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Radioactivity assessment in Euphrates river sediment samples

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Abstract

This study was carried out to investigate builds up a rule map on various radiological factors in and around the Euphrates River in Iraq. Radon levels, radium content and surface and mass radon exhalation rates for 20 sediment tests gathered from different districts along the Euphrates River, Iraq, (about 500km long) using the can technique, with the CR-39 plastic detector. Radon fixation esteems were viewed as going from 835.0 to 2797.7 $Bq.m^{-3}$ with a normal worth of 1703.5 $Bq.m^{-3}$. The normal worth of radium content was viewed as 12.5 $Bg.kg^{-1}$ while the most minimal and most elevated determined upsides of radium content (C_{Ra}) were 6.1 and 20.5 $Bq.kg^{-1}$, respectively. The radon exhalation rates (surface E_S and mass E_m) for the study sediment samples were found to vary from (0.41 to 1.37) $Bq.m^{-2}.h^{-1}$ and from (0.09 to 0.31) $Bq.kg^{-1}.h^{-1}$with average values of 0.83 $Bq.m^{-2}.h^{-1}$ and 0.19 $Bq.kg^{-1}.h^{-1}$, respectively. The values of C_{Ra} for all sediment samples were lower than the recommended value of 30 $Bq.kg^{-1}$ given by UNSCEAR. Hence, the results show that the study area is safe as far as the health hazard effects are concerned, and the values of radium content in all surveyed sites are lower than the allowable limit.

Keywords: Exhalation rates; Euphrates river; CR-39; Radon; Sediments

1. Introduction

The naturally radioactive gas ^{222}Rn is usually used to evaluate the radioactive hazardous risk caused by environmental elements (water, soil, sediment…etc.) (Schmidt et al., 2010). This radioactive gas is one of the α-emitter progenies of the ^{238}U series and it is primarily the decay product of the ^{226}Ra. Radon gas can escape from the sediment to the water, which causes a reduction of radon in the sediments, thus, the radon to radium activity ratio must be less than 1. Subsequently, radon will decay in the water or be liberated in the atmosphere (Hammond and Fuller, 1979).

In the current review, radon levels what's more radium substance furthermore exhalation rates for radon need to be confirmed in the silt tests collected from 20 picked destinations along Euphrates River from Al Anbar to Babil governorates, about 500 Km long, Iraq. Plus, the current examination builds up a rule map on various radiological factors in and around the Euphrates River in Iraq.

1.1. The study area

The Euphrates River is perhaps the longest stream in Southeast Asia; its length is 2786 km. Its bowl territory is 440000 km2 shared by 3 nations, Iraq, Turkey, Syria. The Euphrates river, or "Nahr al Furat" as known in Iraq, crosses the Syrian border and flows into Iraq near Al-Qa'im west of Al Anbar Governorate. The bowl of the Euphrates River is plentiful in

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various non-metallic minerals with gigantic amounts. Limestone, dolostone, and glass sand are additionally present in tremendous amounts. Also, the bowl incorporates many oil and gas fields (Varoujan et al., 2018).

Al-Anbar is that the biggest governorate of Al-Iraq, (228,138 km^2), thirty second of the full-scale area of Al-Iraq. Al-Anbar's people in 2007 was 5,598,148 individuals as per the Iraqi government (University of Anbar, 2020). Euphrates River is generally the most water supply of the native water provides for Al-Anbar tenants. This stream reaches out over a length of five hundred klick from the Syrian boundary to the lines of Babel governorates. There are unit various lakes and dams on the governorate, like Habbaniyah, Haditha Dam, and a part of Tharthar. There are likewise controlled dams in the governorate like Haditha Dam, Ramadi Dam, Al Warar Dam, and Al Fallujah Barrage notwithstanding fundamental controllers like the principle Saqlawiya brook controller, Tharthar regulator, and the Sin Al-Dhban regulator in Habbaniyah.

The silt tests were gathered from 6 areas in the Al-Anbar Governorate, three residue tests from various locales of each region. As well, one sample was collected from Al-Habbaniya Lake and the last sample was collected from Saddat-AlHindya in Babil governorate. Figure 1 shows the guide of the overview region along the waterway which was reached out from Al-Qa'im (400 km northwest of Baghdad near the Syrian border) through Haditha (a city in the west of Al Anbar governorate, about 240 km northwest of Baghdad), Al-Baghdadi (224 km from Baghdad), Hīt (lies northwest of Ramadi the provincial capital, 178 km from Bagdad), Ramadi (about 110 km west of Baghdad) and Falluja (69 km west of Baghdad) then Al-Habbaniya Lake (located halfway between Ramadi and Fallujah) then the last site Saddat-AlHindiya (80 km south of Baghdad) (Wikipedai, 2018).

The population of each district, the cities from which the sediment samples were collected, and the directions of testing destinations are given in Table 1.

Figure 1 The sites of the sediment samples along Euphrates River, Iraq

2. Material and method

Sediment tests were gathered from the waterway bank at 5 cm profundity utilizing Ekman Grab tests. An abundance of water was taken out from the example. At that point, the examples were placed in glass containers with an adequate volume of 10% formalin for safeguarding and moved to the Environment Research Center Lab. From there on, the silt tests were dried within the broiler at 80 °C for sixteen hours. Afterward, the examples were press and pulverized with a processor and afterwards sieved through (2-mm mesh).

Table 1 Districts, population, cities, and coordinates of the surveyed sediment sample sites

Code	District	Population (IAU and OCHA, 2009)	Sampling Sites	Latitude N	Longitude E	Important sites
Q1	Al-Qa'im	137,567	Al Ish	34.36383	41.12606	Uranium ore production, officially named "Chemical Complex of phosphate"
Q2			Rmelan	34.37956	41.15233	
Q3			Khateela	34.4044	41.22154	
H1	Haditha	78,656	Al Sad	34.27962	42.21562	Buhayrat al Qadisiyyah, an artificial lake which was made by the structure of the Haditha Dam, the biggest hydroelectric office in Iraq
H2			Al wasta	34.20469	42.35226	
H3			Al hawiga	34.07114	42.39964	
B1	Al Baghdadi	28,616	East Baghdadi	33.88658	42.53216	The closest village to the U.S. Military's Al Asad Airbase
B2			Al Jawa'ana Bridge	33.86919	42.52804	
B3			Al Mashhad	33.85978	42.54812	
Ht1	Hit	129,004	Al Omera	33.68357	42.78791	A marketplace for agricultural manufacture and oil pipelines to the Mediterranean Sea. The hit marks the start of the high substance plain on the Euphrates, and it contains variety of hot springs (sulfate water)
Ht2			Al Jama'ia	33.65557	42.81349	
Ht3			Al Baker	33.61817	42.86567	
R1	Ramadi	540,474	Al Ta'amim	33.43368	43.2655	Occupies an extremely strategic location on the Euphrates River and therefore the road west into Syria and Jordan
R2			Hay Al Akrad	33.42564	43.27597	
R3			Alwarar	33.4013	43.29948	
F1	Fallujah	529,598	Albu Azam	33.38632	43.67473	Fallujah Barrage is a barrage on the Euphrates River. Its fundamental capacity is to raise the water level of the waterway for water system
F2			Alsaqlawia	33.35512	43.44282	
F3			Albu Thiab	33.34612	43.7612	
HL	Habbaniyah		Habbaniyah Lake	33.29049	43.45166	Near Al-Taqaddum base of operations and shut on the banks of the river had already been established the Royal Air Force airbase of RAF Dhibban, later renamed RAF Habbaniya.
Hn	Babil	33,900	Saddat Al Hindiyah	32.7104	44.2811	Both the modern and old Hindiya Barrages are located near it

Alpha particles radiated from atomic number 86 gas ^{222}Rn, one among the U women, were calculable by a shut will procedure utilizing robust state atomic track identifiers CR-39. The heaviness of twenty g of every silt take a look at was set at the muse of the will. The examples were then left for a substantial length of your time (2 months) to allow the emanation of radon gas from the examples and get a sensible number of α-molecule tracks. Toward the finish of the openness time frame, CR-39 pieces were artificially treated in 6.25N NaOH answer at seventy degree Celsius for five hours. Afterward, alpha molecule tracks were counted by Associate in Nursing optical magnifying instrument with a force of 400×.

Radon concentrations C_{Rn} in (Bq.m^{-3}), viable radium content C_{Ra} in (Bq.kg^{-1}), in the sediment tests were given by conditions (1) and (2), respectively (Sarma, 2013; Salih et al., 2015):

$$C_{Rn} = \frac{\rho}{KT} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$C_{Ra} = \frac{C_{Rn}V}{M} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, ρ = The track thickness (ρ) in the samples (Tracks/cm^2), T = the openness time (day), V = the volume of the space over the example (m^3), M = weight of the example (kg), K = the alignment factor is determined hypothetically and controlled by depending on the model given by Barillon & Klein (1993), Eugin et al. (2012), and Sarma (2013) model, for the boundaries; how much alpha particles exists in the air, aspects of the compartment and the locator's sort utilized through drawing conditions by utilizing condition (3) (Sarma, 2013; El-Araby, 2013).

$$K = 0.25R\left[2cos\theta_c - \frac{R}{R_\alpha}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, (R) the holder range (cm), (θ_c) CR-39 basic point, and (R_α) α particles range in CR-39. The determined worth of K is 0.04891 Track.cm^{-2}.d^{-1} /Bq.m^{-3}.

The surface and mass exhalation rates of radon, E_S (Bq.m^{-2}.h^{-1}) and E_M (Bq.kg^{-1}.h^{-1}) are determined by the following formulas (Zubair et al., 2012):

$$E_S = \frac{C\ V\ \lambda}{A[T + \lambda^{-1}\{e^{-\lambda T} - 1\}]} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$E_M = \frac{C\ V\ \lambda}{M[T + \lambda^{-1}\{e^{-\lambda T} - 1\}]} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where: A is the surface area of the sample λ is the decay constant of radon gas, C is the calculated incorporated radon exposure as estimated by SSNTDs of type CR-39 (Bq.m^{-3}. h)

3. Results and discussion

The forms of Rn levels depend upon the geographical boundaries and environmental condition, like sand, residue, and dirt arrangement even as the air temperature and strain, and wind speed (LaBrecque et al., 2001; Sundal et al., 2008; Smetanova et al., 2009). Also, the radium and radon fixations rely upon the dirt's sort, the progression of water in the review areas, the land development of rocks, and the hour of sedimentation. Thusly, radon levels in the examined silt tests got from picking areas over the Euphrates River in many districts of the Al Anbar governorate and one sample from Saddat AlHindiya were determined.

The outcomes are summed up in figure 2. As per the got results, the most noteworthy radon level was observed in sediment sample B2 (Al Baghdadi-Al Jawa'ana Bridge) with the value of 2797.7 Bq.m^{-3} while the lowest value was found in the sediment sample HL (AlHabbaniya Lake) with the value of 1881.4 Bq.m^{-3}. The average value of radon was 1703.5 Bq.m^{-3}. Nonetheless, radon focuses in most silt tests were higher than the world normal action esteem suggested by the International Commission of Radiation Protection (ICRP) of noble gas fixation in soil and sediment, that is within the reach of two hundred to eight hundred Bq.m^{-3} (ICRP, 1993).

The variations of radon activity may rely upon nearby attributes of dregs for the contemplated territory. As well, military operations can be considered as one of the most important factors that contributed to the environmental pollution in the water and the land, it was impacted the public health due to the huge destruction of buildings and infrastructure of residential complexes in cities and countryside, as well as the direct impact on the Human and living beings. Since 2003, Iraq and specifically Al Anbar governorate has witnessed many military operations which can be considered as the main reason for the pollution of the Euphrates River (Mahmoud, 2018).

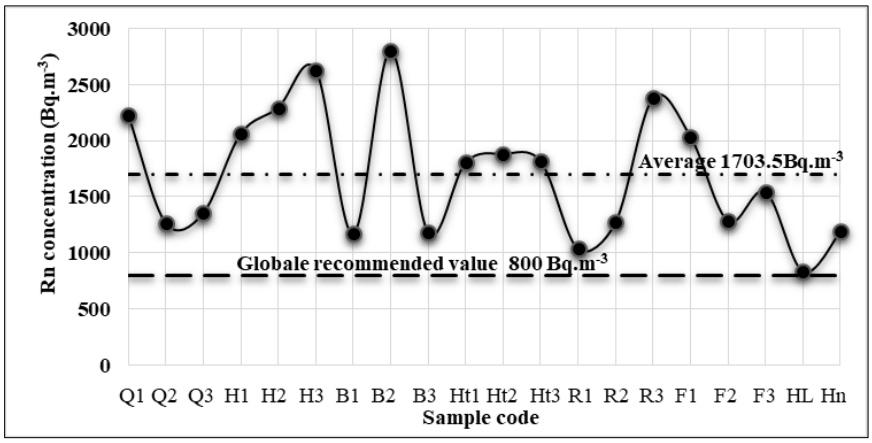

Figure 2 Radon concentration (Bq.m-3) with the researched sediment tests gathered from chosen places over Euphrates River

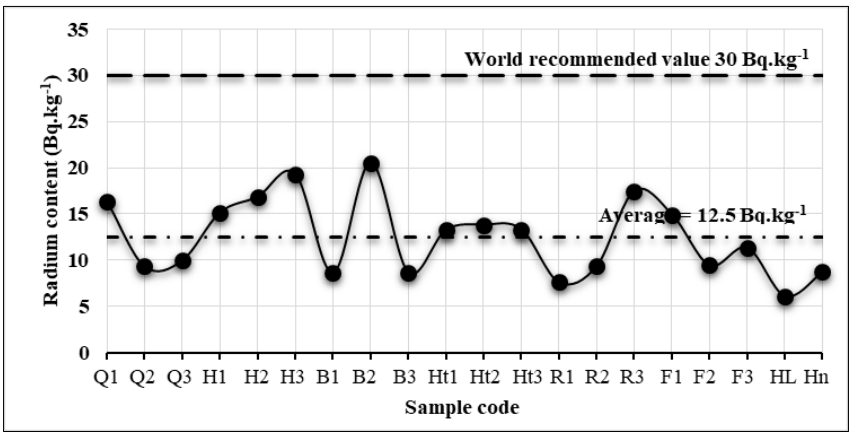

Figure 3 The radium content of the researched silt tests was gathered from picked places over the Euphrates River

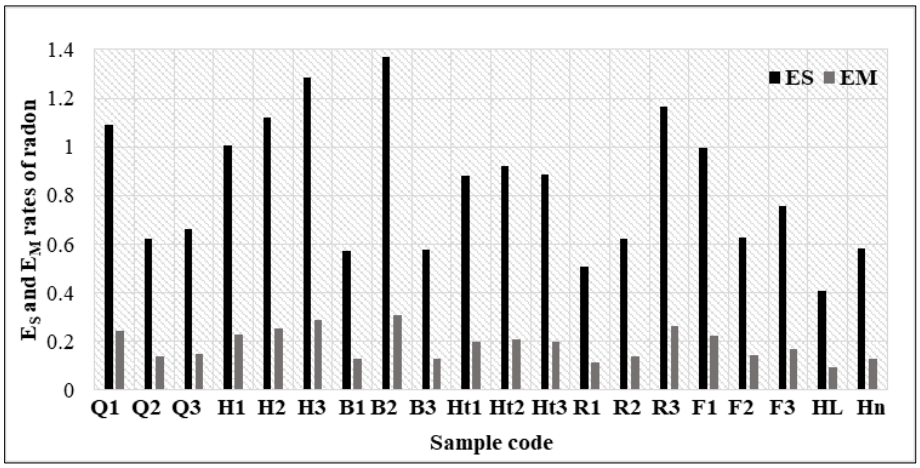

Figure 4 Surface and mass exhalation paces of radon gas in dregs samples

The radium content in the review residue tests was additionally determined and represented in figure 3. The most elevated radium content estimated esteem was 20.5 Bq.kg^{-1} while the most minimal worth was 6.1 Bq.kg^{-1} also the normal radium content worth was 12.5Bq.kg^{-1}. The distinctions in radium content might result as indicated by the fluctuation in the kind of dregs and different life exercises that sway the environment of the Euphrates River (Al-Obaidy and Al-Khateeb, 2013). The values of radium content in the surveyed sites are lower than as far as possible (30 Bq.kg^{-1}) as recommended by UNSCEAR [21].

The reach and mean (between sections) values for the surface and mass radon exhalation rates, ES and EM, procured in these assessments have showed up in Figure 4. The outcomes show that the surface and mass exhalation paces of radon change from 0.41 to 1.37 (0.83) Bq.m−2.h−1 and from 0.09 to 0.31 (0.19) Bq.kg−1.h−1, respectively. It is obvious from Table 2 that the surface and mass exhalation rates fluctuate from the highlight point. The radon exhalation in studied sediment samples was found to be much below the average world value of 118.8 Bq.m−2.h−1 (UNSCEAR, 2000).

Radon exhalation rates are expected to depend on the concentrations of uranium and radium in the studied samples and also depend on many other factors, such as permeability, porosity, density, texture and grain size (Nagaraju et al., 2013; Saad et al., 2013). The study of the exhalation rate of radon was significant for understanding the comparative distribution of the material to the total radon concentration determined in the sediment samples and useful to investigate the radon health hazard (Abd-Elzaher, 2012; Yousef et al., 2016). The distinctions in radon levels might result as per the difference in the kind of silt and different life exercises (Sahar et al., 2021). Additionally, the gathering of radium and radon depends upon the sort of soils, water stream around there, the geological advancement of rock sedimentation time and human activities.

4. Conclusion

The alpha activity in sediment tests, gathered from 20 chosen places along the Euphrates River in Al Anbar Governorate, was not really settled utilizing CR-39 SSNTD. From the acquired aftereffects of the recent review, the accompanying has been finished up:

- The aftereffects of the deliberate radon movement were higher than the worldwide mean action esteem in all testing locales.
- Significant differences were noticed in radon concentrations in surveyed sites which are due to the sort of soils, water stream around there, the geological arrangement of rock sedimentation time and human activities.
- The values of radium content in all surveyed sites are lower than the allowable limit.
- The exhalation rates given by all investigated sediment samples were found to be below the recommended value.
- The sediments do not pose any harmful hazards and they were safe as far as the health hazard effects are concerned.
- A tomography rule guide of the river may be drawn out and utilized as a knowledge reference for the assessment of any future changes within the radiation of the sediments.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

Author contribution

All authors contributed equally to this work.

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