

Measurement and mapping of radioactivity and Rn-222 emission rate in Babil Governorate using nuclear trace detector and remote sensing techniques

Emad H. Ahmed

Department of Physics, College of Science, University of Mustansiriyah, Baghdad, IRAQ
emadhameed321@uomustansiriyah.edu.iq

Abstract

In this research, Babil Governorate, located south of Baghdad's capital, was studied by studying C_{Rn} . Ten areas were selected throughout the governorate and soil samples were taken from those areas. The Rn-222 concentration and emission rates were measured by counting the effects of alpha particles emitted from Rn-222 gas using (CR-39 detector). It was noted that the highest percentage was in area No. 8, which is called Al-Mutahiyah, where the concentration was (173Bq/m^3) and the Rn-222 gas emission rate was ($463.14\mu\text{Bq/m}^2\text{h}$), and the lowest percentage was in area No. 10, which is called Al-Hashimiyah, where the C_{Rn} was (53Bq/m^3) and the Rn-222 emission rate was ($138.94\mu\text{Bq/m}^2\text{h}$). The other part of the work was to draw predictive maps for areas with unknown concentrations using geographic information systems and remote sensing technology, where interpolation technique was used to complete those maps.

قياس ورسم خرائط النشاط الإشعاعي ومعدل انبعاث غاز الرادون في محافظة بابل باستخدام كاشف الأثر النووي وتقنيات الاستشعار عن بعد

عماد حميد أحمد

الجامعة المستنصرية / كلية العلوم - قسم الفيزياء

مستخلص:

في هذا البحث تم دراسة محافظة بابل الواقعة جنوب العاصمة بغداد من خلال دراسة تراكيز غاز الرادون حيث تم اختيار عشر مناطق في عموم المحافظة وتم أخذ عينات تربة من تلك المناطق وتم قياس تراكيز غاز الرادون ومعدلات انبعائه من خلال عد تأثيرات جسيمات ألفا المنبعثة من Rn-229 باستخدام كاشف (CR-39) ولوحظ أن أعلى نسبة كانت في المنطقة رقم 8 والتي تسمى المتاهية حيث بلغ التركيز (173Bq/m^3) ومعدل انبعاث غاز الرادون ($463.14\mu\text{Bq/m}^2\text{h}$) وأقل نسبة كانت في المنطقة رقم 10 والتي تسمى الهاشمية حيث بلغ تركيز الرادون (53Bq/m^3) ومعدل انبعاث الرادون ($138.94\mu\text{Bq/m}^2\text{h}$). وكان الجزء الآخر من العمل هو رسم خرائط تنبؤية للمناطق ذات التركيزات غير المعروفة باستخدام نظم المعلومات الجغرافية، تقنية الاستشعار عن بعد، حيث تم استخدام تقنية الاستيفاء لاستكمال تلك الخرائط.

Introduction

It results from naturally occurring of the decay radionuclide Ra226-, which was decay product in U-238, Thoron (Rn220-), an isotope of Rn-222, is a decay product in Th232- series. as well as, its seepage from further migration and the ground. [1].

Since Rn-222 is a gas, It can leak into the air from the material it is made of and since U-238 and Ra226- are most found in, rocks and soil, Rn-222 is available anywhere - outdoors, as well as indoors [2]. This work aims

to determine C_{Rn} gas in soil samples in selected areas in Babylon province using alpha emitter recordings emitted by Rn-222 in a nuclear trace (CR-39 detector).

Description of Study Area

The lands of Babylon Governorate, which slope towards the south, rise 35 m above sea level. It has a desert climate characterized by low rainfall and high temperatures in the summer, which reach 50 °C. It has a warm climate in the winter, as shown in Figures (1) and2))respectively.



Figure (1) Iraq map

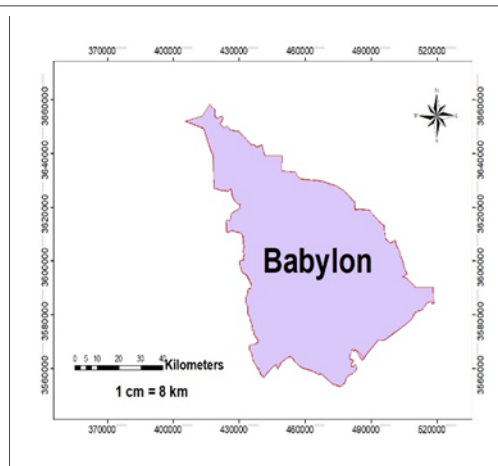


Figure (2) Babylon map

Experimental Part

The C_{α} particles emitted by C_{Rn} in soil samples were determined using a (CR-39detector) with a thickness of

(300 μ m). Soil samples were collected from the various locations in the districts of Babylon Governorate at a depth of(6 cm), then they were dried

and cleaned of impurities using a special sieve (diameter 0.30mm), and the sample weight was about of (30 g), and the C_{Rn} in the soil samples was gained using the sealed technique of cup as shown in Figure(3).

30 days is the irradiation time and

(CR-39 detector) were etched in a solution of (6.25N) (Na OH) at a temp. of (70°C) for (six h), and using the optical microscope to measuring track density(ρ) ,and (ρ) in the samples was calculated according to the relationship[3].

$$\text{Track density} = \frac{\text{Average number of total pits(tracks)}}{\text{Area of field view}} \dots\dots\dots (1)$$

The exhalation rate of Rn-222 (E_{exh}) in any samples is defined by the flux of Rn-222 released from the material's

surface. (E_{exh}) can be calculated by [6]:

$$E_{exh} = \frac{CV\lambda}{A[T + \lambda^{-1}(e^{-\lambda T} - 1)]}$$

Where:

C: is the integrated Radon exposure (Bq.m³).

V: is the volume of air in cup (m³) = 150 cm³ = 0.00015 m³

λ : is the decay constant for 222Rn (h⁻¹) = 0.1812 day⁻¹ = 0.00755 h⁻¹

A: is the surface area of the sample (m²) = 1.52×3.14=7.0685cm²=0.0007068 m²

T: is the exposure time (h) = 30day =720 h

Results and Discussion

Soil samples from 10 distinct locations in the Babylon Governorate were analyzed to estimate the amount of Rn-222 gas present. The sealed cup method was used to collect soil samples at a depth of 6cm. Table 1 shows the concentrations of Rn-222 and the rate of Rn-222 gas emission in ten different areas in Babil Governorate,

which are: Al-Eskandarya ,Al-Sakar, Al-Mashrooe, Al-Mahaweel, Al-Kefil, Al-Taleia, Al-Shomaly, Al-Mithatyah, Al-Imam, Al-Hashimyah.

It was found that the maximum C_{Rn} gas was in area No.8, called the Al-Mithatyah area, where it reached (173 Bq/m³). In contrast, it was found that the lowest value of Rn-222 gas concentration was in area No. 10, called the

Al-Hashimiyah area, where it reached (53 Bq/m^3) as shown in Table 1. Also, the highest value of the Rn-222 emission rate was in area No. 8 and the lowest value of the Rn-222 emission rate was in area No.10, see Fig.(4). We note that there is a difference in the concentration values of the regions, and this is due to the difference in terrain and soil type from one place to another. According to the current findings, the amount of C_{Rn} in soil is less (200 Bq/m^3) permitted (ICRP)[7].

Rn-222 radioactivity maps were created for each sample above for the research region using the geographic information systems and remote sensing. These maps are displayed in Figures (5), and(6), respectively. Also, the interpolation map for the (E_{exh}) and the contour map are shown in Fig.(7)and (8), respectively [8-11].

Conclusions

The current results showed that the C_{Rn} and the rate of Rn-222 gas emission in all selected areas in Babylon Governorate are less than the limit permitted by (ICRP).

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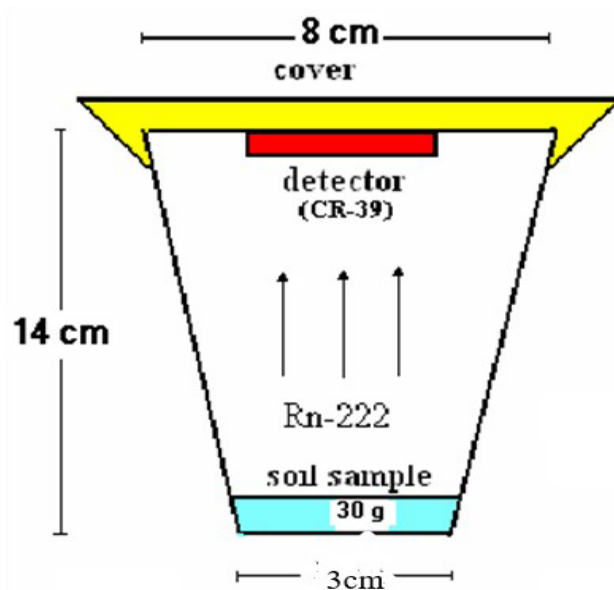


Fig.(3) A schematic diagram of the sealed-cup technique in the soil sample.

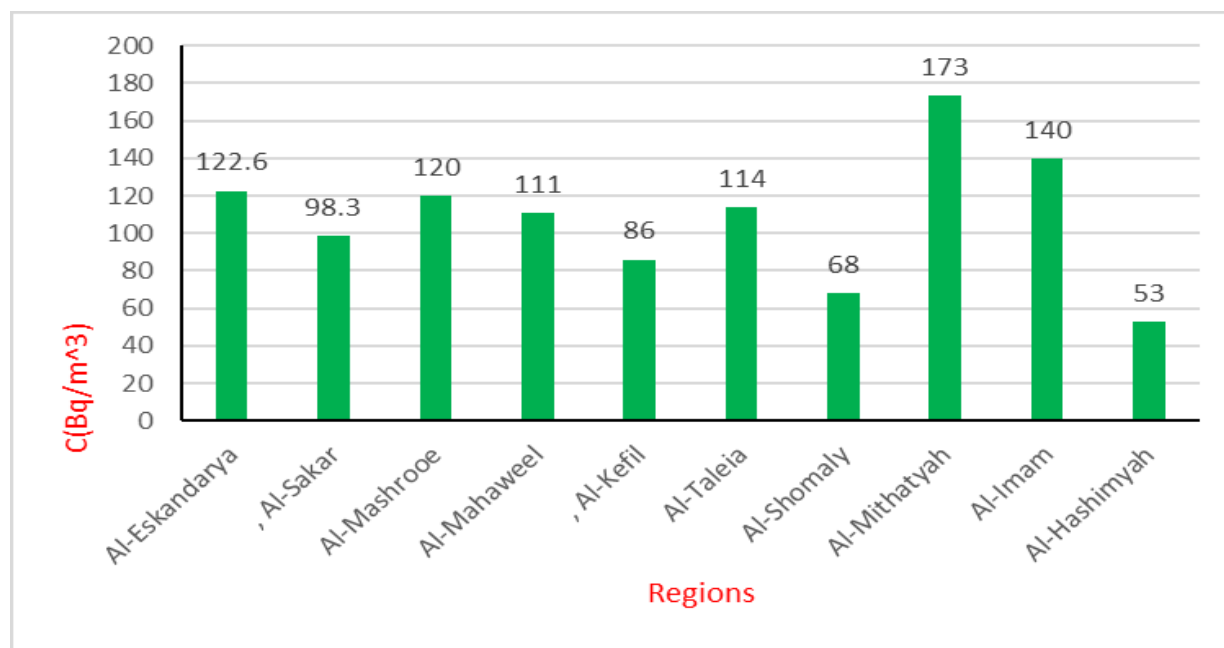


Fig.(4) Rn-222 gas concentration (Bq/m³) in soil samples in all regions studied.

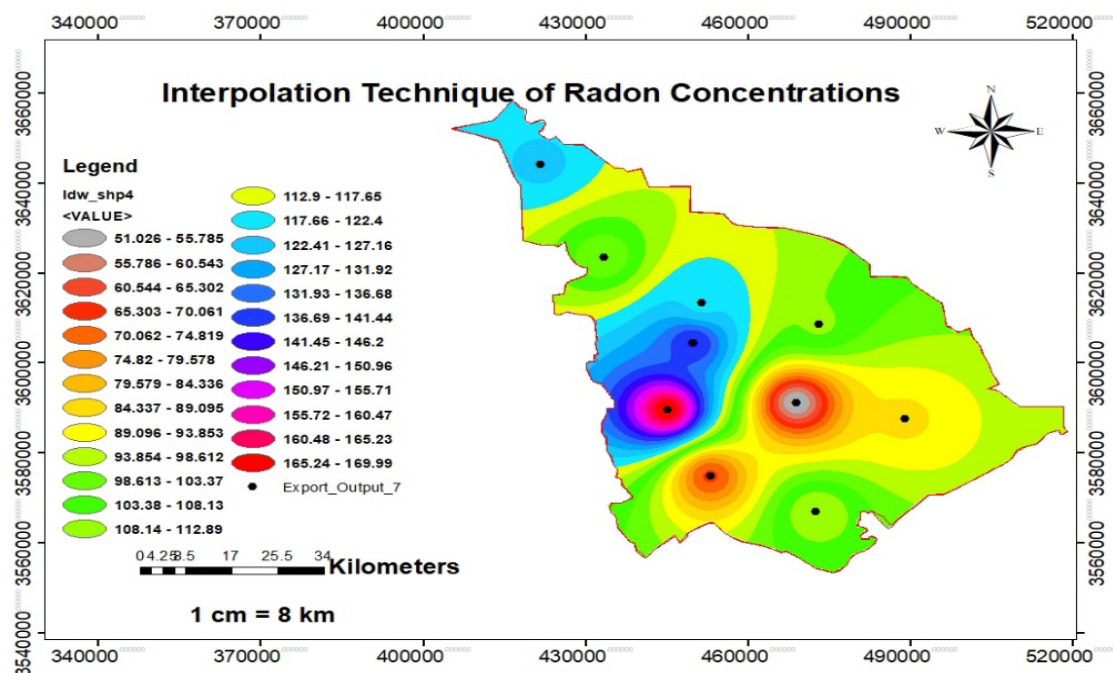


Figure (5) Distribution map of Rn-222 concentrations for the study region in the soil

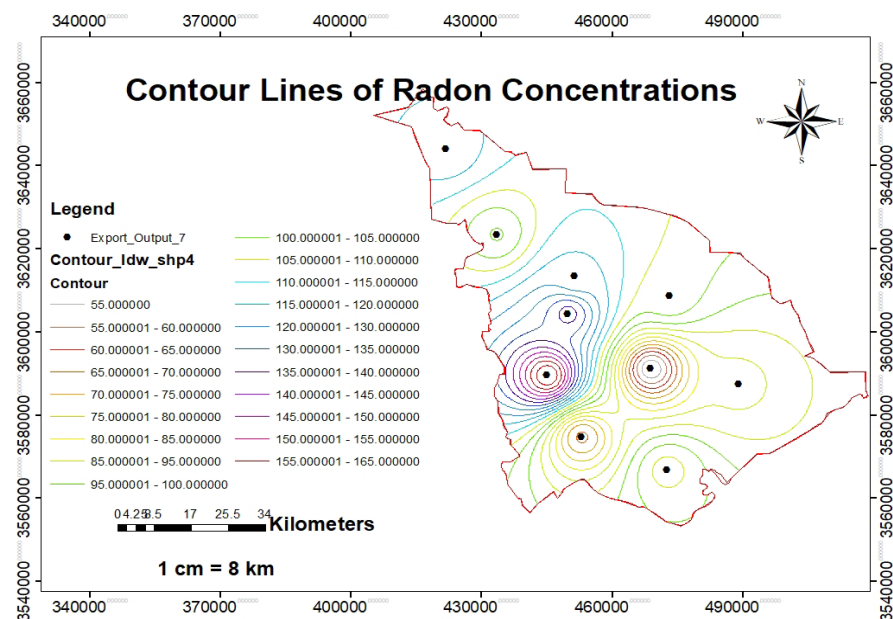


Figure (6) Rn-222 contour map

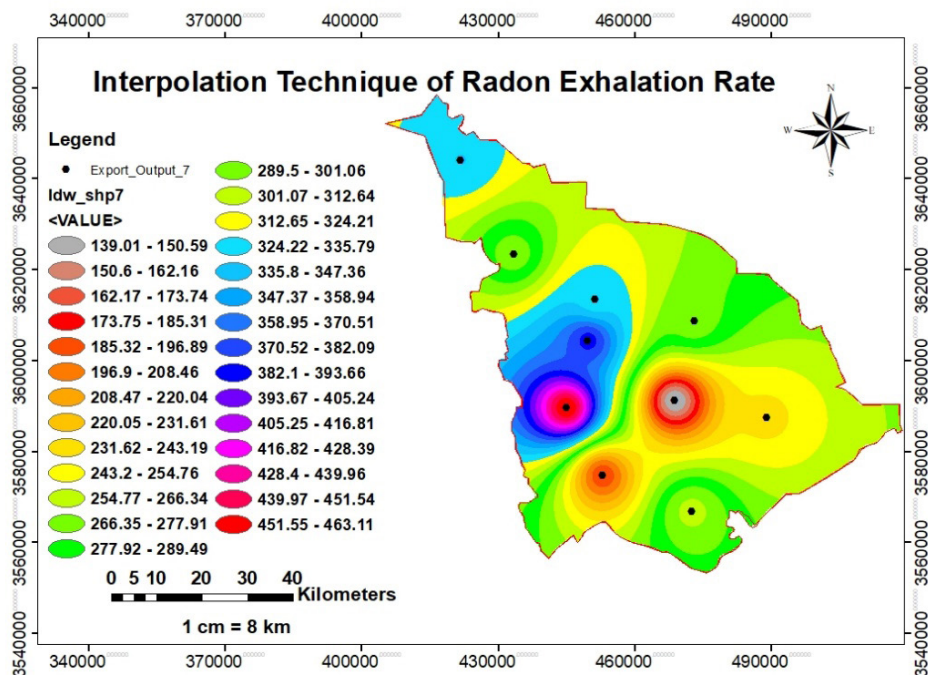


Figure (7) Distribution map of Rn-222 exhalation rate for the study area

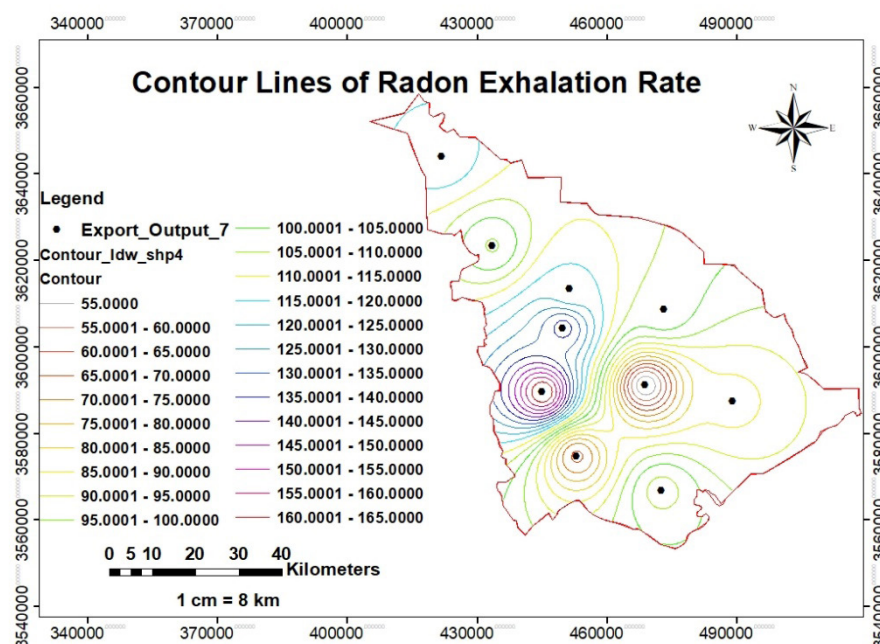


Figure (8) contour map of Rn-222 exhalation rate for the study area

**Table (1) shows the Rn-222 gas concentration
for soil samples in Babylon governorate**

No	Regions	Rn-222 gas Concentration (Bq/m ³)	Track density (Track .mm ⁻²)	Rn-222 exhalation rate (μBq/m ² h)
1	Al-Eskandarya	122.6	17.92	336
2	Al-Sakar	98.3	14.34	271
3	Al-Mashrooe	120	17.54	329.6
4	Al-Mahaweel	111	15.8	296.5
5	Al-Kefil	86	12.75	239.7
6	Al-Taleia	114	16.24	305
7	Al-Shomaly	68	10	187.98
8	Al-Mithatyah	173	24.65	463.14
9	Al-Imam	140	20.6	386.86
10	Al-Hashimyah	53	7.39	138.94