Assessment of Radiation Hazards and Mathematically Estimation Of the Radon dose Received by Drilling Workers of the Surface Water Wells in the Western and Southwestern Suburbs of Tripoli

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Abstract

•In this study, 8 samples were collected from the depths of surface wells ranging from 20m to 80m and two surface samples for comparison, from some southwestern and western suburbs of the Libyan capital "Tripoli", in order to evaluate their radioactivity and estimate the radon dose mathematically which the drilling wells workers can be exposed.
•The all values and indicators indicate initially that the surface depths of 20m-80m do not contain radiation activity that is different from the normal activity rates of surface soils •What drew attention, however, was the reverse migration of the NORM of phosphate fertilizer from surface to depth.

Introduction

In the mid-eighties of the last century, the cities of the Libyan coast suffered of a lack of fresh drinking water. The inhabitants dug deepwater wells in a random manner without government permits specially in 1990s. meanwhile the arrival of the industrial river water to the coastal cities , this phenomenon had receded, but had not disappeared , and it has also emerged clearly in recent years as a result of the current political and security situation

In this paper, an attempt is made to monitor the NORM (naturally occurring radioactive materials) produced during the drilling process and the changing of their concentration as a result of the surface depths changing, and estimate the Radon dose mathematically which the workers (excavators) can be exposed in terms of the depth increasing, specially with no safety controls, as well as all the remnants of the drilling process are dumped in random dumps or sometimes were left on the middle of the road..

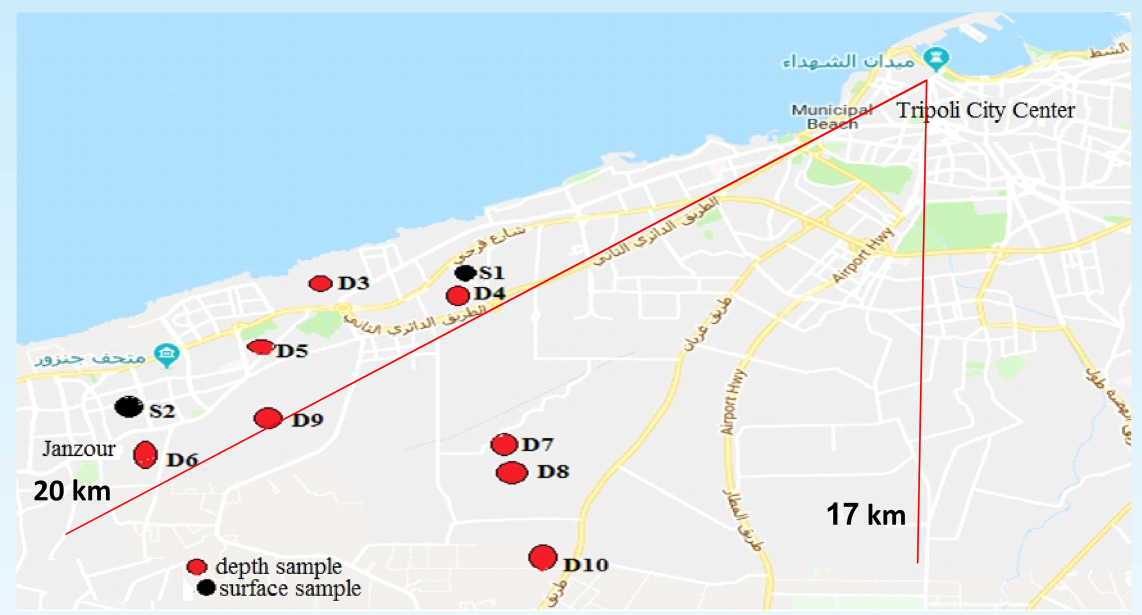
Background

Natural radioactivity arises from both cosmic and terrestrial sources. Radiation from naturally occurring materials (NORM) which include the radioisotopes ^{238}U, ^{235}U and ^{232}Th and ^{40}K represent particularly important natural sources. These radionuclides are primordial and their very long radiological half-lives mean that they are ubiquitously distributed in all components of the wider surface environment including in foods, soil, air water, vegetation, building materials etc.The radioactive decay series headed by ^{238}U, ^{235}U and ^{232}Th transmute into a range of radioactive progeny, finally decaying into as table isotope of lead, namely ^{206}Pb, ^{207}Pb, and ^{208}Pb ,respectively. The earth's crust constitutes the major source of NORM in the environment but the distribution of these radionuclides depends on petrological factors and the degree of mineralization in the local geology. In a natural ecosystem,the distribution of ^{238}U, ^{235}U, ^{232}Th and their daughter products are governed by many factors such as chemical properties of the nuclides, physical features of the ecosystem, physiological and ecological attributes of the biota. These factors determine the path ways along which some of these elements traverse a terrestrial ecosystem.

Experimental Arrangements and Techniques

Eight samples were collected from the western and southwestern suburbs of the capital city Tripoli, , at depths ranging from 20 to 80 meters. These samples were as a mud and two surface samples from the same suburbs for a comparison. After the routine preparation of the samples as cleaning, drying and filtering, as well as calibration of the detector,all samples were measured using HPGe detector which is highly efficient (40%) with a vertical position and a resolution 1.89 kev.

Geographical locations of samples relatively to the Tripoli center



The Initial Information of Samples

Sample code	The area of collection	The depth (m)	Collection Date	Detection Date	Duration of Detection
S1	Almshergy (surface)	0	Mar 2017	Dec2017	48 hour
S2	Janzour (surface)	0	Mar 2017	Dec2017	48 hour
D3	Al Madina Alseyahia	30	Mar 2017	Dec2017	48 hour
D4	Al-Drabi	20	Mar 2017	Dec2017	48 hour
D5	Al-Geran	33	Mar 2017	Dec2017	48 hour
D6	Janzour	30	Mar 2017	Dec2017	48 hour
D7	Al-Adawa Alsslamia1	27	April2017	Dec2017	48 hour
D8	Al-AdawaAlsslamia2	34	April2017	Dec2017	48 hour
D9	Al-Saraje	30	April2017	Dec2017	48 hour
D 10	Al-Sswani	80	April2017	Dec2017	48 hour

Radiological risk assessment

Calculated Equation	The Indicator
$A = \frac{net\ CPS\ samples}{Eff\ I_\gamma W} Bq/kg$	The Activity Concentration (A)
$Ra_{eq} = A_u + (A_{Th} \times 1.43) + (A_K \times 0.077)$ (Bq/kg)	Radium Equivalent Activity (Ra_{eq})
$D = (0.462 \times A_U) + (0.604 \times A_{Th}) + (0.0417 \times A_K)$ (nGy/ h)	Absorbed Dose Rate in Air (D)
$AEDE = D \times 1.23 \times 10^{-3}$ (mSv/y)	Annual Effective Dose Equivalent (AEDE)
$H_{int} = \left(\frac{A_U}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810}\right)$	Internal Hazard Index (H_{int})
$H_{ext} = \left(\frac{A_U}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810}\right)$	External Hazard Index (H_{ext})

Estimated Doses of ^{220}Rn and ^{222}Rn

$C_{Rn} = \frac{C_{Ra}}{\varepsilon} f \rho_s \frac{(1-\varepsilon)}{(m[K_T - 1] + 1)} Bq/m^3 \rightarrow 8$	calculation of Radon gas concentration in soil C_{Rn} [UNSCEAR Report. (2000)-Pg-98-Se95]

Where
C_{Ra} is the concentration of radium (^{226}Ra) in the soil in unit Bq / kg,
f is known as the emission factor,
ρ is the average soil density (1600-2700 kg /m^3)
ε is porosity, including water and air phases,
m is the part of porosity when the soil is saturated with water
K_T is the coefficient of radon transmission division between water and air phases, For dry soil m = 0.

In warm moist soil at 25C (for example, K_T = 0.23, m = 0.95).
As well as in typical soil conditions, ε= 0.25 = and f= 0.2.

Equilibrium Equivalent Radon Concentration

$CRn_{eq} = 0.105C_1 + 0.515C_2 + 0.38C_3$ (^{222}Rn series) $CRn_{eq} = 0.913C_4 + 0.087C_5$ (^{220}Rn series)	Equilibrium Equivalent Radon Concentration C_{Rneq} [UNSCEAR Report. (2000)-Pg103-Se122]

Where symbols C_1, C_2, C_3, indicate to the Activity concentrations in Bq / kg of ^{218}Po, ^{214}Pb and ^{214}Bi, in series ^{222}Rn respectively.Where symbols C_4, C_5, Indicate to the activity concentrations in Bq / kg of ^{212}Pb and ^{212}Bi for the ^{220}Rn series (thoron) respectively.These constants represent the percentage of each product decay contributing to the total potential energy of the decomposition of activity of one unit of the gas.

The effective dose in the air

The effective dose in the air of the gas dose that workers can be exposed on the dredgers is calculated as follows:

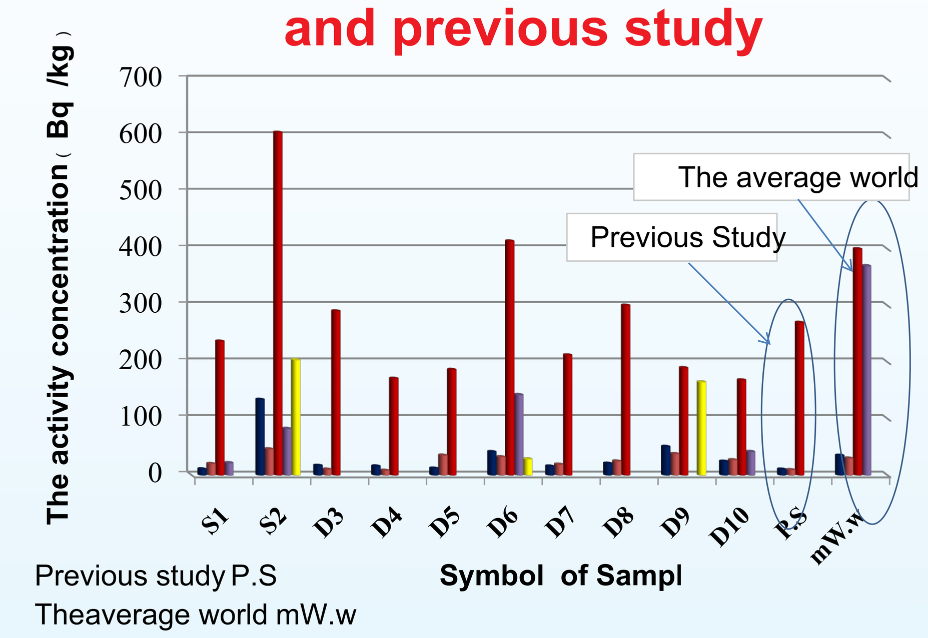
$10\ Bq\ m^{-3} \times 1{,}760\ h \times 0.17\ nSv\ (Bq.\ h\ m^{-3})^{-1} = 0.003 mSv$ for ^{222}Rn

$10\ Bq\ m^{-3} \times 1{,}760\ h \times 0.11\ nSv\ (Bq.\ h\ m^{-3})^{-1} = 0.002 mSv$ for ^{220}Rn

Where an outdoor 10Bq / m^3 for ^{222}Rn gives an effective dose 3μSv and ^{220}Rn gives an effective dose 2μSv per 10Bq / m^3, 1760h is the average hours the person spent per year outdoors for ordinary people, which is considered in this research the same hours that can be spent by the worker on the dredgers.

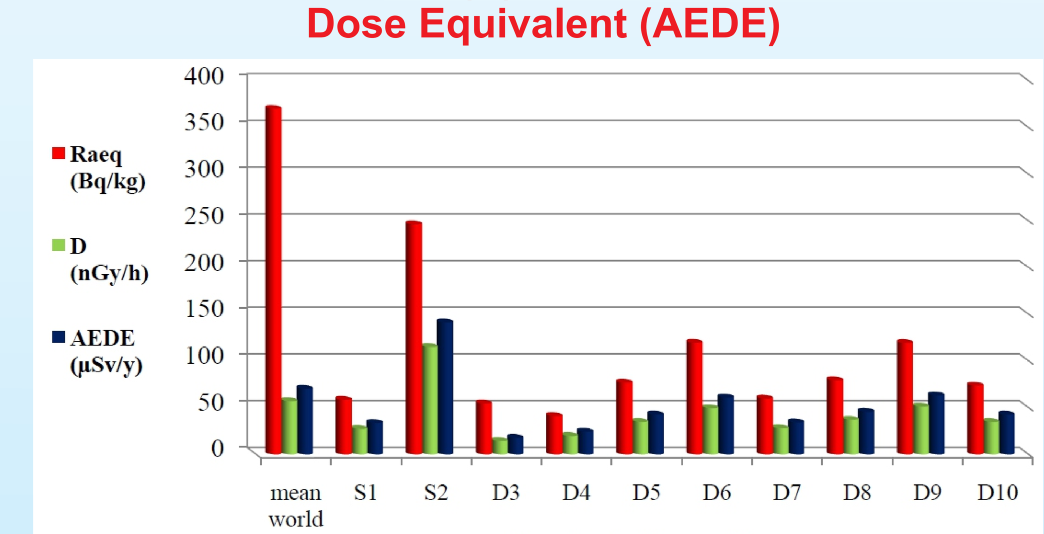
Results and discussion

The samples Activity concentration compared to the mean world and previous study

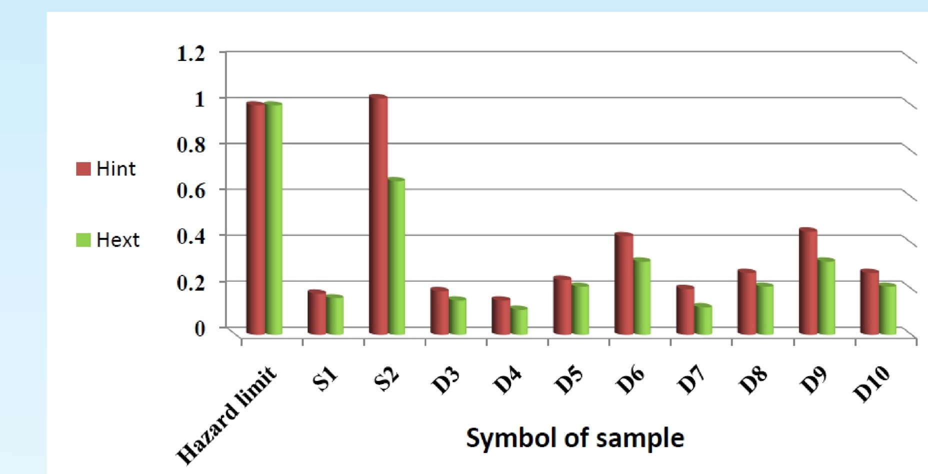


Previous study P.S
Theaverage world mW.w

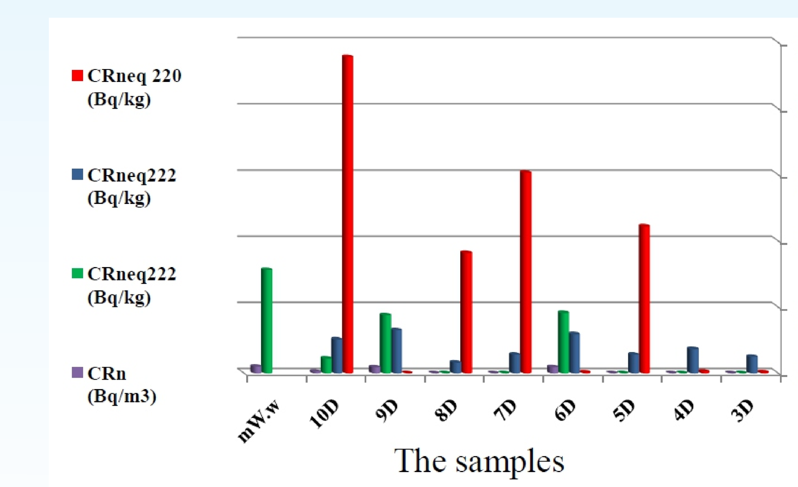
Radium Equivalent Activity (Ra_{eq}) , Absorbed Dose Rate in Air(D) and Annual Effective Dose Equivalent (AEDE)



Internal Hazard Index (H_{int}) and External Hazard Index (H_{ext})



Radon Gas Concentration and Equilibrium Equivalent Radon Concentration



Conclusions

According to the results obtained, NORM distribution in surface depths is similar to surface distribution and there is no clear increase in activity of $^{222-220}Rn$ at these depths. The results through measuring the radioactivity of samples S2 , D6 and D9 indicate to the probability of leaking of the NORM of phosphate which associated with phosphate fertilizers to the surface layers of agricultural areas ,because the radioactivity of these samples is relatively high relative to the area which dose not included any industrial activity and the geology of their surface layers is not different from the other area of Tripoli .

Recommendations

Research and study should be carried out in this area especially in areas of agricultural origin to monitor the effect of phosphate fertilizer on the surface water used by the inhabitants and to study of the distribution of4 natural radioactive materials for the geology of the region.

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