in this study was compared to those found in previous studies. For instance, Shittu *et al*., (2008) reported pH levels of 6.8 to 7.3 in a study done in Abeokuta, Nigeria. Other studies include that of Nkansah *et al*, (2010) reported with pH range 6.9 – 7.7 in hand-dug wells in Kumasi Metropolis. Studies conducted by Amankona (2010), recorded a pH levels of 5.03 to 6.54 in boreholes in Ashanti Region. Aquatic organisms could survive within a certain pH range of 5.5 – 8.5. At upstream sampling point, the pH range was 0.1 – 6.4 which indicated an acidic zone as a result of increased concentrations of chemicals and other anthropogenic activities washed into the river as compared to the midstream (0.3 – 6.4) and downstream (0.2 – 6.5). This has heavily polluted the river creating anoxia condition, thereby reducing the population of aquatic animals and water consumption. Water pH of high acidic levels affects both biological and chemical processes (Oluyemi *et al.*, 2010). When water has pH values that are either less than 4.5 or greater than 9.5, they may be very deadly to living things in the water body. When the values of pH seem extreme, they militate against the reproductive and other life processes of living things within the water bodies. PH shows the chemical nature of certain chemical entities and these may determine reactivity, bioavailability and toxicity.

Turbidity

The turbidity of Kwama River at the Upstream (101.92±42.91 NTU), Midstream (78.54±45.59 NTU) and the Downstream (66.32±16.77 NTU) locations for picking the samples were very high when matched against the Ghanaian and worldwide required benchmark of 5.0 for potable water

(WHO, 2007). The high turbidity value obtained from upstream water samples could be caused by surface run-off of sediments and particulate matter into the Kwama River as a result of the release of agrochemicals such as pesticides, fertilizers and Galamsey operation. Turbidity additionally meddles with the infiltration of light. This diminishes photosynthesis and subsequently diminishes the essential efficiency whereupon the fish nourishment creatures depend. As an outcome, angle creation is lessened. Turbidity makes it troublesome for sea-going life to discover nourishment. Then again, a few living organisms may be shielded from predators (Ulrich *et al*., 2001). Furthermore, high rate of turbidity shows that the water may contain a lot of germs and infectious components and thereby posing health challenges in people (Olson, 2004).

Total Dissolved Solids (TDS)

When there are very high components of solids that have dissolved in water bodies, they tend to make the water dangerous to human health. The highest level of dissolved solids that could be permitted for potable water according to the WHO is 1000 mg/L (WHO, 1996). in a study by Kempster *et al.* (1997) when the dissolved solid content of drinking water reaches 2450 mg/L or greater than that, it could be labelled as very critical and actually cause various health challenges. From the findings of the study, the number of dissolved solids from the river showed that it was within acceptable standards for safe human consumption. The highest average concentration obtained for the number of solids dissolved was 89.38±33.62 mg/L, recorded in water samples from downstream sampling site as a result of sewage or waste discharge into the river. The elevated levels of total dissolved solids could be observed in the river as having a bitter or salty taste; results in incrustation or corrosion of fixtures, and reduction in efficiency of water filter and equipment. Total dissolved solids emanated from natural sources, sewage, urban run-off, industrial wastewater discharge, chemicals used in the water treatment process and the nature of the piping lines used to carry water.

Nitrate

The study of nitrate in water is very crucial as these have been identified as major pollutants in groundwater globally (Kempster *et al*., 1997). Research has indicated that high concentration of nitrate (NO_3^-) results in adverse health risks including methaemoglobin anaemia or syndrome especially in pregnant women and bottle-fed infants. WHO (2004) proffered that water could be deemed potable when it contains nitrates components up to 50 mg/L. The research work identified that the nitrate components of all the samples collected met the Ghanaian national standard of 50 mg/L. Again, this shows that the average concentration levels of nitrates from the samples from the river fell within the acceptable standards of the WHO. However, water samples taken from the downstream of the river under study showed lower average concentrations of nitrates when compared to the samples taken from the upper sampling point. The presence of nitrate at the downstream (1.40 ± 1.29) mg/L occurred due to human activities such as application of fertilizer and pesticides. Furthermore, the concentration of dissolved ions caused the river to be salty as well as scale formation/staining. High total dissolved solids may also affect the aesthetic quality of the water (Deshpande *et al.*, 2012).

Phosphate

The excess of phosphorus at the downstream (2.87 ± 0.95) mg/L that gets into the river under study from farming related activities causes more algae and river plants to grow thereby reducing the amount of oxygen dissolved in the water. When this happens, living things within the water bodies are at risk since they are exposed to lower levels of oxygen necessary for their lives. The levels of average phosphate concentration found from the various study points in the river were varied. The observed levels of concentration found from all the study points however showed lower levels when matched with the required standard of 400 mg per litre for potable water. As is opined by Adeyemo *et al* (2008), the lower phosphate concentration of the river could be traced to the geological nature of the study area. The highest mean concentration of (2.87 ± 0.95) mg/L recorded at the downstream sampling site could be as a result of greater amounts of fertilizer application. The intensity of farming activities at the downstream sampling site is high as compared to the other sampling sites. Most of the fertilizers used for farming contain some levels of phosphates.

Table 2: Mean and standard deviations Microbiological parameters of Kwama River

Parameter (cfu/100ml)	Upstream	Midstream	Downstream	*p-value	WHO guidelines
Faecal coliform	800 ± 187.08	960±336.15	1280 ± 998.49	0.48	0.00
Total coliform	13340± 7822.90	16200 ±7216.67	10220 ± 7247.20	0.47	0.00
Echerichia coli	480 ± 148.32	389 ± 130.38	580 ± 370.14	0.76	0.00

*p is significant at $p \leq 0.05$

Bacteriological Parameters

Both in Ghana and according to WHO standards, potable water is expected to have a zero count of total coliforms. When water has higher coliform components, what it means is that the water tends to be more exposed to more contaminating elements such as protozoa, bacteria and viruses. From this study, it was identified from the water samples collected from the midstream study points that had higher concentration of faecal coliform in the river (960±336.15) cfu/100 ml. This could be explained from introduction of human and animal excreta into the water body. These may emanate from direct human or animal excreta into the water bodies, pouring of waste water and the like into water bodies and discharges that may arise from farming and livestock activities. Even though higher faecal coliforms in water bodies do not necessarily imply that the water is harmful, they could mean that the water is contaminated with germs in some cases. According to the WHO standards, a zero count of faecal coliform per 100 ml of water is the safety requirement for drinking water. From the study, it was found that the amount of faecal coliforms at the various study sites exceeded acceptable standards of the WHO.

E. coli was detected in all the sampling sites. Mean concentration of *E. coli* exceeded that of Ghana and WHO standards of 0.00 for drinking water. The highest load of 580 cfu/100 ml recorded at the midstream. This was due to open defecation nearby the water source by inhabitants. The microbial load observed at these sites revealed that Kwama river contaminated by faecal matter of human origin (Asbolt *et al*., 2001), and rendering the water unsafe for drinking (WHO, 2004), posing health risks to humans (WHO, 2012).

The fact that the samples contained E. *coli* components showed that there could be harmful pathogens in the water body. This is in concussion with the study of Kara *et al.*, (2004) which held that when water bodies contain E. *coli*, they are also very likely to contain harmful disease causing bacteria, protozoa and viruses. In the same vein, an earlier study of the district showed that water from the aquifer polluted because it contained pathogens such as *Clostridium perfringens, Staphylococcus aureus, Klebsiella pneumoniae, Salmonella spp, and faecal streptococci ((*Asbolt *et al*., 2001). As was reported by Nkansah *et al*. (2010) this may result from the indiscriminate defecation along the river beds as well as the irresponsible dumping of domestic waste into the water bodies.

Coliform bacteria in groundwater derived from agriculture runoff, effluent from septic tanks or sewage discharge, infiltration of domestic or wild animals' faecal matter, poor maintenance and construction could pose danger to aquatic organisms.

Table 3: Mean and standard deviations of concentration of heavy metals at different sampling sites

Parameter	Upstream	Midstream	Downstream	*p-value	WHO guidelines
Iron (mg/L)	2.13 ± 1.46	3.49 ± 2.23	1.59 ± 1.44	0.25	0.3
Cadmium (mg/L)	1.33 ± 0.42	1.73 ± 0.62	2.16 ± 0.75	0.14	0.003
Lead (mg/L)	0.93 ± 0.56	1.45 ± 0.81	1.33 ± 1.12	0.62	0.01
Mercury (mg/L)	1.59 ± 0.54	1.81 ± 0.69	2.17 ± 1.05	0.52	0.001
Oil, Grease	0.43 ± 0.19	0.62 ± 0.21	0.48 ± 0.15	0.39	0.00

* P is significant at $p \leq 0.05$

Levels of Heavy Metals

Various research works showed that living things in water bodies could survive through their foods by certain metal components. The levels of bioaccumulation may vary from specie to specie and from site to site. The mean range of iron content at the midstream (3.49 ± 2.23) mg/L which exceeded the WHO standards 0.3 mg/L. This indicates that when iron levels are too high, serious health effects can develop including iron overload, which could cause mutation in the gene that digests iron, hemochromatosis which can lead to liver, heart and pancreatic damage, as well as diabetes, weight loss, fatigue, joint pain, stomach problems, nausea, vomiting and other issues.

For example, the American lobster (*Homarus americanus)* has cadmium accumulation in its hepatopancreas. Goldberg (2005) points out that aside mercury; there is no proof of biomagnification of metals that occurs through the food supply system of aquatic life. Mercury is commonly found in higher amounts in fish muscle. There were illegitimate mining activities at the upstream study setting some metals; and in particular mercury (2.17 ± 1.05) mg/L, cadmium (2.16 ± 0.75) mg/L found at the downstream which were used in mining were found having blended with proteins that join metals such as metallothionein which helps to reduce the amounts of toxic concentrations of the water. Up to a certain level, living things could effectively combine metal binding proteins as a way of adapting to situations when a higher metal component gets introduced. This seems to justify how certain living organisms have been able to adapt to life in spite of the high units of metals in their environment. According to a study by Ohioma *et al*., (2009) when human take in high metal components; their health tends to be exposed to higher risks.

Cadmium (Cd)

The study found that the amount of dissolved cadmium in the various study locations fell within the acceptable standard except that of the downstream. The highest levels of cadmium were recorded at the downstream sampling site (2.16 ± 0.75 mg/L).

The levels recorded from the midstream (1.73 ± 0.62 mg/L) and downstream (2.16 ± 0.75 mg/L) sampling sites exceeded critical levels. Levels of cadmium was higher in areas supplied with soft water of low pH, as this would tend to be more corrosive in plumbing systems containing cadmium. Cadmium could potentially cause health effects when people are exposed to it at certain levels above the maximum contaminant levels (MCL) for relatively short periods of time: nausea, vomiting, diarrhoea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock and renal failure. Long-term exposure of cadmium could also cause kidney, liver, bone and blood damage (U.S.EPA, 2007).

Iron (Fe)

According to the World Health Organisation (2004), the highest acceptable level of iron in potable water should be up to 0.10 mg per litre even though Ghana has quite a higher level of 0.3 mg per litre. The study however found iron concentrations that exceeded even the Ghanaian standard. For the iron concentration level for the midstream (3.49±2.23) mg/L were noticeably high in the water samples as compared to the upstream (2.13±1.46) mg/L and downstream (1.59±1.44) mg/L. Hence, the iron concentration of the Kwama River at the various sampling sites was very high which is above the acceptable range for human consumption. More noteworthy measures of iron advance development of green growth, which could square daylight from plants and upset environments and nourishing practices. Broad green growth nearness brings down water freshness and advances stagnation. Press tainting influences propagation and sustaining propensities for angle and other oceanic life. High groupings of iron some of the time result in expanded corrosiveness of water killing or harming amphibian life and negative consequences for people or animals expending them (Bharati, 2012).

Lead (Pb)

The study found higher levels (1.33±1.12 mg/L) above the WHO standards of lead concentration from the samples picked from all three study points (WHO, 2004). This will have serious health implication on the people upon drinking the water. Adverse health effects of exposure to high levels of Pb includes reduced birth weight, early birth, delayed mental and physical development in children, anaemia, damage to the nervous system and the kidney (Daniels and Mesmer, 2010).

Mercury (Hg)

Mercury is used during ore processing. Mercury constitutes the major pollutants of surface and ground water in small scale gold mining areas (Ntengwe, 2006). The result showed the mean concentrations of mercury at downstream area (2.17±1.05) mg/L were higher compared to the WHO standard for potable water. The high level of Mercury at the downstream can be attributed to run-off of the small scale gold mining (Galamsey) operations within the area. This imposes a severe health risk to the people as well as living organisms in the river. Mercury occurs naturally in the environment and cycles among the atmosphere, water, and sediments. Human activities such as power plants, coal burning, illegal mining, waste incineration, increase the amount of mercury cycling in the environment. Anthropogenic mercury emissions resulted in increased mercury levels in terrestrial and aquatic ecosystems. People exposed to mercury (methyl mercury) could experience adverse health effects such as loss of vision, muscle weakness, impairment of speech, walking and hearing, and lack of coordination of movements (USEPA, 2007).

Oil and Grease

The mean concentration of oil and grease at the three sampling sites were extremely higher than WHO standard for potable drinking water (WHO, 2006). The highest mean concentration was recorded at midstream (0.62 ± 0.21) of Kwama River. This is probably because of the fact that oil plants and engines as well as washing bays are sited close to the water body.

Hence, poses health risk to the people and living organisms. The accumulation of these oils and/or grease retarded the growth, respiration, phytoplankton, and killed many young aquatic organisms and extinction of fish and shell fish (Otitoloju and Don-Pedro, 2002). Oil residuals emanated from chemical shops, automobiles, oil refinery, oil terminals, and fuel tankers could be discharged into the river thereby contaminating the river.

Sanitation Assessment

Consumption of water from the Kwama River is found to pose several health challenges. From some of the respondents of the study, this was ascertained through comments such as *"there are microbes in the water which cause health problems"*. The river has been contaminated from many sources, comprising naturally occurring chemicals and minerals for example, mercury, iron, lead, cadmium and uranium), oil and grease, local land use practices (fertilizers, pesticides, concentrated feeding operations), manufacturing processes, and sewer overflows or wastewater releases.

Lack of improved sources of water in the area forces households to use the Kwama River. The rather surprising contradiction found is that the people who depend on the Kwama River do not make use of any treatment agent to kill infections. This was ascertained through comments such as, *"I have no water disinfectant"* and *"that is how our water has been and we have been drinking it since time immemorial in the same way"*. The residents were however in the know of the possible dangers they face if waste materials such as food coverings, polythene bags and other plastic materials are dumped into the water body. A respondent for example said *"the only reason we get sick is because dirty things are dumped into the water"*

Careless defecation in unauthorised places, pit latrine without slab/open pit, septic tank, flush or pour-flush to elsewhere, hanging toilet or hanging latrine were what most people 83 % used. The reason given for this was that there were inadequate private and public latrines and/or water closet facility, presumably in light of the low income of the average families. The subsequent dangers coming out of hand and individuals were uninformed that the development of lavatories would be useful to address the issue.

Further, high incidence of "Galamsey" or illegal mining in recent times in the area posed severe threats and this has perplexed the minds of the general public in the community. Galamsey could also cause more damaging deforestation than bad farming practices. In a quest to know more, visits were made to Freeman Gold Mining sites in some communities to witness the devastating nature of Galamsey in the district. Extensive studies conducted on the Galamsey phenomenon estimate that half of those employed in Galamsey operations in Ghana, were the youth, women and children.

Virgin lands had been destroyed without considering the future generations. The factors that combine to trigger someone involve in this illegal mining were easy to identify. One major cause of this devilish act was the burning desire for material things. It was always the ambition of most young men and women to get rich quickly in order to obtain whatever was fashionable. There was almost finish lack of controlled waste dumps site, absence of rubbish gathering frameworks and low access to improved water sources compounded this issue, and waste administration was a noteworthy worry of the area. The people living at Asankrangwa rely on three main water sources for domestic use. Specifically, for drinking, 35.9% of the respondents rely on borehole, 6.7% of the respondents also rely on rain water that is gathered in tanks and the majority of them (57.4%) rely on surface water for drinking. For the most part, individuals had understanding of utilizing sterilization procedures, for example, chlorination; however they did not execute them, for different reasons. This is likely to be the result of the additional work or extra costs required. Families utilized just untreated water sources. The outcomes from this research accordingly demonstrate that 57.4 % of families utilize unimproved water (surface water and water tank) for drinking purposes. This extent was higher than the guideline values reported by WHO and UNICEF (2013).

Observation of maternal practices in dealing with kids' excreta demonstrated that regularly no prudent steps were taken. This circumstance could support the vehicle of faecal infections. The investigation uncovered that disgraceful transfer of waste and unsanitary taking care of practices of kids' dung were related with an expansion of 32 % brought about diarrhoea (USEPA, 2004a). Moreover, systematic hand-washing after defecation remained marginal. Wastewater, as well as solid waste, is poorly managed in the district. These anthropogenic activities posed a risk to public health. In some communities, people used garbage as fertilizer on plantation establishment. Improper application of fertilizer and pesticides and wastewater could be washed into the river thereby causing pollution.

Conclusion

In sum, the study ascertained that all water samples collected from the various sampling sites in the Kwama River were acidic. This made the water not suitable for drinking because the pH concentrations of the river fell outside the desired acceptable standards.

The average levels of turbidity (66.32 ± 16.77) NTU obtained from the samples studied notably exceeded nationally known levels of turbidity. This makes the Kwama River not suitable to be used for domestic purposes. The study further showed that the conductivity of water from all the water samples did not exceed the national levels. The water was further found safe for drinking because the estimated dissolved solids (0.19 mg/L) in the Kwama River remained at the conventionally accepted level (0.3 mg/L) for drinking water.

Even though the known national level for nitrate and phosphate concentrations respectively stood at 50 and 400, the findings from the sample sites showed lower levels when matched with the national standards. But for the fact that the sampling site, downstream which showed a higher level of concentration of heavy metals such as cadmium (2.16 ± 0.75) mg/L, all the other remaining sites showed concentration levels that fell within the EPA Ghana standards of drinking water. The levels of lead-mercury detection from the sampled water from all the study sites were above their respective standard values. Even though the acceptable level of concentration of oil and grease is 0.00 for drinking water, the study identified that all the sampling sites showed higher concentration levels. It was further found that for the average level of dissolved oxygen and the total dissolved solids were within 3.04 mg/L and 5.28 mg/L which is the standardised value of World Health Organization. All the sites from which the sampling was done showed results of high count total coliforms and excreta coliforms and E. *coli*.

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