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Natural Radioactivity Levels of Nile Water in Qena Governorate

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***Abstract*-Total of 53 water samples were collected from Nile River at three different locations, Southern area (Qus region), Central area (Qena region), and Northern area (Nagi-Hamadi region), within Qena governorate, south of Egypt. ^{226}Ra, ^{232}Th, and ^{40}K - were measured by low-level gamma-ray spectrometer NaI (Tl). The average values of ^{226}Ra, ^{232}Th and ^{40}K were 0.44±0.009, 0.22± 0.001 and 4.73±0.10Bq/L, for Qus region respectively, but for Qena region the values were 0.50±0.0039, 0.45±0.0035 and 5.46±001Bq/L. - In Nagi-Hamadi region the activity concentration was 0.29±0.0019, 0.19±0.001 and 4.12±0.08 for ^{226}Ra, ^{232}Th and ^{40}K respectively. The radium equivalent activity (Raeq) and absorbed dose rate (D) for all samples under studying were agree with the world average value. These values present no hazards tohuman.**

***Keywords*-NaI (Tl), Radionuclide, Nile water, Hazard index**

I.INTRODUCTION

Most people on the planet are vulnerable to a level of the background radiation. One research trend that draws public attention is the exposure of humans to ionizing radiation since the bulk of the population's overall exposure to radiation is caused by natural radiation [1]. In the earth's surroundings, natural radioactivity is prevalent in a variety of geological forms such as rocks, soil, sand, plant, water as well as air. Therefore, human beings should be conscious of radioactive consequences by radioactive elements in the natural environment, whether they are of natural or induced origin.

Long-term uranium, as well as radium exposure by inhalation, does have a variety of consequences on human health, including acute leukopenia, chronic lung diseases, mouth necrosis, and anemia. While the exposure to radium results in tumors in the bone, cranial as well as the nasal tract, the effects of exposure to thorium are including cancers of liver, kidney, pancreas, lung, and bone in addition to leukemia [2].

Knowledge of the radioactivity distribution derived from natural materials allows the assessment of potential radiological threats to humanity when such materials are utilized. Across history, the Nile River has served various civilizations in Egypt and proceeds to provide a crucial function in the water supply for the people of Qena governorate, south of Egypt, in terms of drinking, irrigation as well as industry. Herein, we aim to provide data about radioactivity levels due to naturally occurring radionuclides present in Nile River water from the area under study.

II. MATERIALS AND METHODS

1. Study Area

Qena governorate is one of the most significant industrial and agricultural areas in Egypt. It located at 600 km south of Cairo city, the capital of Egypt, and it covered an area10,798 km2 and its population is 3,340,409. The governorate is located between latitude (26o15\ N-28o8\ N) and longitude (32o 50\ E - 32o.42\ E). The samples were collected from 3 districts: Nagi-Hamadi (19 samples),Qena (25 samples) and Qus (9 samples).

2. Samples Collection and Preparation

The collection of the samples was performed at 1 m in-depth by dipping a closing cap bottle under water surface with the help of a 2 m wire then the bottled cap is opened at the requested depth. The collected samples were transferred to the laboratory and charged in polyethylene Marinelli beakers with a capacity of 1.4 liters, which were regarded as measuring containers.

Prior to utilization, washing the beakers was realized by the assistance of dilute hydrochloric acid, followed by rinsing in distilled water. Beakers were filled up individually until reaching its brim, followed by pressing a tight cap on the beakers to eliminate the inside air. Water samples were left for at least one month to reach a secular equilibrium for radium and thorium with their progenies [3].

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Fig.1 Location of the Nile River with experimental sites in Qena.

3. Measurement of the Activity Concentration

26Ra,232Th and 40K were measured using low level background gamma ray spectrometer consists basically of 3×3 inchNaI (Tl), S-1212-I model, with a 1024 microcomputer multichannel analyzer, 5510 Ortec Norland. The applied detector has a peak gamma ray efficiency of 2.3×10-2 at 1332 keV, energy resolution of 7.5% at 662 keV and operation bias voltage 805 V dc. The detector was housed inside a massive cylindrical lead shield with quarter 50 cm to reduce the background radiation, Schematic view of the experimental system shown in figure 2.

Standard point sources (60Co, 137Cs) and standard solution QCY48 were employed, respectively for energy and efficiency calibrations purposes. For more than one day, each sample was located over the detector in face-to-face geometry to measure the concentrations of 226Ra, 232Th and 40K. Before sampling counting, the background was typically taken by using identical measurement conditions of the sample every week. The concentration of 226Ra was measured by the utilization of gamma-lines of 214Bi (609.32, 1120, and 1765 KeV) while 232Th content was determined by the utilization of gamma-lines of 228Ac (911.16 keV), and 212Pb (238 keV). The concentration of 40K was evaluated by measurement of its single peak at 1460.8 keV [4]. The specific activity concentration A(Ei) with Bq/kg, of a nuclide and for a gamma-line (i) with energy E, is given by:

$$A(E_i) = \frac{N(E_i)/T - n(E_i)/t}{\varepsilon(E_i) \cdot P(E_i) \cdot M} \quad (1)$$

Where, N(Ei) is the counts in a given peak (i) area, T is the sample counting lifetime, n(Ei) is the number of counts in background peak (i), t is the background counting time, P(Ei) is the number of gammas per disintegration of this nuclide (emission probability), M is the mass in kg of the measured sample, ε(Ei) is the detection efficiency of the measured gamma-line energy.

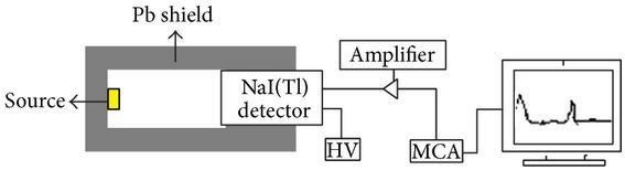

Fig.2 Schematic view of the experimental system

4. Dose assessment

The absorbed dose rate of gamma-ray, D, in nGy.h-1 above the ground level at a 1.0 m height in the outdoor air can be calculated by means of the activity concentrations of 226Ra, 232Th series and 40K isotope, which is measured in Bq.kg-1 as the following UNSCEAR-2000 equation [2]:

$$D(nGy/h) = 0.462\, A_{Ra} + 0.604\, A_{Th} + 0.0416\, A_K \quad (2)$$

where A_{Ra}, A_{Th} and A_K are the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in Bq/kg.

5. Radium Equivalent Index; (Raeq)

RaEq index in Bq/kg is a convenient index to compare the specific activities of samples containing different concentrations of 226Ra, 232Th (228Ra) and 40K. It is defined based on the assumption that 10 Bq/kg of 226Ra, 7 Bq/kg of 232Th and 130 Bq /kg of 40K produce the same gamma dose rate. It is calculated using the following equation [3]:

$$Ra_{eq} = A_{Ra} + 1.43\, A_{Th} + 0.077\, A_K \quad (3)$$

where: ARa, ATh and AK are the specific activities Bq/kg of 226Ra, 232Th and 40K, respectively [6].

III. RESUTLS AND DISCUSSION

Table I shows the activity concentration for (226Ra, 232Th, and 40K) in water samples collected from Qus, Qena, Nagi-Hamadi regions within Qena governorate, south of Egypt. The average value of 226Ra was 0.44±0.009, 0.50±0.0039, and 0.29±0.0019 Bq/L for Qus, Qena, and Nagi-Hamadi, respectively, whereas, the average value of 232Th was 0.22± 0.001, 0.45±0.0035, and 0.19±0.001 Bq/L. 40K values were one order of magnitude higher than 226Ra and 232Th values and its values were 4.73±0.10, 5.46±001 and 4.12±0.08 Bq/L for Qus, Qena, and Nagi-Hamadi, respectively.

In general low and slight variation in radioactivity levels was observed for Nile River water samples from different studied areas in Qena governorate. This can be explained as a result of the same geological formations of these areas. The slightly increase of radioactivity levels for Qena samples in comparison with other areas may be due to the drain of agricultural wastewater into the Nile River, where Qena region has five drainage sources in comparison to one drainage source for Nagi-Hamadi

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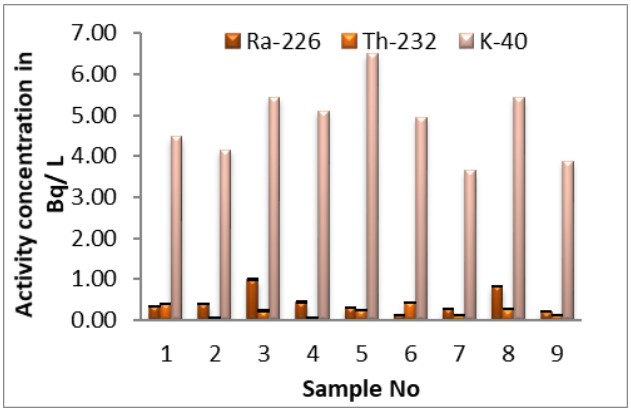
region and no drainage sources for Qus region, the water from drainage sources contain tracer deposits of agricultural fertilizers reflecting the slightly increase of radioactivity for Qena samples [7]. Figure (3) shows the activity concentration for (226Ra, 232Th, and 40K) Nile River water samples collected from Qus, Qena and Nagi-Hamadi regions.

The calculated values of absorbed dose rate and radium equivalent index are listed in table 1. Average value of the absorbed dose rate for Qus, Qena and Nagi-Hamadi was 0.54, 1.7 and 1.07 nGy.h-1 Nevertheless, based on UNSCEAR-2000 [10], the outdoor air dose rate from terrestrial gamma rays is approximately 57 nGy.h-1 in normal conditions. Accordingly, the estimated doses achieved for all samples in this research are lower than the global average value. Also, the average value of the radium equivalent index was0.666, 0.73 and 0.47 for Qus, Qena and Nagi-Hamadi , respectively.

Table 1 Average Radionuclide Concentrations, Radium Equivalent Activity, and Absorbed Dose Rate in Different Samples.

Sample No.	Area	Activity concentration(Bq/Kg)			R_{aeq}	H_{ex}	H_{in}	I	Absorbed dose rate
		Ra-226	Th-232	K-40					
1	Qus	0.33±0.001	0.47±0.003	4.47±0.09	1.360	0.003	0.005	0.010	0.63
2		0.39±0.002	0.06±0.0002	4.15±0.08	0.809	0.002	0.003	0.006	0.40
3		0.98±0.009	0.23±0.001	5.43±0.12	1.732	0.003	0.007	0.012	0.82
4		0.44±0.001	0.06±0.001	5.10±0.11	0.913	0.002	0.004	0.007	0.45
5		0.31±0.002	0.25±0.001	5.49±0.12	1.168	0.002	0.004	0.009	0.57
6		0.13±0.005	0.43±0.002	4.95±0.11	0.0005	0.003	0.364	0.133	0.53
7		0.28±0.001	0.12±0.004	3.64±0.06	0.002	0.002	0.536	0.287	0.36
8		0.83±0.007	0.43±0.002	5.42±0.12	0.008	0.003	0.912	0.832	0.77
9		0.21±0.009	0.11±0.003	3.87±0.07	0.001	0.002	0.461	0.212	0.33
	Average	0.44±0.009	0.22± 0.001	4.73±0.10	0.666	0.002	0.255	0.168	0.54
	Max.	0.99±0.009	0.47±0.003	6.49±0.1	1.732	0.003	0.912	0.832	0.82
	Min.	0.13±0.001	0.06±0.001	3.6±0.6	0.000	0.002	0.003	0.006	0.33
10	Qena	0.20±0.0009	0.17±0.0007	5.53±0.13	0.43	0.007	0.003	0.002	0.878
11		0.26±0.0013	0.42±0.0027	6.69±0.17	0.65	0.010	0.004	0.004	1.378
12		0.64±0.0051	0.52±0.0037	7.48±0.20	0.92	0.014	0.007	0.005	1.959
13		0.58±0.0044	0.14±0.0005	5.55±0.13	0.58	0.009	0.005	0.003	1.205
14		0.48±0.0033	0.23±0.0011	5.44±0.12	0.59	0.009	0.005	0.003	1.238
15		0.52±0.0038	0.13±0.0005	4.68±0.10	0.52	0.008	0.004	0.003	1.077
16		0.32±0.0018	0.16±0.0006	4.84±0.10	0.44	0.007	0.003	0.002	0.918
17		0.24±0.0012	0.52±0.0038	5.40±0.12	0.65	0.010	0.004	0.004	1.401
18		0.35±0.0020	0.50±0.0036	4.88±0.10	0.67	0.011	0.005	0.004	1.439
19		0.35±0.0020	0.87±0.0082	6.20±0.15	0.95	0.015	0.007	0.006	2.073
20		0.12±0.0004	0.61±0.0048	4.31±0.08	0.61	0.010	0.004	0.004	1.329
21		0.90±0.0086	0.11±0.0004	4.90±0.10	0.69	0.010	0.006	0.004	1.439
22		0.36±0.0022	0.95±0.0093	5.22±0.11	0.96	0.015	0.007	0.006	2.126
23		0.60±0.0046	0.99±0.0098	5.49±0.12	1.10	0.018	0.008	0.007	2.432
24		0.83±0.0075	0.82±0.0075	5.57±0.13	1.11	0.017	0.009	0.007	2.432
25		0.50±0.0035	0.46±0.0032	5.66±0.13	0.74	0.012	0.006	0.004	1.594
26		0.94±0.0092	0.84±0.0077	5.73±0.13	1.18	0.019	0.010	0.007	2.589
27		0.50±0.0035	0.70±0.0059	6.12±0.15	0.91	0.014	0.007	0.005	1.972
28		0.79±0.0071	0.33±0.0019	5.26±0.12	0.79	0.012	0.007	0.005	1.673
29		0.66±0.0053	0.31±0.0017	4.96±0.11	0.70	0.011	0.006	0.004	1.485
30		0.36±0.0022	0.87±0.0081	4.89±0.10	0.89	0.014	0.006	0.005	3.096
31		0.46±0.0031	0.10±0.0003	6.05±0.14	0.53	0.008	0.004	0.003	3.304
32		0.92±0.0088	0.13±0.0004	6.64±0.17	0.78	0.012	0.007	0.004	1.611
33		0.64±0.0051	0.14±0.0005	4.84±0.10	0.58	0.009	0.005	0.003	1.212
34		0.16±0.0006	0.20±0.0009	4.08±0.08	0.36	0.006	0.002	0.002	0.754
	Average	0.50±0.0039	0.45±0.0035	5.46±001	0.73	0.012	0.006	0.004	1.705
	Max.	0.94±0.0092	0.99±0.0098	7.48±0.20	1.18	0.019	0.010	0.007	3.304
	Min.	0.12±0.0004	0.10±0.0003	4.08±0.08	0.36	0.006	0.002	0.002	0.754
35	N.Hamady	0.17±0.0007	0.14±0.0005	3.17±0.05	0.29	0.005	0.002	0.002	0.605
36		0.16±0.0006	0.28±0.0015	3.61±0.06	0.39	0.006	0.003	0.002	0.841
37		0.34±0.0020	0.10±0.0003	4.62±0.09	0.41	0.006	0.003	0.002	0.841
38		0.52±0.003	0.08±0.0002	4.32±0.08	0.49	0.007	0.004	0.003	1.008
39		0.53±0.0039	0.06±0.0001	4.93±0.10	0.49	0.007	0.004	0.003	0.995
40		0.98±0.009	0.75±0.0065	6.78±0.17	1.19	0.019	0.010	0.007	2.588
41		0.53±0.0038	0.11±0.0004	5.20±0.11	0.53	0.008	0.004	0.003	1.090
42		0.54±0.004	0.08±0.0002	3.50±0.06	0.45	0.007	0.004	0.003	0.927
43		0.59±0.0045	0.11±0.0003	5.00±0.11	0.55	0.008	0.005	0.003	1.128
44		0.44±0.0029	0.10±0.0003	4.49±0.09	0.45	0.007	0.004	0.003	0.929
45		0.50±0.0035	0.07±0.0002	4.12±0.08	0.44	0.007	0.004	0.002	1.518
46		0.38±0.0023	0.26±0.0013	4.58±0.09	0.52	0.008	0.004	0.003	1.345
47		0.22±0.0010	0.43±0.0028	3.62±0.06	0.51	0.008	0.004	0.003	0.968
48		0.14±0.0005	0.15±0.0006	3.50±0.06	0.30	0.005	0.002	0.002	0.624
49		0.08±0.0002	0.42±0.0028	2.96±0.05	0.42	0.007	0.003	0.002	0.917
50		0.17±0.0007	0.07±0.0002	4.07±0.08	0.29	0.005	0.002	0.002	0.580
51		0.33±0.0019	0.32±0.0018	3.45±0.06	0.49	0.008	0.004	0.003	1.049
52		0.27±0.001	0.07±0.0002	2.52±0.04	0.27	0.004	0.002	0.002	0.567
53		0.38±0.002	0.10±0.0003	3.30±0.06	0.37	0.006	0.003	0.002	0.777
	Average	0.29±0.0019	0.19±0.001	4.12±0.08	0.47	0.007	0.004	0.003	1.016
	Max.	0.98±0.009	0.75±0.0065	6.82±0.17	1.19	0.019	0.010	0.007	2.588
	Min.	0.08±0.0002	0.06±0.00017	2.5±0.039	0.27	0.004	0.002	0.002	0.567



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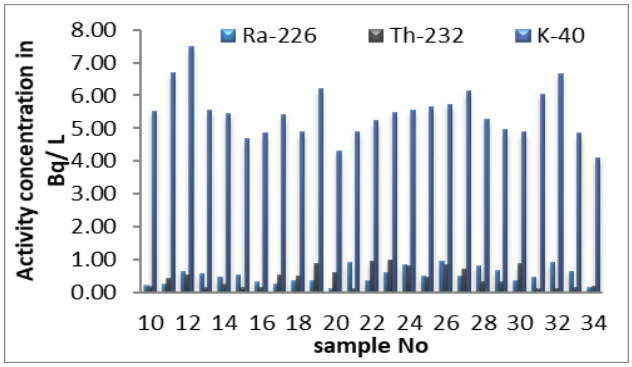

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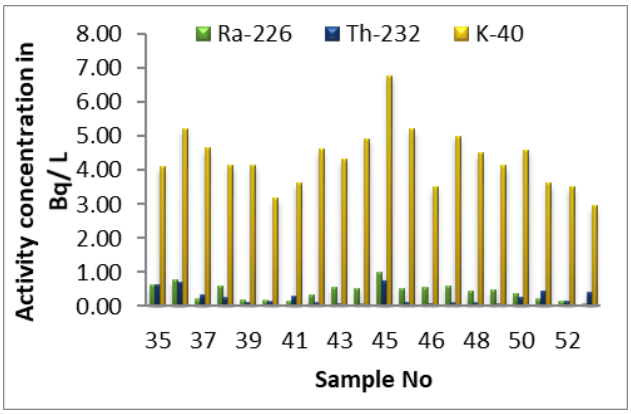

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Fig.3 Activity concentrations (Bq/L) for 226Ra, 232Th and40K a for Qus b for Qena and c for N.Hamadi.

IV. CONCLUSION

In this paper natural radioactivity levels in Nile River water samples collected from three different regions within Qena Governorate were determined using NaI (Tl) spectrometer. The activity concentration for 226Ra, 232Th, and 40K of samples collected from Qena region was higher than other water samples. The reason may be due to the effect of drainage agricultural wastewater into the Nile River at Qena area. Radium equivalent index and absorbed dose rate for all samples were lower than the world average value.

REFRENCES

[1] United Nations Scientific Committee on the effects of Atomic Radiation, "UNSCEAR," Sources, Effects and Risks of Ionizing Radiation. New York: United Nations, 1993.
[2] Taskin, H., Karavus, M., Ay, P., Topuzoglu, A., Hindiroglu, S. and Karahan, G., "Radionuclide Concentrations in Soil and Lifetime Cancer Risk Due to the Gamma Radioactivity in Kirklareli, Turkey," Journal of Environmental Radioactivity, vol. 100, pp. 49–53, 2009.
[3] American Society for Testing Materials, "Standard Method for Sampling Surface Soils for Radionuclides," ASTM Report, No. C, 983, 1983.
[4] American Society for Testing Materials, "Recommended Practice for Investigation and Sampling Soil and Rock for Engineering Purposes", ASTM Report, No. D, 109, 1986.
[5] Ramasamy, V., Suresh, G., Meenakshisundaram, V. and Ponnusamy, V., "Horizontal and Vertical Characterization of Radionuclides and Minerals in River Sediments", Applied Radiation and Isotopes, vol. 69, pp. 184–195, 2011.
[6] Chen, Hong and Cutright, Teresa, "The interactive Effects of Chelator, Fertilizer, and Rhizobacteria for Enhancing Phytoremediation of Heavy Metal Contaminated Soil", Journal of Soils and Sediments, vol. 2, pp. 203-210, 2002.
[7] J. Beretka, P. J. Mathew, "Natural Radioactivity of Australian Building Materials, Industrial Wastes and by Products," Health Physics, vol. 48, pp. 87-95, 1985.
[8] I.C. Mantazul, M. N. Alam and S. K. S. Hazari, "Distribution of Radionuclides in the River Sediments and Coastal Soils of Chittagong, Bangladesh and Evaluation of the Radiation Hazard," Applied Radiation and Isotopes, vol. 51, pp. 747-755, 1999.
[9] Krieger, R. "Radioactivity of Construction Materials," BetonwerkFertigteil-Technik, vol. 47, pp. 468-473, 1981.
[10] United National Scientific Committee on the Effects of Atomic Radiation "UNSCEAR", Sources and Risks of Ionizing Radiation. Report to the General Assembly with Annexes, United Nations, New York, 2000.