

#### BASELINE MEASUREMENT OF NATURALLY OCCURRING RADIOACTIVE MATERIALS (NORM) IN THE AGRICULTURE SOIL OF UNITED ARAB EMIRATES (UAE) USING HIGH-RESOLUTION GAMMA SPECTROMETRY

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### Introduction



- Growing demand for agricultural soil data information (Guidotti et al., 2015).
- Radiological status of the environment is defined by the radionuclides concentration (Rani et al., 2015).
- Naturally Occurring Radioactive Material (NORM) occurs mainly from primordial radionuclides such as uranium <sup>238</sup>U, thorium <sup>232</sup>Th, potassium <sup>40</sup>K and any of their decay products (Gaafar et al., 2016).
- Phosphate fertilizers for agricultural purposes enriches the radioactivity in the soil (Boukhenfouf and Boucenna, 2011).
- The natural radionuclides in soil generate background radiation exposure for the public (Karahan and Bayulken, 2000)

# Objectives of the Study



"Developing a primordial radioisotopic concentration baseline database for a limited number of naturally occurring radioisotopes in agricultural soils in the United Arab Emirates"

# International Interest in the work



Image: The National

- The UAE is one of the most recent countries entering nuclear power and is currently constructing four nuclear power plants.
- There is a world-wide interest to know about this subject as it is being studied since many years ago in most of the countries except the UAE
- The study focuses on agriculture soil which is of special interest to different communities
- On local level, it is crucial to establish environmental background radiation before the operation of nuclear power plant.

#### The Survey area

- The UAE Covering approximately 83,600 km<sup>2</sup>.
- The total population estimated to be 9,267 million in 2016 (Worldmeters, 2017).
- The climate is characterized with high temperatures reaching around 46°C.
- Rainfall rates about 160 mm. (Ministry of Information and Culture, 2010).
- The soil texture is mainly sandy soil (Ajaj et al., 2015).
- Chemical analysis for the agriculture soil has been done during the Ph.D work.



Image: http://www.nationsonline.org



#### STUDY DESIGN

- The target population for this study came from the agriculture topsoil distributed over the UAE.
- A total of 145 agricultural soil samples were collected.



#### Sample Collection

- Samples were collected during the period January-March 2016,
- All the samples gathered were from the surface layer ~ (30 cm)
- a total of (2-3 Kg) were mixed thoroughly and were collected in a sampling bag at the sampling point





#### Sample Preparation

- The soil samples were dried at 80°C for 24 hours
- Each dried sample was ground and sieved using a sieve of (1-mm).
- Samples packed in a (1.1 L) Marinelli beaker, sealed and stored for one month (4 weeks) to allow for secular equilibrium between <sup>226</sup>Ra and its progeny.



#### **Analytical Methods**

- The samples were analyzed by Board Energy- Germanium detector "BEGe" planar detector with a relative efficiency of 19.5% and FWHM 1.6 KeV at 1332 KeV.
- Genie 2000 spectroscopic software used for data acquisition and analysis.
- LABSOCS mathematical efficiency tool used for determining the efficiency curves.
- The detection system was calibrated for energy efficiency on weakly basis.
- For different types of soils, individual efficiency peak calibration performed depending on soil density.
- Energy calibration was conducted by using <sup>226</sup>Ra at 11 energy points (186.21, 295.22, 351.93, 609.31, 785.96, 934.06, 1120.29, 1238.11, 1377.67, 1764.49, and 2204.21 KeV).



#### **Theoretical Calculation**

The activity concentration of the radionuclides is estimated using the following relation:

$$C\left(\frac{Bq}{Kg}\right) = \frac{R_n}{I_{\gamma} \times \varepsilon_{Pf} \times M_s}$$

• The Radium Equivalent Activity Index  $(Ra_{eq})$ :

$$Ra_{eq} = C_{Ra} + (1.43 C_{Th}) + (0.077 C_K)$$

• The Absorbed Dose Rate  $(D_r)$ :

$$D_r\left(\frac{nGy}{h}\right) = DCF_{Ra} \times C_{Ra} + DCF_{Th} \times C_{Th} + DCF_K \times C_K$$

- The total annual effective dose (indoor & outdoor) from terrestrial radiation is given by:  $D_{eff}\left(\frac{mSv}{yr}\right) = (D_{eff})_{outdoor}\left(\frac{mSv}{yr}\right) + (D_{eff})_{intdoor}\left(\frac{mSv}{yr}\right)$
- The Hazard Index  $(H_{ex}) \& (H_{in})$ :

$$H_{ex} = \frac{C_{Ra}}{370} + \frac{C_{Th}}{259} + \frac{C_K}{4810} < 1 \qquad \qquad H_{in} = \frac{C_{Ra}}{185} + \frac{C_{Th}}{259} + \frac{C_K}{4810} < 1$$

#### **Results and Discussion**

- The activity concentration for <sup>226</sup>Ra, <sup>232</sup>Th, and <sup>40</sup>K in the study area is **15.24±2.8**, **4.26±1.6** and **314.27 ± 63.5** BqKg<sup>-1</sup> respectively.
- Global revised average values which are 30, 35 and 420 BqKg<sup>-1</sup> (UNSCEAR, 2000).







#### **Results and Discussion**

Radiological Parameters	Present Result	World Average	Ratio of the present average/world average
$Ra_{eq}(BqKg^{-1})$	45.24	370	0.12
$D_r (nGyh^{-1})$	22.68	60	0.38
$(D_{eff})_{Outdoor} (mSvy^{-1})$	0.03	0.07	0.43
$(D_{eff})_{Indoor}(mSvy^{-1})$	0.19	0.34	0.56
$D_{eff}(mSvy^{-1})$	0.21	0.41	0.54
<b>H</b> <sub>ex</sub>	0.12	0.5	0.24
<i>H<sub>in</sub></i>	0.16	0.5	0.32





Poor Positive Correlation Pearson correlation coefficient of 0.232 with Sig. (2-tailed) is 0.01.





Strong Positive Correlation Pearson correlation coefficient of 0.025 with Sig. (2-tailed) is 0.809.

#### RESULTS AND DISCUSSION: POSITIVE CORRELATIONS

In general, the positive correlation is a good indicator of the activity concentration of one radionuclide the other radionuclide (Dhawal et al., 2014).



# RADIOLOGICAL MAPS

#### The Annual Absorbed Effective Dose



## Conclusion

- The study provides the first baseline reference database about natural radioactivity levels in agricultural soil in the UAE.
- The distribution of selected primordial radioisotopes in this study sample area is uniform.
- UAE agricultural soil has low natural radioactivity and is thus safe for the population.
- The values of all radiation parameters studied are within international standards permissible limits.
- For future perspectives of this work, a baseline for radioactivity concentration and transfer factors for various plants in UAE is advisable.

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