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# Estimation of Radioactive Concentrations of Sediment Samples in Baghdad Province

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## Abstract

This paper has been conducted to assess the concentrations of radioactive namely $^{40}$K $^{226}$Ra, and $^{232}$Th in sediment, and Fish using using a higher purity germanium spectrophotometer in ten of the most common sediments samples were collected from the edge and bottom of the site in Baghdad city and there in Tiger river during 2015-2016 .The results obtained of sedament sample showed that the the concentration of $^{40}K$ ranged from 276.19 to 467.23 Bq/kg at $F_5$and $F_3$ with an average 399.315Bq/kg, the concentration of$^{226}Ra$ is ranging from 19.22 to 72.56 Bq/kg in in $F_5$and $F_3$ sample with average 48.357 Bq/kg and the concentration for $^{232}Th$ are 18.63 to 29.23 (Bq/kg) at$F_4$and $F_5$ with average is 24.962. On the other hand, the radioactive concentration at depth 35 cm show that 185.64-390.81Bq/kg for $^{40}K$ isotope at $HF_5$ -$HF_{10}$ samples, while 11.12-64.36 Bq/kg for $^{226}Ra$ at $HF_5$ -$HF_3$ samples and 10.25 - 21.21Bq/kg for $^{232}Th$, at $HF_4$ -$HF_5$ samples.These confirm that that never affected on the integrity of the environment and fisheries at Baghdad province, its indication a certain degree of bio-accumulation. That's refers to conditions will help the fish to withstand sudden changes if available oxygen generators . The results of radioactive concentration showed that the concentration at edge upper than concentration at depth 35 cm of sediment samples . This confirms that sediments samples are never affected on the environment and human healthy at this time

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**Keywords:** Radioactive Concentrations, Sediment Samples, Baghdad Province

## Introduction:

One of the most important problems in the world is the environment pollution,its increasing in last years ago and causes many grave and more damage in different sight of the earth. The environments s pollution are different type such that soil, water, air, noise and light pollution [1]. Environment pollution has been taken account different forms included that auditory, intellectual, noise, visual, long range, and close-range.On the other hand the major components of pollution are soil, air and water [2]. The natural radionuclide's of Radium ($^{226Ra}$), Thorium ($^{232}$Th), Uranium ($^{238}$U) and potassium (40K) beside $^{137Cs}$ in the fluvial environments could be concentration in transferring through the foods and the all damage of the biological effect on ecosystems from the ionizing radiation processes [3]. The most important interest was focusing on consumption of variety marine foodstuffs such that seaweeds, fish and manufacture the different products including radioactivity. All the dose of radiation was received and accumulated in the human body due to marine fauna that came from the natural uranium series, the alpha particales are emitting from radionuclide's $^{210}$Po is approximately 90% of the natural radiation that's receiving from marine organisms and $^{137}$Cs has more abundant in environment [4] . The environment pollution by variety heavy metals has been become a most dangerous problems in recent years ago and future, as results as they are indestructible and all of them has been effectively on organisms. Among of the environmental pollution problem that's heavy metals were concern, particularly from their potential toxic effect to bioaccumulation in aquatic ecosystems. The heavy metals concentrations in aquatic ecosystems always monitored by measuring in sediments and water which it existed inside water and attained considerable concentration in sediment [5] .

The heavy metals were including essential and non-essential elements had a particularly significance in ecotoxicology . However they are higher persistent and all had the potential to be toxic to living organisms [6]. The sediment was the main sources of various pollution liked pesticides and heavy metals, It's playing a significant role in remobilization of contaminant in aquatic system with interaction water and sediments [7]. In this paper, nine samples from different cite in baghdad city was taken and analyzed to estimate the concentrations of $^{40}$K, $^{226Ra}$, $^{232}$Th and$^{238}$U in (Bq/Kg) in the sediment samples were measured.

## Material and Methods

## Description of study area

This study is cary out in province of Baghdad, it's the capital of the republic of Iraq that's locating along the Tigers River. It is in the center of Iraq. In this study, the ten samples are taken from variety sites at different direction ;north, south, east, and west of Baghdad province .The sediment ten samples are collected from different sites at lakes around Tigris River . The sample are determining considering the environmental conditions and sediment structure. However, the nine of sediment samples are taken through November 2015 to May 2016 depending to international standards . The samples are saying to be taken from the lakes next to Tigers River with a depth ranged from 35 cm, its illustrated in the table (1) follows

**Table 1.** the sites of which testing samples were collected from Baghdad city.

| **Location** | **Sample Code From edge** | **Sample Code Atdepth 35cm** |
|---|---|---|
| Abu Graib | $F_1$ | $HF_1$ |
| A Rashidya | $F_2$ | $HF_2$ |
| Al-Yousifya | $F_3$ | $HF_3$ |
| Latifiya | $F_4$ | $HF_4$ |
| Madain | $F_5$ | $HF_5$ |
| Arab Jabour | $F_6$ | $HF_6$ |
| Al Wihda | $F_7$ | $HF_7$ |
| Tiji | $F_8$ | $HF_8$ |
| Jisir Diyala | $F_9$ | $HF_9$ |
| Al Tarmiyah | $F_{10}$ | $HF_{10}$ |

## Sampling and Sample Preparation

The sediment samples were collected from different sites in Baghdad province from November 2015 to May 2016 for two different ranging from edge to 35 cm in the lake. On the other hands, the sediments samples are taken from the edge and bottom of the site . A total of ten samples of the sediment samples contain water rate and needed to drying, it kept in cleanse plastic bags and transport to the laboratory at room temperature. The sediment samples were exposed to sun for many days, less than 20 days of the fine dried grains and it was crushed to made good powder to facilitated the testing of sample . It has been tested using the high-purity germanium detector system [8].

## Calculations

1) The radiation specific activity ($RSA$) could be given by [9]:

$$RSA = \frac{Area\ under\ the\ photo\ peak}{M.I_\gamma(E_\gamma).\epsilon(E_\gamma).\tau} = \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Here $M$is mass sample, $I_\gamma(E_\gamma)$ is the abundance at for gamma energy ($E_\gamma$),
$\epsilon(E_\gamma)$ is the efficiency of detector and $\tau$ is time of measurement.

2) Estimation the hazard Indices in sediment samples:

Hazard index is important indices that's using to describe the risk by metals of presenting the exterior exposing and its estimation by [10].

$$HAI_{ex} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where $A_{Ra}$, $A_{Th}$ and $A_K$ are activation of $^{226}Ra$, $^{232}Th$ and $^{40}K$ .

Since the interior risk index of radon exposing is [10] .

$$HAI_{int} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

However, the hazard index of gamma radiation [11].

$$I_\gamma = \frac{A_{Ra}}{150} + \frac{A_{Th}}{100} + \frac{A_K}{1500} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

3) The Estimation of Concentration

The final concentration of metal in sediment sample $E_c$ (µg/g) can be measuring using [8] .
$E_c = A_M B_V C_D$……(5)
Where $A_M$ is the concentration of metal in calibration curve (mg/l), $B_V$ is the final volume of sample (ml) and $C_D$is the dry weight of sample (g).
Activity Concentration

4) The specific activity of radiation could be written as [10].

$$A = \frac{C(E_\gamma)}{M\beta(E_\gamma)\epsilon(E_\gamma)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where $C(E_\gamma)$ is the count of net peak area per second at energy$(E_\gamma)$, M is the mass fish sample, $\beta$ is the the transition probability of gamma-decay at energy $(E_\gamma)$ and $\epsilon$ is the detector efficiency at energy $(E_\gamma)$.

The radium equivalent hazard index in (Bq/kg) $R_{equ}$ estimation that connection the $^{226}Ra$, $^{232}Th$ and $^{40}K$and by [12].

$$R_{equ} = A_{Ra} + 1.43A_{Th} + 0.077A_K \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Whereas, $A_{Ra}$, $A_{Th}$ and $A_K$ are the specific activity of $^{226}Ra$, $^{232}Th$ and $^{40}K$ and taken 10 B$q$/ $k$g for $^{226}Ra$, 7 B$q$/ $k$g for $^{232}Th$ and 130 B$q$/ $k$g for $^{40}K$ respectively .

## Results and Discussion

The result of radiological testing in sediment samples that's collection from every lakes at every sampling sites (Abu Graib, Al Rashidya, Al-Yousifya Latifiya, Madain, Arab Jabour, Al Wihda, Tiji, Jisir Diyala and Al Tarmiyah) in Baghdad province and next the Tigris river are presented in tables (1) and (2) for edge lake and 35 cm in bottom depth of lakes respectively. Radiological test is including the radioactivity concentrations $RSA$ in (Bq/kg) for $^{40}K$, $^{226}Ra$, and $^{232}Th$, the exterior exposing $HAI_{ex}$, the hazard index of gamma radiation ($I_\gamma$), the radium equivalent hazard index ($R_{equ}$) in sediment samples . Tables (1) and (2),shows the present data of radiological measurements on ten sediment samples taken from edge and depth of lakes . Table (1) shows the radiological testing at edge of lakes, we can show the concentration of $^{40}K$ ranged from 276.19Bq/kg in $F_5$ sample to 467.23 Bq/kg in $F_3$ with an average 399.315Bq/kg . The concentration of$^{226}Ra$ is ranging from 19.22 in $F_5$sample to 72.56 Bq/kg in $F_3$ sample with average about 48.357 Bq/kg in table(1). On the other hand, the table (1) show that the range of concentration for $^{232}Th$ are 18.63 Bq/kg) at $F_4$ to 29.23 at $F_5$ show that average is 24.962 Bq/kg . While in table (2), the data measurement at depth 35 cm show the minimum $RSA$ value of $^{40}K$ isotope was 185.64Bq/kg detected in $HF_5$sample and the maximum $RSA$ value was 390.81Bq/kg for $HF_{10}$sample and minimum of radioactivity concentrations $RSA$ in (Bq/kg) for $^{226}Ra$ was 11.12 Bq/kg measured in $HF_5$ sample and the maximum value was 64.36

Bq/kg measured in $HF_3$ sample. For $^{232}Th$, data I tabe(2) show that a minimum $RSA$ was 10.25 Bq/kg for $HF_4$ sample and the maximum $RSA$ was 21.21Bq/kg for $HF_5$ sample. In generally, its observing that samples of sediment were recorded higher concentration in the three site $F_3$for Al-yousifya, $F_9$ for Jisir Diyala and $F_4$for Latifiya. The $^{40}K$ at recorded its highest concentration in sediment 467.23 in $F_3$ with average 399.315 in Al-yousifya and the maximum value for $^{226}Ra$ was 72.56Bq/kg detected in $F_3$ sample by average 48.357, while the overall maximum concentration of $^{232}Th$ was 29.23 Bq/kg with average 24.962. However, it had its highest concentration in the Al-yousifya followed by the Jisir Diyala, Latifiya and the least at Al Madain in both $^{40}K$ and$^{226}Ra$ but have large concentration for$^{232}Th$ . The calculation of the most important effect on the human healthy is hazard index $HAI_{ex}$ that calculation in ten samples using Eq.(2) are listed in Tables (1) and (2). The hazard index $HAI_{ex}$ calculation for ten sediment sample at edge lake are ranging from . 0.222 for $F_5$ to 0.405 at $F_3$ compare with the results at 35 cm depth have raging from 0.150 at $HF_5$ to 0.315 at $HF_3$. The low values results that calculated of $HAI_{ex}$t, $I_\gamma$, and $R_{equ}$ (Bq/kg) in edge of lakes were 0.222, 0.604, and 82.285 Bq/kg for $F_5$ sample and the maximum values were 0.405, 1.084, and 149.963 Bq/kg calculated for $F_3$ sample. While the low values results that calculated of $HAI_{ex}$t, $I_\gamma$, and $R_{equ}$ (Bq/kg) for bottom lakes at 35 were 0.150, 0.409, and 55.744Bq/kg for $HF_5$ sample and the maximum values were 0.315, 0.857, and 118.925Bq/kg calculated for $HF_3$ sample . However, figures (1) and (2) and (4) and (5) shows the histograms of $RSA$ (Bq/kg) of measurements for $^{226}Ra$, $^{232}Th$ and $^{40}K$, for investigated sediment samples. Since the figures (3) and (6) show that illustrated of the calculated both that hazard indices, $HAI_{ex}$ $I_\gamma$, and $R_{equ}$ respectively. However, we can show from compare of three figures in (1) (2) and (3) we can note that $RSA$ (Bq/kg) data for all measurement sediment samples have behavior naturally, that's leading to say the increment of $RSA$ is $RSA_{^{40}K} > RSA_{^{226}Ra} > RSA_{^{232}Th}$ . Therefore, the present measurements of the radioactivity Concentrations of $^{226}Ra$, $^{232}Th$ and $^{40}K$ indicate that good agreement with standard data for the UNSCEAR data that's equivalent 17↔60 Bq/kg for$^{226}Ra$, 11↔64 Bq/kg for $^{232}Th$ and 140↔850 Bq/kg for $^{40}K$ with the mean of 35, 30 and 400 Bq/kg, respectively[13] . However, the data of these $RSA$ (Bq/kg) indicate that the hazard index values is normally except in Al-yousifya, which can see in figure (3) for $I_\gamma$ =1.084 that greater than unity. The radium equivalent$R_{equ}$ Bq/kg) in figures(7) and (8) and hazard index indicate that the gamma representative index and refers to safety. So that, the sediment samples $F_1$, $F_5$, and $F_7$ have high safety compare with other samples and all samples have high safety according on report of the environmental agencies in UNSCEAR the samples have good safety that have $R_{equ}$ less than 370 Bq/kg [13].

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***Table 1:*** **Results calculation of the specific radioactive concentrations *RSA* Hazard index of exposing $HAI_{ex}$, Hazard index of gamma radiation $I_\gamma$ and the radium equivalent hazard index $R_{eq}$ in Bq /kg for sediment samples at edge of lake.**

| Site | Code of Sample | Radioactivity Concentrations *RSA* (Bq/kg) | | | $HAI_{ex}$ | $I_\gamma$ | $R_{equ}$ (Bq/kg) |
|---|---|---|---|---|---|---|---|
| | | $^{226}Ra$ | $^{232}Th$ | $^{40}K$ | | | |
| Abu Graib | $F_1$ | 39.34 | 23.87 | 378.87 | 0.277 | 0.752 | 102.647 |
| A Rashidya | $F_2$ | 57.15 | 26.91 | 398.73 | 0.341 | 0.915 | 126.333 |
| Al-yousifya | $F_3$ | 72.56 | 28.97 | 467.23 | 0.405 | 1.084 | 149.963 |
| Latifiya | $F_4$ | 56.38 | 18.63 | 413.76 | 0.310 | 0.838 | 114.880 |
| Madain | $F_5$ | 19.22 | 29.23 | 276.19 | 0.222 | 0.604 | 82.285 |
| Arab Jabour | $F_6$ | 53.78 | 25.37 | 415.38 | 0.329 | 0.889 | 122.043 |
| Al Wihda | $F_7$ | 46.53 | 26.49 | 385.28 | 0.308 | 0.836 | 114.077 |
| Tiji | $F_8$ | 28.99 | 22.33 | 403.16 | 0.248 | 0.685 | 91.965 |
| Jisir Diyala | $F_9$ | 68.42 | 20.91 | 417.89 | 0.352 | 0.943 | 130.498 |
| Al Tarmiyah | $F_{10}$ | 41.11 | 27.63 | 436.66 | 0.308 | 0.841 | 114.243 |
| Average | | 48.357 | 24.962 | 399.315 | 0.310 | 0.838 | 114.893 |

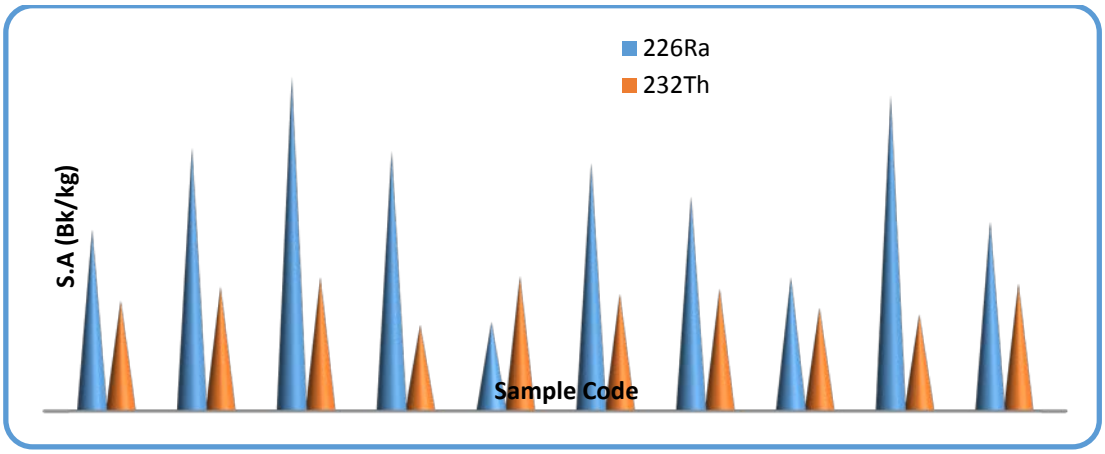


***Fig.1:*** **The concentration activity of radiation for, $^{226}Ra$, and $^{232}Th$ at sediment samples in the edge of lakes.**

***Table 2.*** **Results calculation of the specific radioactive concentrations $RSA$, Hazard index of exposing $HAI_{ex}$, Hazard index of gamma radiation $I_\gamma$ and the radium equivalent hazard index $R_{equ}$ in Bq/kg for sediment samples at 35 cm depth of bottom of lake.**

| Site | Sample Code At depth 35cm | Radioactivity Concentrations $RSA$ (Bq/kg) | | | $HAI_{ex}$ | $I_\gamma$ | $R_{equ}$ (Bq/kg) |
|---|---|---|---|---|---|---|---|
| | | $^{226}Ra$ | $^{232}Th$ | $^{40}K$ | | | |
| Abu Graib | $HF_1$ | 28.43 | 14.75 | 314.57 | 0.198 | 0.546 | 73.744 |
| A Rashidya | $HF_2$ | 46.65 | 18.37 | 341.37 | 0.266 | 0.722 | 99.204 |
| Al-yousifya | $HF_3$ | 64.36 | 18.36 | 367.67 | 0.315 | 0.857 | 118.925 |
| Latifiya | $HF_4$ | 41.64 | 10.25 | 381.46 | 0.231 | 0.634 | 85.669 |
| Madain | $HF_5$ | 11.12 | 21.21 | 185.64 | 0.150 | 0.409 | 55.744 |
| Arab Jabour | $HF_6$ | 39.13 | 20.39 | 382.58 | 0.264 | 0.719 | 97.746 |
| Al Wihda | $HF_7$ | 34.97 | 17.13 | 258.19 | 0.214 | 0.576 | 79.346 |
| Tiji | $HF_8$ | 12.47 | 18.54 | 342.72 | 0.176 | 0.497 | 65.371 |
| Jisir Diyala | $HF_9$ | 49.24 | 16.26 | 371.86 | 0.273 | 0.738 | 101.125 |
| Al Tarmiyah | $HF_{10}$ | 31.01 | 18.13 | 390.81 | 0.215 | 0.648 | 87.028 |

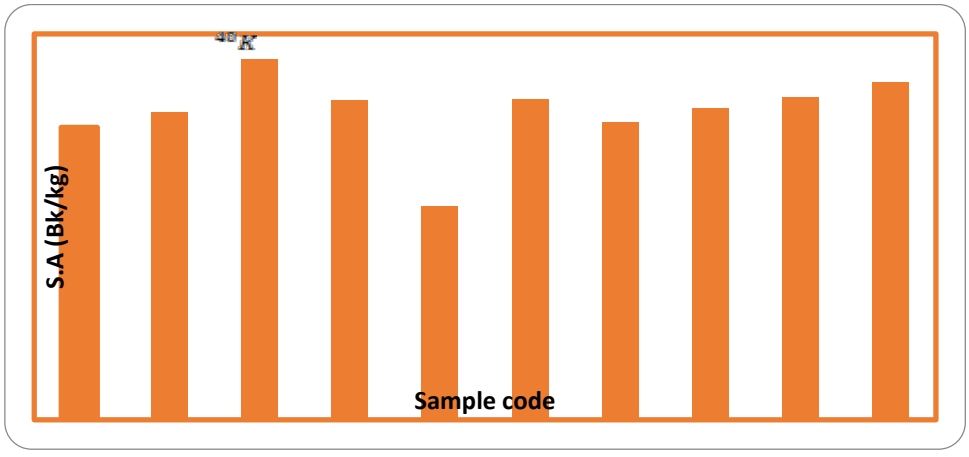


***Fig.2:*** **The concentration activity of radiation for $^{40}K$ at sediment sample edge of lakes.**

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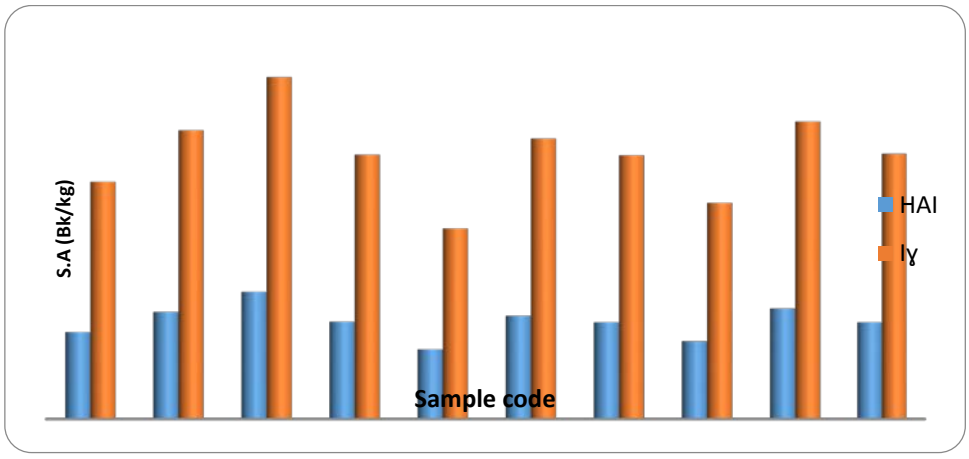


***Fig.3:*** **Data results of evaluation of $HAI_{ex}$ and Iγ hazard indices histograms of sediment samples at edge of lakes.**

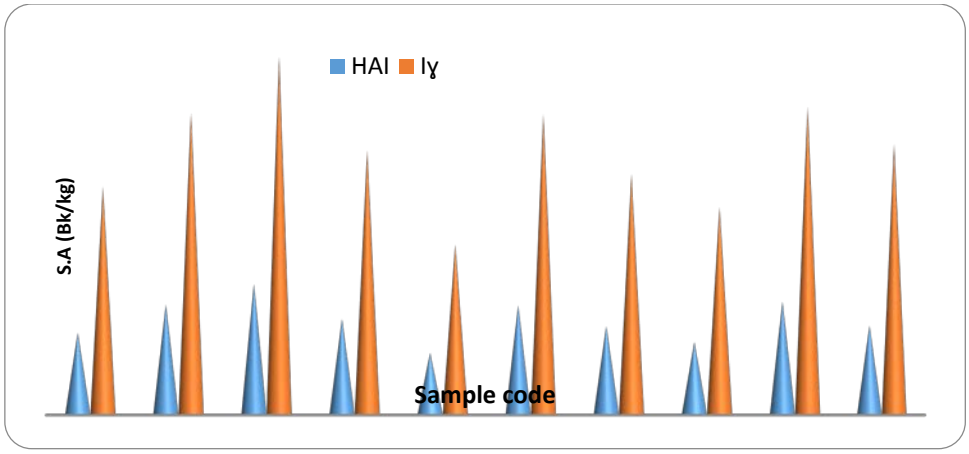


***Fig.4*** **The concentration activity of radiation for, $^{226}Ra$, and $^{232}Th$, at sediment samples at bottom 35cm depth.**

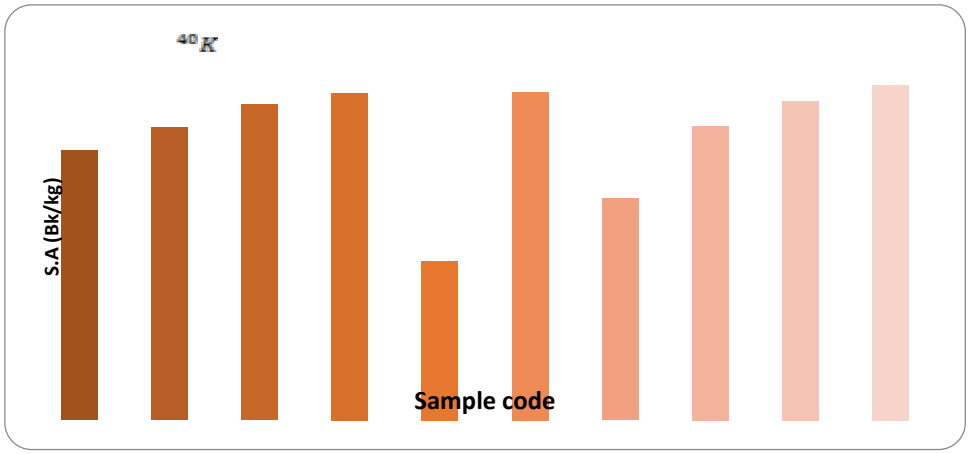


***Fig.5*****: The concentration activity of radiation for $^{40}K$ at sediment sample at bottom in 35 cm depth.**

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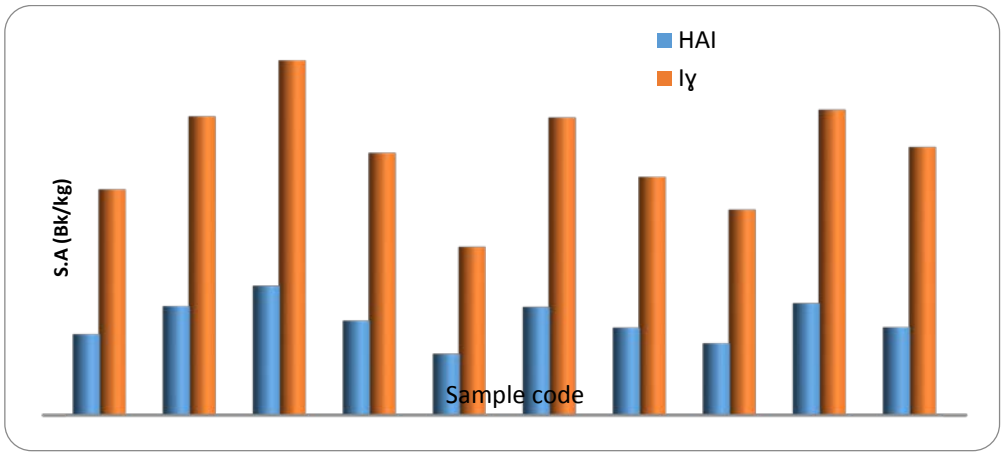


***Fig.6*: Data results of $HAI_{ex}$ and Iγ hazard indices histograms of sediment samples at bottom in 35cm depth.**

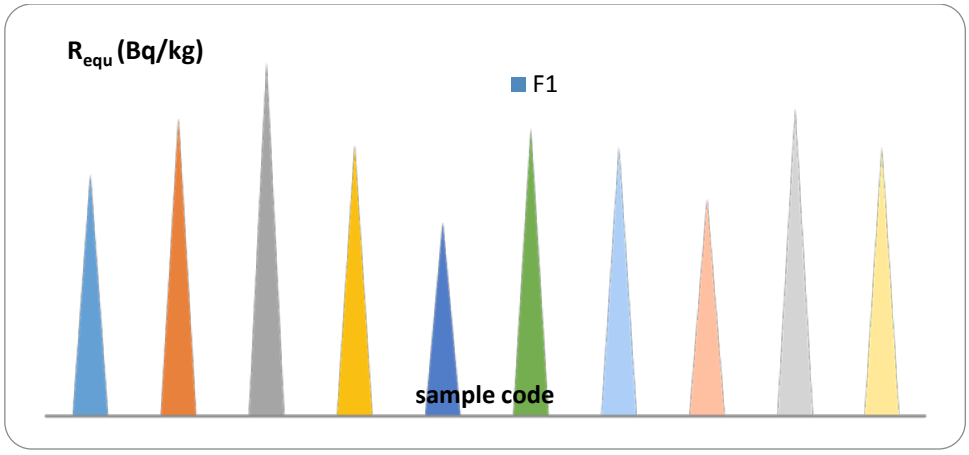


***Fig.7*: Results of the radium equivalent hazard index of sediment samples at edge of lakes .**

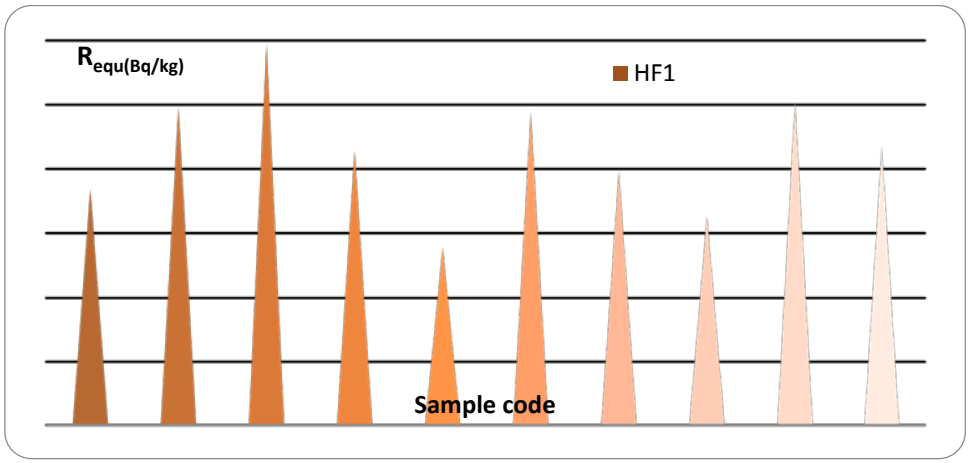


***Fig.8*: Results of the radium equivalent hazard index of sediment samples at bottom of lakes in 35 cm depth.**

## Conclusions

This paper focusing on the measurement of radioactive concentrations in many site of Baghdad province by using the high-purity germanium detector technique. Furthermore, the results leading to suggested that radioactivity of sediment samples hasn't effected on human health and environment. The measurement of concentration and hazard index are investigated all ten samples are suitable with allowed permissible international limits. The results data of hazard indices ($HAI_{ex}$), the hazard index of gamma radiation ( $I_\gamma$) and the radium equivalent hazard index ($R_{equ}$) in sediment samples are safety levels for human consumption and environment and the ($HAI_{ex}$ < 1) except ($HAI_{ex}$) at $F_3$ for Al-yousifya with values greater than one (>1). In summary, the results that obtained of the ten sample were under the critical maximum standard data of concentrations that reported by UNSCEAR.

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