International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 109-114 www.ijaem.net ISSN: 2395-5252

Determination of Gross Alpha and Beta Radioactivity in Ground Water from Maiyama Local Government, Kebbi State, Nigeria

S. Mamuda[1] and A. Bello[2]

[1]*Department of Science Education, Kebbi State University of Science and Technology, Aliero, Nigeria*
[2]*Department of Physics, Kebbi State University of Science and Technology, Aliero,Nigeria*

Submitted: 10-01-2021 Revised: 23-01-2021 Accepted: 26-01-2021

ABSTRACT: The aim of this research work is to Survey of gross alpha and beta radioactivity in ground water from Maiyama LGAs of kebbistste, Nigeria. Twenty four (24) samples were drawn by means of stratified random sampling from locally dug-wells in the surveyed area and were analyzed using the Eurysis-eight channel gas filled proportional counter. The result obtained from the proportional counter show that the range of alpha activity varied from 0.01Bq/L to 3.40Bq/L with geometric mean of 1.705Bq/L and range of beta activity varied from 0.52Bq/L to 20.52Bq/L with geometric mean of 10.52Bq/L. Therefore, some samples show the higher concentration is above the limit set by WHO of value 0.55Bq/L guideline for alpha activity and 1.00Bq/L for beta activity, quite a reasonable number does not meet the WHO standard.

Keywords: Gross Alpha and Beta Radioactivity, Proportional Counter, Ground water.

I. INTRODUCTION

Water is one of the most important natural resources and demand for it is on the increase. Skillful management of water bodies is therefore required if they are to be used for diverse purposes (Habila, 2008). The determination of radionuclide in environmental samples is a crucial task in relation to the protections of human health (Selcuket al., 2009) and their effects on humans are always depends on the regional geological and geographical behavior.

Natural and man-made sources of ionizing radiation are present in the environment in which man lives; there is a continuous release of the ionizing radiation in our environment. This is as a result of the presence of radionuclide in all activities undertaken by man. Naturally occurring radionuclide are found in the food we eat, the air we breathe and the water we drink and have resulted in health hazards among the general public. Agriculturalcontamination results primarily from the overuse of pesticides and fertilizers that later seep into groundwater sources, thereby causing groundwater pollution. On the other hand, individuals also cause ground water contamination by improper disposal of wastes namely motor oil, detergents and cleaners can leak into water sources. More significantly, ground water can also be contaminated by naturally occurring sources. Heavy metals present in certain soils and geologic formations may pollute groundwater by leaching. This can be aggravated by over-pumping wells, particularly for agriculture purpose.

It is known that radioactive materials produce about 50 % of the natural radiation which the public is exposed to (UNSCEAR, 2000). Radionuclide and their isotopes present in soil can be dissolved into the surrounding aquatic ecosystem (Balaet al., 2012) and produced an increased background level of natural radiation in a particular ecosystem.

According to the United Nations Scientific Committee on Effects of Atomic Radiation Report (UNSCEAR, 2000),the greater contribution to mankind's exposure is from natural background radiation, and the worldwide external average annual effective dose is 2.4 mSv (UNSCEAR, 2000). However, much higher levels of exposure are usual for inhabitants of natural high background radiation areas.

Higher level of radiation above the earth is mainly due to naturally occurring radioactive elements in the earth's crust such as ^{238}U, ^{232}Th and ^{40}K. Residents in high altitude areas are also more affected by cosmic radiations (ICRP, 1991). Water sources are equally polluted by naturally occurring radioactive materials (NORMS) of the earth's crust (terrestrial radioactivity); which emits α, β and γ radiations. These materials which are normally from the ^{40}K, ^{238}U and ^{232}Th series are more concentrated in deep ground water than in surface water (Onoja, 2004).

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 109-114 www.ijaem.net ISSN: 2395-5252

They contaminate water bodiesdirectly with their radionuclide products; and indirectly, through the ^{222}Rn and ^{220}Rn gaseous products, which can solidify and attach themselves as aerosol to air particles and are washed down by rain into water bodies (Fasasi, 1999).Drinking water sourced from deep wells and boreholes are usually expected to have higher concentration of radioactive nuclides. This is because they pass through fractures in bedrocks or within the soil which contains minerals deposits that might have radioactive constituents and thus leaking into the water ways. Radioactivity in drinking water is one of the major ways in which radionuclide from the environment gets into the human body, which might consequently lead to radiation-induced disorder (USEPA, 2010). It is therefore important to determine the amount of radioactivity in drinking water for every area where people reside, so as to guard against its deleterious effects (WHO, 2006).

II. STUDY AREA

The area under survey is Maiyama LGA metropolis; Maiyama is a LGA in Kebbi State, Nigeria. Its headquarter are in the town of Maiyama. It has an area of 1028 km^2 and a population of 176,686 at the 2006 census (Federal Republic of Nigeria, 2012). Maiyama local Government Area is bounded to the North by Kalgo and Jega LGAs, to the east by Sokoto State, to south by Koko/Besse LG and to the west by Suru local Government Area.Maiyama LGAs located at longitude of 4^o 21′23.4468″E and latitude of 11^o 48′37.08″Nas shown in the topographic map of Maiyama in figure 2.1.Agriculture is the main occupation of the people in Maiyama. Crops produced are mainly grains; animal rearing and fishing are also common. Therefore, ground water (wells and boreholes) is used for various purposes like irrigation, fishing, swimming, drinking for livestock and major source of water supply to the residents of the area. The raw materials distribution in Maiyama LGA are millet, maize, beans, sorghum, potato, cassava, rice, mango, onion, pepper, sugarcane, groundnut, livestock, spices, etc

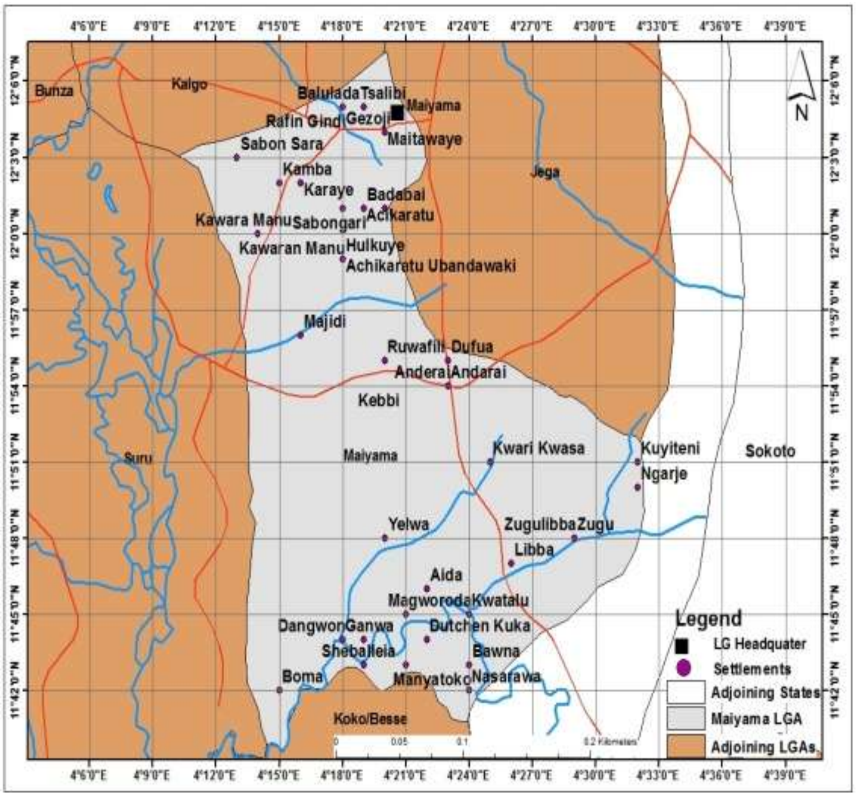


Figure2.1: The stratified map of the surveyed area.

III. MATERIALS AND METHODS

There are lots of materials that are going to be involved in this research work, but the most important among them are: gas flow proportional counter for gross alpha and beta counting;

3.1Samplingmaterials: Plastic containers-(2liters), Disposable hypodermic syringe (20ml) dilute nitric acid, Thermometer, Indelible pen and masking tape, Polyethene bags for sediment sample.
3.2 TDS experiment materials: Cellulose Mz\embrane filtration (0.45 pore size), Filtration apparatus, Mechanical suction pump, Analytical balance (0.1 mg), Measuring cylinder, beakers and evaporating dish.
3.3 Sample preparation materials: Hot plate for evaporation, vinyl Acetate, ethanol for even spread of the sample in the planchette, sources for alpha and beta standards, deionized water, planchette (0.3 m in diameter, 0.002 thickness), candle wax and Vaseline.

3.4 Sample Selection

The method adopted for the sampling, is stratified random sampling. The mapped area will be divided into grids. From each grid, one settlement will be selected by simple random process. Two ground water samples will be collected per each settlement.

3.5 Sampling Procedure

Taking reading from Geographical Positioning System (GPS) at each location of sample source; the sample container will be rinse two times with the water being collected, to minimize contamination from original content of the sample container; the amount of water collected was such that an air space of about 1 % of container capacity will be left for thermal expansion; filtration will be done before acidification; about 20ml of dilute nitric acid will be added to the samples for absorption on the walls of the container; the sample will be tightly covered and kept until analyses.

3.6 Sample Preparation

To adhere to the ISO-Standard for radioactivity counting, the collected samples were evaporated using hot plates without stirring at moderate heat in an open beaker of 600ml. On average, it took about 24 hours to complete the evaporation of one liter of the each sample. In the evaporation process, when the level of the sample in the beaker reached 50ml, it was then transferred into a Petri dish and placed under infrared light source to completely dry the residue.The samples were then allowed to cool before weighing. The weight of the residue was obtained by subtracting the weight of empty Petri-dish from the weight of Petri-dish plus sample residue. An empty planchette was weighed after which about0.077g of the residue was transferred to the planchette. 0.077g is arrived from the fact that, ISO-Standard requires about 0.1Amg of residue should be placed on the planchette for counting, where A is the area of the planchette in mm2. The planchette plus residue was then weighed. A few drops of vinyl acetate is added on the sample to make them stick to the planchette to prevent scattering of the residue during counting. The sample was then kept in a desiccator until ready for counting.

IV. RESULTS AND DISCUSSION

The results of gross alpha and beta activity of the surveyed areas are presented on Table 1. As well as Figure 1. These results were discussed and compared with other available results from other areas as no similar work has been done in this present location.

Table 1: Gross alpha and beta activity concentrations measured from ground water in the selected locations within the Surveyed area.

S/N	Locations (villages)	Geographical coordinates	Alpha activity (Bq/L)	Beta activity (Bq/L)
1.	R/gindi	12.060^0N,4.90^0E	0.48±0.06	4.25±0.20
2	Sabonsara	12.058^0N, 4.98^0E	0.26±0.11	2.76±0.35
3	Gezoji	12.055^0N, 4.101^0E	0.06±0.10	1.31±0.16
4	Maitawaye	12.040^0N, 4.110^0E	0.03±0.02	1.15±0.06
5	Kamba	12.039^0N, 4.125^0E	0.25±0.02	3.54±0.15
6	sabongari	11.0570^0N, 4.178^0E	0.04±0.02	10.30±0.46
7	K/ Hulkaye	11.075^0N, 4.255^0E	0.21±0.04	11.20±0.55
8	Karaye	11.068^0N, 4.194^0E	1.20±0.23	3.71±0.21
9	Achikaratu	11.054^0N, 4.228^0E	1.16±0.02	0.52±0.06
10	Majidi	$11.04^8$0N, 4.263^0E	2.11±0.22	20.52±0.88
11	R/Dufua	11.039^0N, 4.215^0E	0.07±0.03	18.72±0.57
12	Andarai	11.035^0N, 4.210^0E	0.05±0.02	3.63±0.20
13	Kebbi	11.048^0N, 4.215^0E	0.26±0.10	2.52±0.10

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 109-114 www.ijaem.net ISSN: 2395-5252

14	K/ kwasa	11.029^{0}N, 4.192^{0}E	1.10±0.14	9.45±0.25
15	Yelwa	11.018^{0}N, 4.178^{0}E	0.07±0.02	6.48±0.30
16	Zugunliba	11.022^{0}N, 4.198^{0}E	3.40±0.32	2.65±0.02
17	Aida	11.010^{0}N, 4.271^{0}E	0.03±0.02	7.36±0.32
18	Kwatalo	11.009^{0}N, 4.252^{0}E	3.40±0.32	5.32±0.27
19	Ganwa	11.017^{0}N, 4.188^{0}E	0.27±0.07	2.38±0.10
20	D-kuka	11.015^{0}N, 4.182^{0}E	0.22±0.05	4.21±0.16
21	Bauna	11.021^{0}N, 4.108^{0}E	0.16±0.03	0.81±0.02
22	Sheballela	11.019^{0}N, 4.125^{0}E	0.13±0.06	0.76±0.02
23	Boma	11.017^{0}N, 4.120^{0}E	0.04±0.02	7.50±0.36
24	Nasarawa	11.010^{0}N, 4.122^{0}E	0.01±0.02	1.38±0.06

The distribution of the alpha activity and beta activity concentrations is represented as a bar chart in figure 4.1 and figure 4.2.

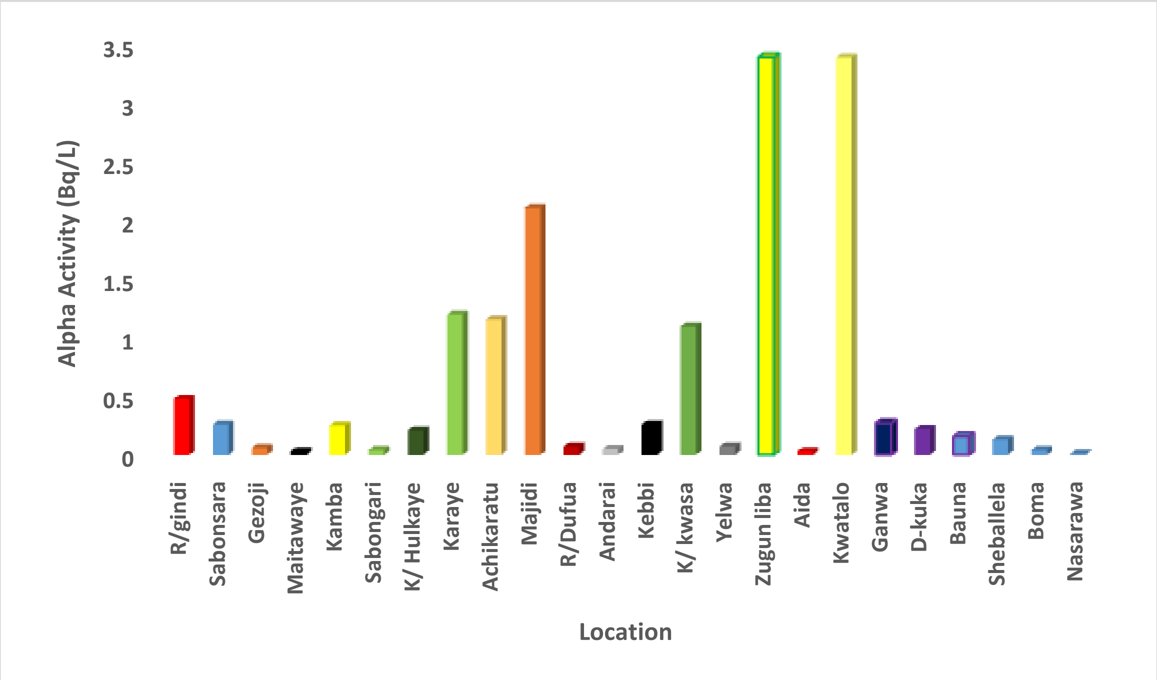


Figure1: Bar chart of Distribution pattern of Alpha Activity in Well water from the Surveyed Area

Figure 1 is the distribution of alpha activity and shows few elevated alpha activities. This may be due to geological constituents of the surveyed area. From the figure it can be seen that the distribution of alpha activity is skewed towards the center. This indicates that most of the areas have low alpha activity. It could be observed that the samples collected from Zugun-Liba, Kwatalo and Majidi have the highest of alpha activity concentrations. The remaining areas are of low alpha activities. The area that has high activities is stressed to the presence of Limestone (sedimentary rocks) in the area and inorganic fertilizers used by the farmers in the area which washes from the surface of the land into these water bodies.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 109-114 www.ijaem.net ISSN: 2395-5252

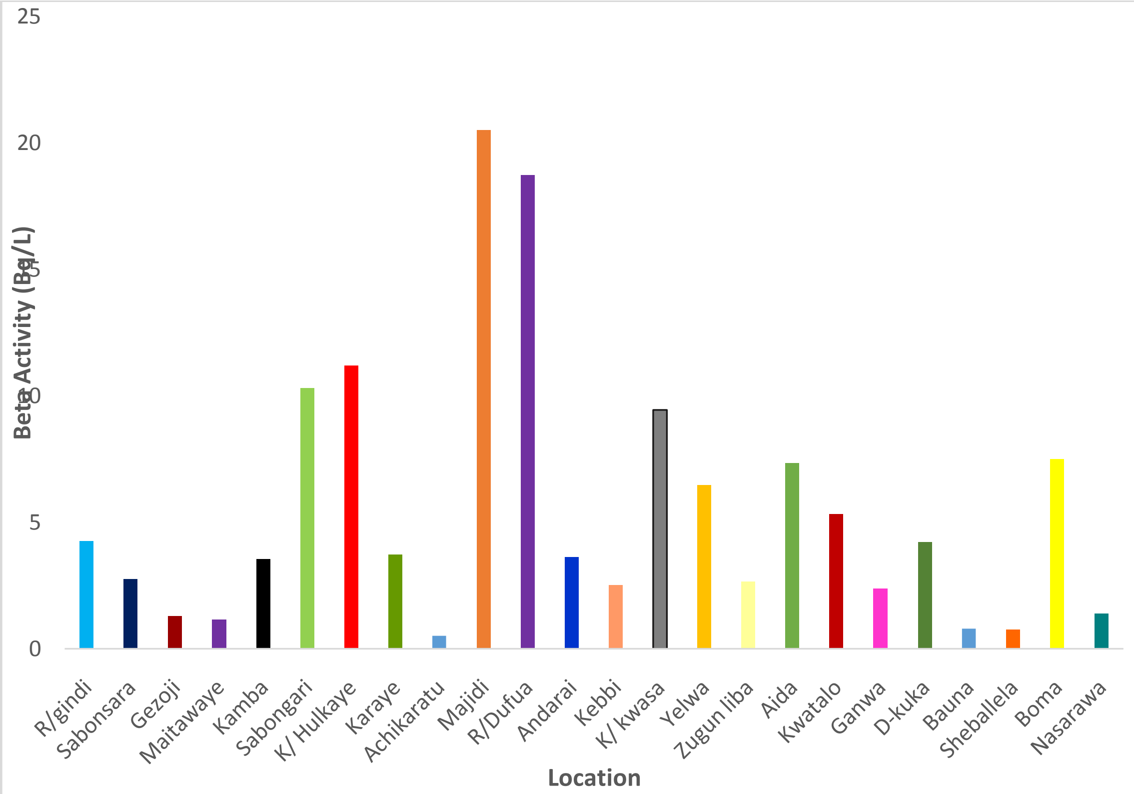


Figure 2: Bar Chart of Distribution pattern of Beta Activity in Well water from the Surveyed Area.

Figure 2: is the distribution of beta activity and show few elevated beta activities. From the result obtained, only six (6) out of twenty four (24) samples representing 25% satisfy the recommended contaminant limit of less than 1.0Bq/L recommended by WHO and 1.85Bq/L set by USEPA, these areas are: Achikaratu, Bauna, Sheballela, Gezoji, Maitawaye and Nasarawa. Similarly, eighteen (18) samples representing 75% do not meet recommended value set by W.H.O and USEPA. Therefore, the higher value of Gross beta activity could be as a result of the geological formation of the area whose land is highly invaded with phosphorus, a by- product of phosphate that has potassium-40 which is a beta and gamma emitter whose source is fertilizer used by the farmers.

V. DISCUSSION OF RESULTS

Table1: presents the summary of the major results of the gross alpha and gross beta activity concentrations in ground water from the surveyed area. In the present study, gross alpha activities in majority of the sample below the screening limit set by World Health Organization (WHO), and gross beta activity in majority exceeded the limit. From the results obtained for alpha activity in different places in the studied area, 71 % of alpha activity in the area satisfies the contaminant limit of 0.55 Bq/L for alpha and that 29 % were above the limit. Similarly, the obtained results for beta activity in different places in the surveyed area, only 25 % of the activity satisfy the recommended contaminant limit less than 1.0 Bq/L recommended by WHO and 75 % are above the contaminant limit. For these reasons, there was strong correlation between the gross alpha and gross beta activity concentrations from studied area.Furthermore, it is important to note that the beta activity concentration is higher than that of alpha activity concentration at each locations/villages. The latter fact is illustrated in Figure 1 and Figure 2 of the relative distribution of alpha and beta activities in the different villages of the studied area.

The bar charts of the distribution of gross alpha and beta activity concentrations in the samples of ground water collected from different villages in the Maiyama Local Government Area are demonstrated in figure 1 and figure 2 respectively. It could be concluded from the charts that correlation exists in concentrations of alpha and beta activities in ground water of different locations of the study area.

It could also be observed that the samples collected from Nasarawa, Sheballela, Bauna, Maitawaye and Gezoji have the lowest of alpha and beta activity concentrations respectively. Moreover, the sample collected from Zugun-Liba has the highest level of alpha radiation while sample obtained from Nasarawa village has the lowest level concentration of alpha radiations. Similarly, the sample collected from the Majidi village has the highest level concentration of beta radiation while the sample obtained from Achikaratu has the lowest level concentration of beta radiation.

Therefore, there are extensive phosphate rocks and inorganic fertilizers used by the farmers in the area which washes from the surface of the land into the water bodies. It should be noted that ^{40}K were regarded as the major contributor to the gross beta activity and that ^{40}K considered as a strong beta and gamma rays emitter. According to the finding of the present study, the maximum specific activities caused by radionuclide's emitting alpha and beta particles in ground water of the studied area are 3.40 Bq/L and 20.52 Bq/L respectively.

REFERENCES

[1]. Bala, S. S., Mohammed, F. K., & Mahmud, D. (2012). The gross alpha and beta radioactivity concentration on drinking water. Journal of science and Technology. 2, 49-51.

[2]. Fasasi, M. K., Tchokossa, P., Ojo, J. O., &Balogun, F. A. (1999). Radiochemistry and Nuclear Methods of Analysis. Journal of Radio-analytical Nuclear Chemistry. 249, 949-952.

[3]. Habila N. (2008). Survey of Gross Alpha and Beta Radioactivity in Jos City. Unpublished M.Sc, thesis, University of Jos, Nigeria.

[4]. ICRP, (2000). International Commission on Radiological Protection, Protection of the Public in Situations of Prolonged Radiation Exposure. First edition. Pergamo Press, Oxford, U K.

[5]. Onoja, R. A. (2004). Survey of Gross Alpha and Beta Radioactivity in Well Water from Zaria Area. An Unpublished M.Sc. Ahmadu Bello University, Zaria. 6-39.

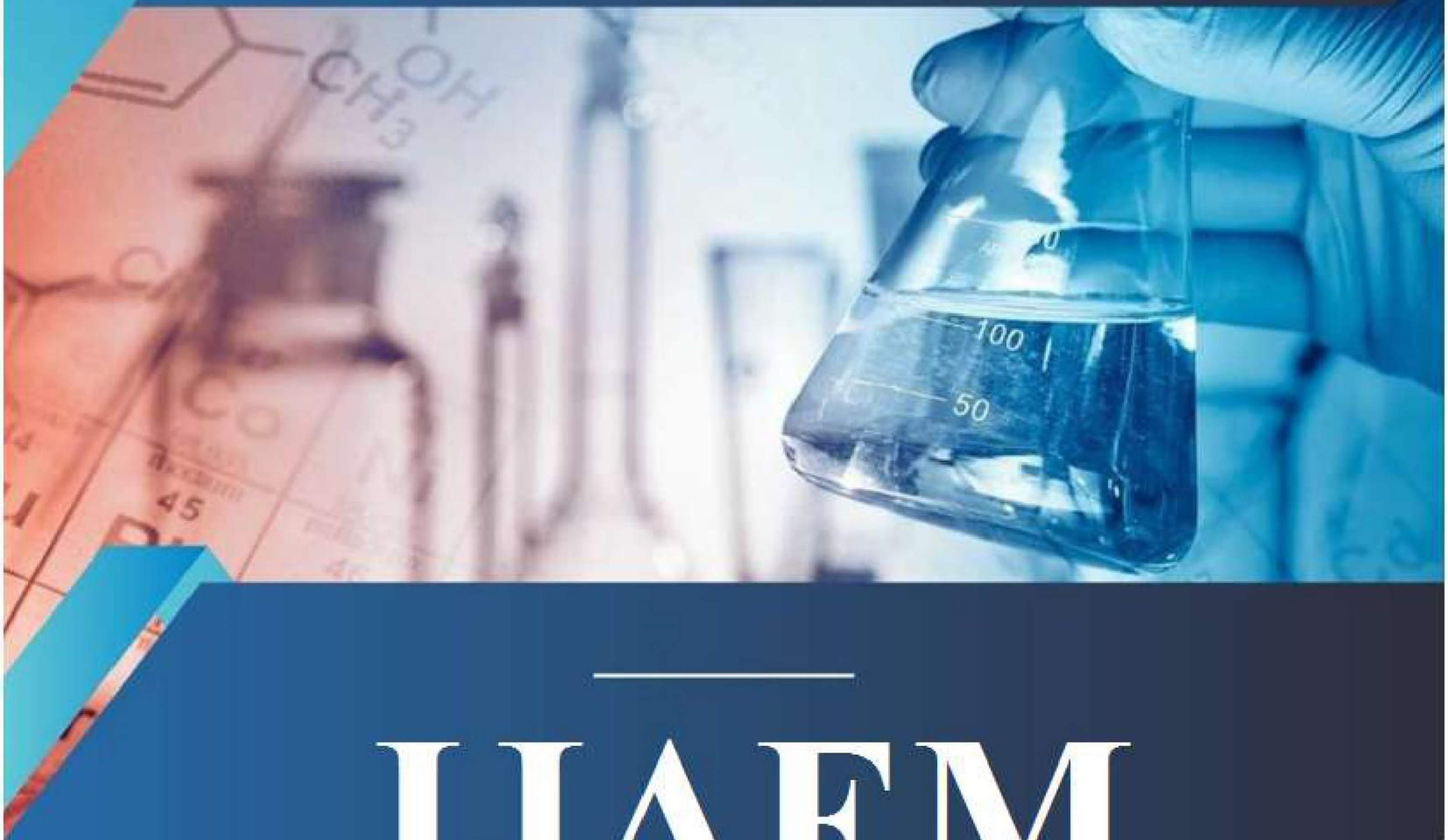
[6]. Selcuk, Z. O., Ceylan, H., Dogru, M. (2009). Gross alpha and beta radioactivity concentration in water; soil and sediment of the Bendimahi River and Van Lake (Turkey). EnvrionMon Assess, First edition, 148, 39-46.

[7]. UNSCEAR, (2000). Sources, effects and risks of ionizing radiation United Nation Scientific Committee on the effects of Atomic Radiation Report to the General Assembly United Nations, New York.

[8]. USEPA ,(2010). United State Environmental Protection Agency. Prescribed procedures for measurement of radioactivity in drinking water. Environmental monitoring support laboratory. EPA.

[9]. WHO, (2006). Guidelines for Drinking-water Quality, Third edition, 1 -9. accessed: 24th July, 2018.

International Journal of Advances in Engineering and Management
ISSN: 2395-5252



IJAEM

Volume: 03 Issue: 01 DOI: 10.35629/5252

www.ijaem.net
Email id: ijaem.paper@gmail.com