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Assessment of Gross Alpha and Beta Radioactivity in Surface and Ground Water of Komadugu-Yobe Riverine Areas of Yobe State

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Abstract
Water in its purest form is odorless, colorless and tasteless. However, resulting from human and animal activities, it is usually contaminated with solid and human waste, effluents from chemical industries and radionuclides. Baseline data on radiation in environments are of great importance in environmental safety assessment and protection of public health. This study investigated the gross alpha and beta activities (GABAs) in surface and ground water of river Komadugu-Yobe riverine areas of Yobe state, Nigeria. Surface and ground water samples were collected and analysed using MPC-2000DP Low Background proportional counter. The GABA result indicated that all the alpha and beta activity concentrations in the ground water samples analyzed across the study area were below the WHO 0.5 Bq/L and 1Bq/L for alpha and beta activity benchmarks. Similarly, all the alpha and beta activity concentrations in the surface water samples analyzed across the study area were below the WHO 0.5 Bq/L and 1Bq/L for alpha and beta activity benchmarks except in river E and G samples where extreme values of 0.6034±0.0197Bq/L and 4.9276±0.1629Bq/L alpha activities as well as1.2382±0.0402Bq/L and 1.2382±0.3055Bq/L beta activities above the WHO benchmark were obtained. This is in agreement with previous study which revealed that GABA concentrations of Gashua (location code A) river water samples along Komadugu-Yobe River were within the typical world average values. Based on the findings of the study, it can be concluded that all the water samples analyzed have no significant radiological health burden on the environment and the populace except locations E and G surface water. It is therefore recommended that efforts should be intensified to identify further sources of contaminations with a view to addressing the long standing renal and kidney failure scenario experienced by large group in the study area.

Keywords: radioactivity, gross alpha and beta activity, Komadugu-Yobe River, Gashua, proportional counter.

INTRODUCTION
The high rate of kidney failure and other health related problems in the communities of riverine areas of Komadugu-Yobe River is an indication of water pollution from natural and anthropogenic sources as supported by previous studies (Waziri, 2016). According to United States Environmental Protection Agency USEPA (2018) radiations are among the major

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contaminants of ground and river water. Radiations are emissions or transmission of energy in form of electromagnetic wave or particles through space or material media. Radiation source of water pollution may arise from the secondary particles of cosmic radiation, which release radionuclides into the atmosphere, and these radionuclides, are washed down by rain into ground and surface water bodies. Water sources are equally polluted by naturally occurring radioactive materials (NORMs) of the earth's crust (terrestrial radioactivity); which emit alpha, beta and gamma radiations (Nwoke, 2006). These materials normally are elements in the uranium and thorium series and are more concentrated in deep ground water than in surface water. They contaminate the water body directly with their radionuclide products; and indirectly, through the radon and thoron gaseous products which can solidify and attach themselves as aerosols to the air particles and are washed down by rain into water bodies (Nwoke, 2006). People who ingest radioactive polluted water can develop illness and with prolonged exposure can develop cancers; toxicity of the kidneys or bear children with birth defects at doses above 100 mSv (Brenner et al., 2003 &Mangset et al., 2014).

Earlier relevant study conducted by Abba (2013) on measurement of radioactivity (GABA) in water and sediments of Gashua (location A) area of river Yobe showed that activity concentrations were within the typical world average values of 0.5Bq/L and 1Bq/L for alpha and beta activity (GABA) respectively.Despite the study conducted, the populace along the Nguru-Gashua axis ofKomadugu-Yobe riverine areas have been experiencing water borne health related issues, more especially in Gashua town for over three decades (Waziri, 2016). Dimari, *et al*. (as cited in Abba, 2013) reported that kidney related diseases have been observed in large group in the Gashua town. Baseline data on radiation would help environmentalist and health workers in pollution assessment, decision making and also in tracing the history of the recent prevailing health cases of renal failure and kidney diseases in the study area (Waziri, 2016). Therefore, it is against this background that this study investigated the GABAs in surface and ground water of Nguru-Gashua riverine areas of river Komadugu-Yobe using proportional counter and compared the result with the World Health Organisation WHO benchmark.

MATERIALS AND METHODS

Study area: The Kumadugu-Yobe River (KYR) is situated in the Sahel region in Africa, just south of the Sahara desert. It is located between latitude 10.0 N and 13.00 N and longitude 9.450 E and 12.300 E of the prime meridian. The area of study is Nguru-Gashua axis of the river which covers a distance of about 65 km along the river coast. It is the principal river in the state from which Yobe state derived its name. It has a few tributaries, which include river Hadeja, Jama're and river Alkalam. The farmers who live in this area generally rear animals, raise crops and some vegetables (YSPS, 2010).Agrochemicals such as fertilizers, pesticides, herbicides and refuse dump by the riverside are the main sources of contaminant of the river since there are no large cities, no-nuclear enterprises such as radiochemical and phosphate industries and coal-fired power plants situated around the river coast.

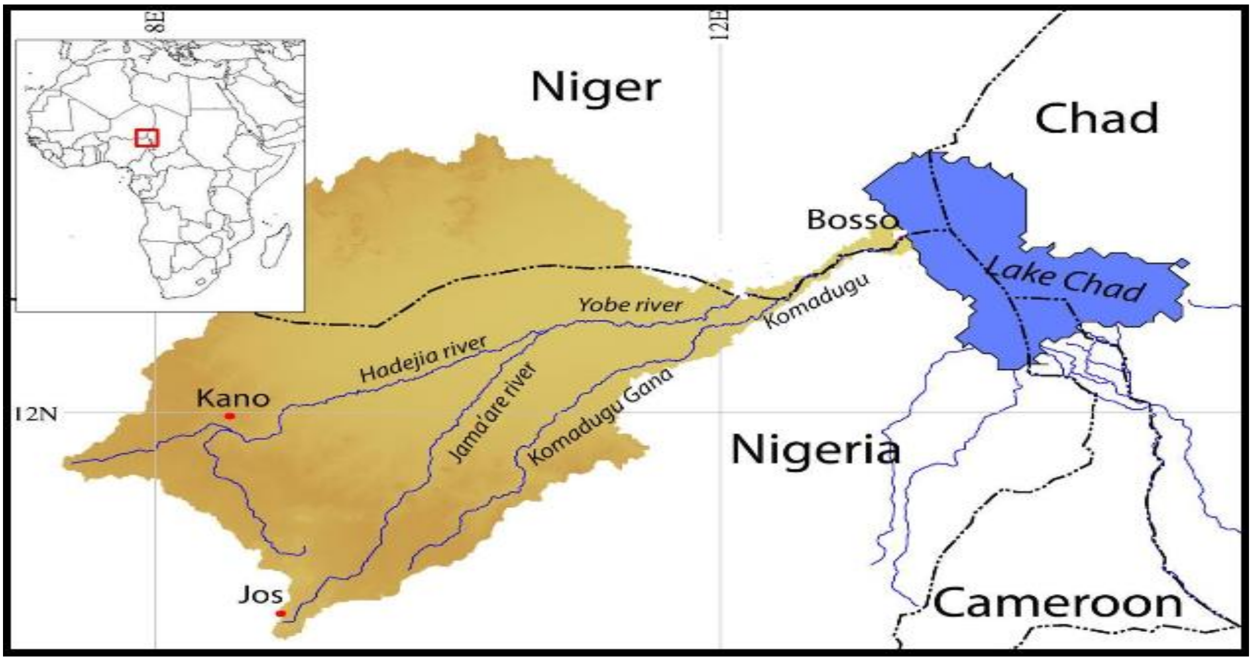


Figure 1.1: Map showing the Komadugu – Yobe river.
Source: adapted from Martinsson, 2010.

Climate: The rainfall in the study area is highly irregular which makes farming difficult since small differences in the amount and timing of rain received at a site may determine the success or failure of critical stages in vegetation development and crop production (YSPS, 2010). Therefore, the developments of agricultural activities heavily depend on irrigation farming. The mean annual temperature of the study area is 37°C with the highest temperature (about 42°C) which is normally experienced in April, while minimum temperatures (about 30°C) are usually recorded in December (Abba, 2013). The rainy season usually starts from June until September and the dry season is from October until May (Martinsson, 2010).This means that rainfall lasts for about 120 days with a marked dry season of eight to nine months and a wet season of only three to four months.

Vegetation: The vegetation of the study area is Sahel (desert) savannah. It is desert vegetation that is characterized by very short grasses and tussock of not more than one metre (0.5m to 1.0m) high interspersed and located in-between sand dunes. The area is dominated by several varieties of the acacia and date - palms (YSPS, 2010).

MATERIALS AND METHODS:
Materials and Equipment used: The materials/ equipment used for GABA analysis include the following:

i. Beaker (500ml)
ii. Petri dish
iii. Police rubber
iv. Reagents (acetone and ethanol)
v. Weighing balance (Mettler AE240)
vi. Hand glove
vii. Plastic container (2 litres)
viii. Desiccator
ix. planchettes
x. Hot plate (adjustable)
xi. Marker and masking tape
xii. GPS device.

Sample locations: Eight (8) sample locations were sited along the Nguru-Gashua axis of the river Komadugu-Yobe with the aid of the Global Positioning System (GPS) device and coded as shown in Table 1.

Table 1: Sample Locations, Codes and their Coordinates

S/N	Location codes	Location names	Latitude coordinates	Longitude coordinates	Elevation (m)
1	A	Gashua	12^{0}52′39″N	11^{0}01′56″E	363
2	B	Dumsai/D. Kuka	12^{0}53′45″N	10^{0}31′07″E	370
3	C	Gassima	12^{0}52′43″N	10^{0}58′13″E	365
4	D	Kanuri Sabon G.	12^{0}53′05″N	10^{0}28′10″E	372
5	E	Bukarti	12^{0}53′39″N	10^{0}54′27″E	369
6	F	Wachakal	12^{0}49′54″N	10^{0}31′32″E	378
7	G	Jajimaji	12^{0}56′53″N	10^{0}47′25″E	364
8	H	Nguru	12^{0}52′45″N	10^{0}27′09″E	373

Source: Google Global Position System, 2017.

Sample collection, preparation and experimentation: The water samples were collected from boreholes (hand driven) and banks of the river (where the river current was minimal) in March 2018 using 2 liter plastic bottles with tight covers after carefully washed and rinsed so that the samples collected could be the representative of the bulk. The samples at the time of collection were acidified with few drops of concentrated nitric acid (15 ml of HNO_3 per litre) to reduce the pH, minimize precipitation and absorption by the walls of the plastic container as well as to prevent the growth of micro-organisms (Mangset*et al*, 2014).A cleansing agent (acetone) was first used to wash the apparatus and weighted 500ml sampled surface and ground water were evaporated to dryness. 0.077g residue were carefullyweighed and transferred to the planchettes for GABA counts.MPC-2000DP Proportional Counter was used for the GABA count in the Alpha and Beta Counting Laboratory of Centre for Energy Research and Training (CERT), Ahmadu Bello University Zaria.Sr-90 (beta source) and Pu-239 (alpha source) were used as calibration sources for MPC2000DP.

Statistical analysis: The data obtained were analyzed using the Excel spreadsheet and SPSS statistical software version 20.

RESULTS AND DISCUSSION

Gross Alpha and Beta Activities in the Study Area

Table 2 shows the levels of gross alpha and beta activities in surface and ground water of the study area

Table 2:Alpha and Beta Activity Concentrations of the Water Samples Analyzed

Sample I.D.	Alpha (Bq/L)	± Error	Beta (Bq/L)	± Error
B/Hole A	0.0614	0.0024	0.1124	0.0049
B/Hole B	0.0094	0.0030	0.0924	0.0067
B/Hole C	0.0211	0.0015	0.0810	0.0027
B/Hole D	0.0120	0.0063	0.1125	0.0135
B/Hole E	0.0823	0.0024	0.0074	0.0056
B/Hole F	0.0634	0.0018	0.1300	0.0042
B/Hole G	0.0434	0.0014	0.0890	0.0025
B/Hole H	0.1094	0.0031	0.2246	0.0064
River A	0.0712	0.0023	0.1461	0.0042
River B	0.0500	0.0028	0.0613	0.0055
River C	0.0922	0.0029	0.1891	0.0058
River D	0.0937	0.0027	0.1923	0.0059
River E	0.6034	0.0197	1.2382	0.0402
River F	0.1584	0.0048	0.1309	0.0117
River G	4.9276	0.1629	1.2382	0.3055
River H	0.1292	0.0038	0.3250	0.0085

From Table 2, the average alpha activity concentration in ground water samples across the study area ranged from 0.0094±0.0030Bq/L to 0.1094±0.0031Bq/L and was of the order of H>E>F>A>G>C>D>B respectively. While in contrast, the average beta activity concentrations in ground water samples in the study area was of the order of H>F>D>A>B>G>C>E, with a minimum beta concentration of 0.0074±0.0056Bq/L and a maximum beta concentration of 0.2246±0.0064Bq/L respectively. Similarly, the mean alpha activity concentrations in surface water samples in the study area was of the order of G>E>F>H>D>C>A>B, with a lowest alpha concentration value of 0.0500±0.0028Bq/L and ahighest alpha concentration value of 4.9276±0.01629Bq/L respectively. While on the other hand, the average beta activity concentration in surface river water samples across the study area ranged from 0.0613±0.0055Bq/L to 1.2382±0.3055Bq/L and was of the order of G>E>H>D>C>A>F>B respectively as shown in Figure 2.

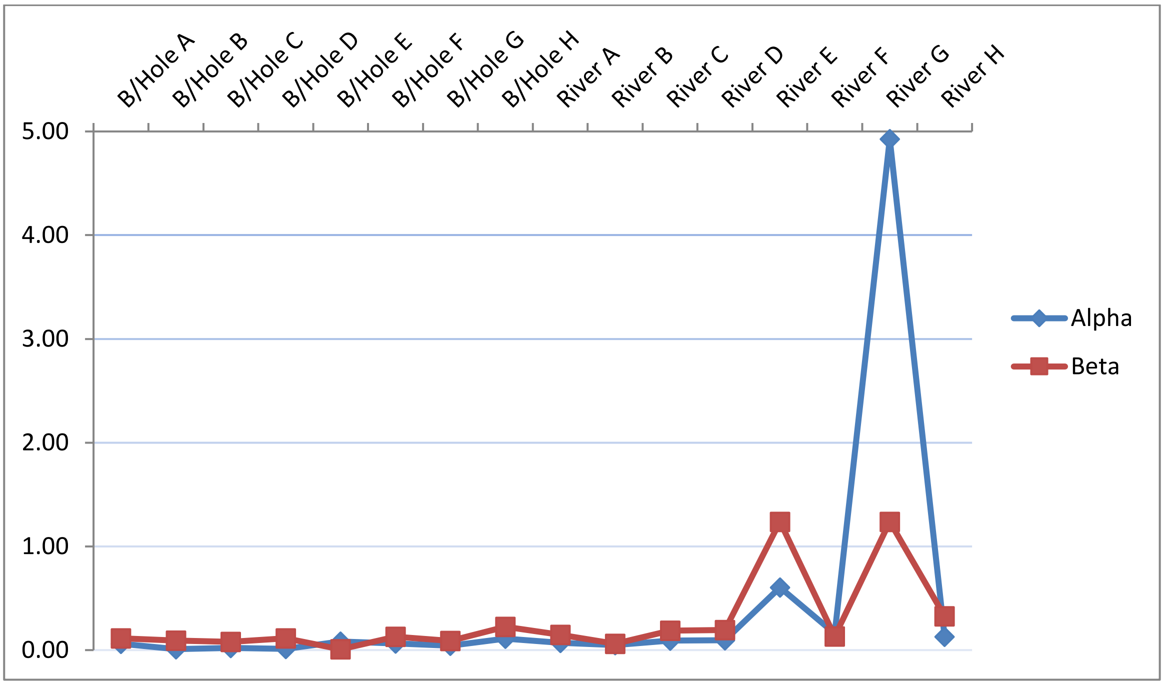
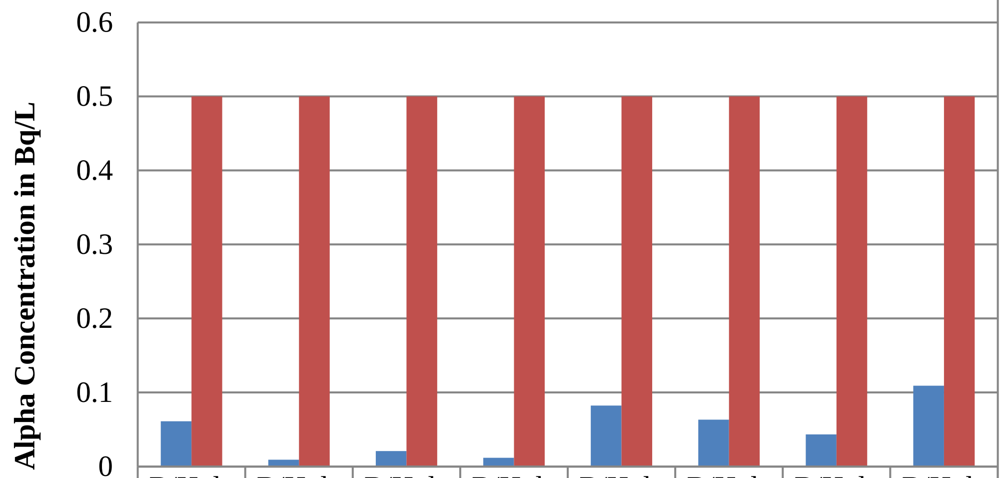


Figure 2:Alpha and Beta Activity Concentrations of the Water Samples Analyzed (all concentrations are in Bq/L).

Comparison of Gross Alpha and Beta activities with WHO global benchmark

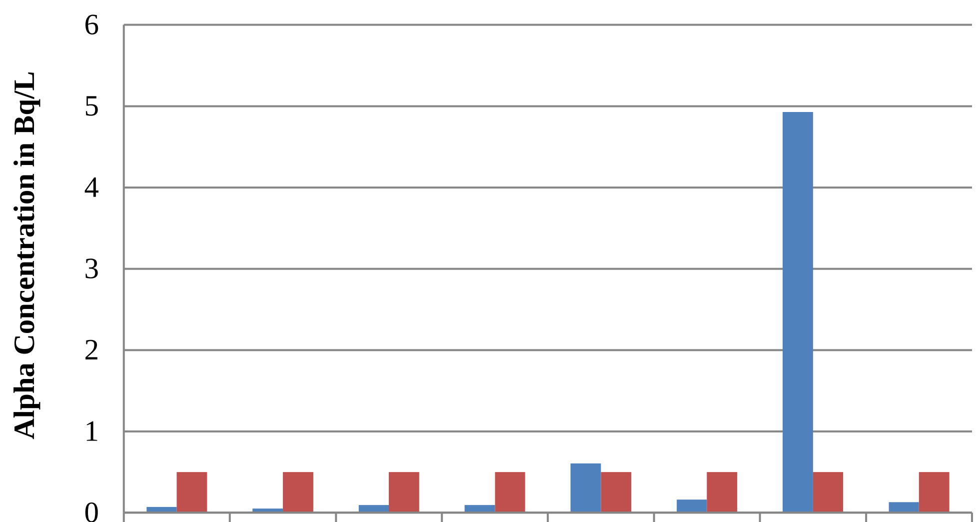
The average alpha and beta activity concentrations measured were compared with WHO benchmark. The results are shown in Figure 3, 4, 5 and 6 respectively.



	B/Hole - A	B/Hole - B	B/Hole - C	B/Hole - D	B/Hole - E	B/Hole - F	B/Hole - G	B/Hole - H
Study Area	0.0614	0.0094	0.0211	0.012	0.0823	0.0634	0.0434	0.1094
WHO Bench Mark	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Figure 3: Comparison between mean alpha activity concentrations in ground water samples of the study area and WHO benchmark.

Figure 3 shows the bar chart comparison of mean alpha activity concentrations in ground water samples of the study area and WHO benchmark. The result indicated that all the alpha activity concentrations in the ground water samples across the study area were below the WHO benchmark.



	River A	River B	River C	River D	River E	River F	River G	River H
Study Area	0.0712	0.05	0.0922	0.0937	0.6034	0.1584	4.9276	0.1292
WHO Bench Mark	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Figure 4: Comparison between mean alpha activity concentrations in surface water samples of the study area and WHO benchmark.

The bar chart comparison of average alpha activity concentrations in surface water samples of the study area and WHO benchmark shown in Figure 4 indicates that all the alpha activity concentrations in the surface river water samples across the study area were below the WHO benchmark except in river E and G where extreme values of 0.6034±0.0197Bq/L and 4.9276±0.1629Bq/L alpha activities were obtained.

Similarly, figure 5 shows the bar chart comparison of mean beta activity concentrations in ground water samples of the study area and WHO benchmark. The result indicated that all the beta activity concentrations in the ground water samples across the study area were within the range of 0.0074±0.0056Bq/L to 0.2246±0.0064Bq/L below the WHO benchmark.

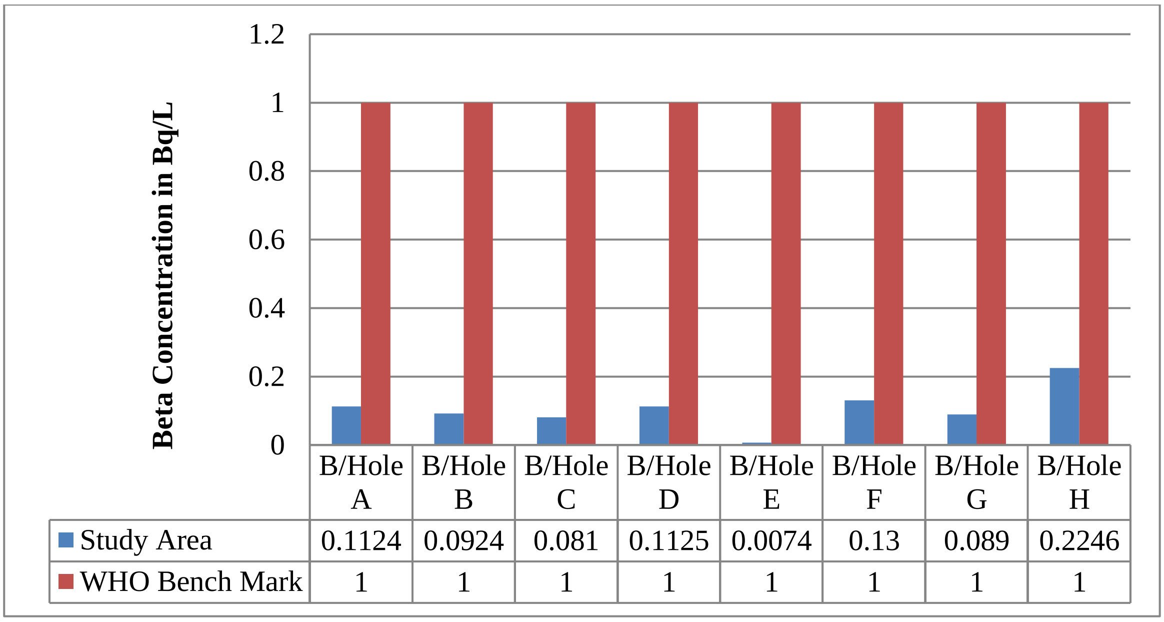


Figure 5: Comparison between mean beta activity concentrations in ground water samples of the study area and WHO benchmark.

In contrast, the bar chart comparison of average beta activity concentrations in surface water samples of the study area and WHO benchmark shown in Figure 6 indicated that all the beta activity concentrations in the surface water samples across the study area were below the WHO benchmark except in river E and G where extreme values of 1.2382±0.0402Bq/L and 1.2382±0.3055 Bq/L beta activities above the WHO benchmark were obtained.

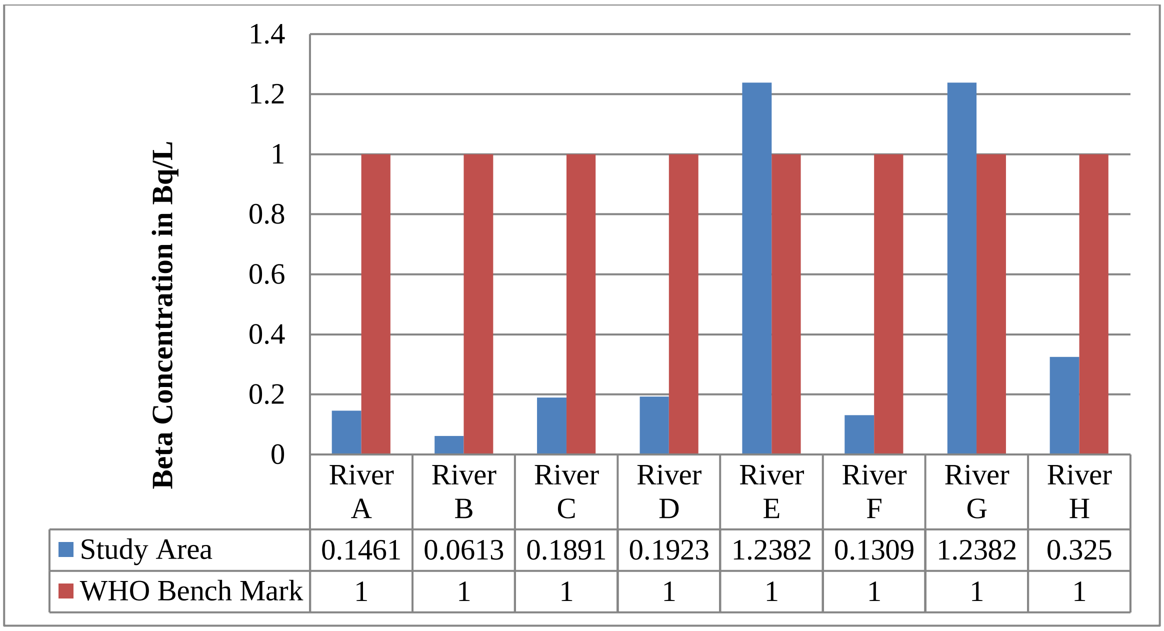


Figure 6: Comparison between mean beta activity concentrations in surface river water samples of the study area and WHO benchmark.

Correlation Coefficients of Gross Alpha and Beta activities

The average alpha and beta activity concentrations measured were correlated using PPMC and the result is shown in Table 3.

Table 3: The PPMC correlation coefficients of alpha and beta activities between grounds bore hole water and surface river water samples.

Activity (Bq/L)	B/Hole (α)	B/Hole (β)	River (α)	River (β)
B/Hole (α)	1.000			
B/Hole (β)	0.359	1.000		
River (α)	-0.030	-0.178	1.000	
River (β)	0.308	-0.500	0.723*	1.000

*Correlation is significant at the 0.05 level.

Table 3 shows the PPMC correlation coefficients calculated to determine relationships among different alpha and beta activity concentrations in borehole and river water samples in the study area. Significant positive correlation among the alpha and beta activity concentrations in the study area was evident in correlation between river (α) and river (β) samples with 0.723 at $P \leq 0.05$ significance level. While bore hole (α) and bore hole (β) concentrations were negatively correlated (weak; -0.030 and -0.178) with average river (α) concentration. However, river (β) was moderately negatively correlated (-0.500) with bore hole (β). Weak positive correlations (0.359 and 0.308) were obtained between bore hole (α), bore hole (β) and river (β) respectively. The analysis implies that the concentration of alpha activity is proportional to the beta activity in all the river water samples studied across the study area, a further testimony to the result shown in figure 2.

CONCLUSION

In conclusion, from the above discourse based on the findings of the study, it can be deduced that all the water samples analyzed have no significant radiological health burden on the environment and the populace except in river sample locations E and G where extreme values of 0.6034±0.0197Bq/L and 4.9276±0.1629Bq/L alpha activities as well as 1.2382±0.0402Bq/L and 1.2382±0.3055 Bq/L beta activities above the WHO benchmark were obtained. It is therefore recommended that efforts should be intensified to identify further sources of contaminants in the study area with a view to addressing the long standing renal and kidney failure scenarior experienced by large group in the study area.

Conflict of Interest:The authors declare no conflict of interest

REFERENCES

Abba, T. H. (2013). *Measurement of Radioactivity in Water and Sediments of River Yobe, North eastern Nigeria*. Unpublished M.sc Radiation Biophysics Thesis, Faculty of Science, ABU Zaria.

Brenner, D. et al. (2003). Cancer Risks Attributable to Low Doses of Ionizing Radiation: Assessing what we really know. *Proceedings of the National Academy of Sciences of the United States of America*, *100*(24), 13761–13766.

Google GPS (2017). Google Global Position System Coodinates of Yobe state.

Mangset, E. W., Christophe, L. D., Solomon A. O., Ike, E. E., Mallam, S. P. &Onoja, R. A. (2014).Gross Alpha and Beta Radio Activity Concentrations and Estimated Committed Effective dose to the General Public Due to Intake of Groundwater in Mining Areas of Plateau State, North Central Nigeria.

Lawson, R. (1999). *An Introduction to Radioactivity*. p.2.Retrieved from:http://qa.ff.up.pt/radioquimica/Bibliografia/Diversos/Introduction%20to%20Radioactivity.pdf

Martinsson, J. (2010).*Changes in the Course of the River KomaduguYobe during the 20th Century at the Border between Niger and Nigeria*. Unpublished M.scEngineering Geology Thesis, Lund University. P. 1-4

Nwoke, J. E. (2006). *Measurement of Gross Alpha and Beta Radioactivity*. Unpublished M.sc Radiation Biophysics Thesis, Faculty of Science, ABU Zaria.

Tanko, I. A. (2000). Improving Land and Water Resources Management in the Komadugu-Yobe River Basin – Northern Eastern Nigeria & South Eastern Niger Phase 1: Improving the Institutional Framework for Water Management in the KomaduguYobe Basin.

United State Environmental Protection Agency, USEPA (2018). Drinking Water Standards and Health advisories Tables. P. 1-10.

Waziri, M. (2016). National Water Resource Institute Partners Gashua Versity to end 3 Decades Gashua water related problem. An article of Federal University Gashua. Retrieved from: http://fugashua.edu.ng/nwri-partners-gashua-versity-to-end-3-decades-gashua-water-related-problem/

World Health Organization WHO (2004). Guidelines for Drinking-water Quality Bench Mark. WHO Library Cataloguing-in-Publication Data, third edition NLM Classification: WA 675.

World Health Organization WHO (2011). Guidelines for Drinking-water Quality Bench Mark.WHO Library Cataloguing-in-Publication Data, 4th edition, p. 206, 311,340,433.

Yobe State Physical Settings, YSPS (2010). Location, Geology, Climate and Vegetation. Retieved from: http://www.onlinenigeria.com/yobe-state/?blurb=382