Ain Shams University
Faculty of Women for Arts,
Science and Education,
Physics Department

Evaluation of Physico-Chemical Characteristics and Natural Radioactivity along El-Salam Canal, Egypt

A Dissertation
Submitted for the Degree Doctor of Philosophy in Nuclear physics

BY

Ahmad Hussein Abd-Elhamied El-Hanbaly
Bachelor of Science in physics (2007)
Masters Degree in Nuclear Physics (2014)

Supervised by

Prof. Dr. Hosnia M. Abu-Zeid
Prof. of Nuclear Physics
Physics Department
Faculty of Women for Arts,Science and Education,
Ain Shams University

Prof. Dr. Abou Bakr A. Ramadan
Prof. of Radiological and
Environmental measurements
Nuclear and Radiological Regulatory Authority

Dr. Thanaa M. Abd-El Maksoud
Ass. Prof. of Nuclear Physics
Physics Department
Faculty of Women for Arts, Science and Education,
Ain Shams University

Dr. Shadia M. Talaat
Ass. Prof .of Nuclear Physics
Physics Department
Faculty of Women for Arts,Science and Education,
Ain Shams University

Dr. Hanan A. Sayd
Ass. Prof. of Nuclear Physics
Physics Department
Faculty of Women for Arts, Science and Education,
Ain Shams University

2018

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Dr. Shadia M. Talaat

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Approval Stamp

/ /2018

Date of Approval

/ /2018

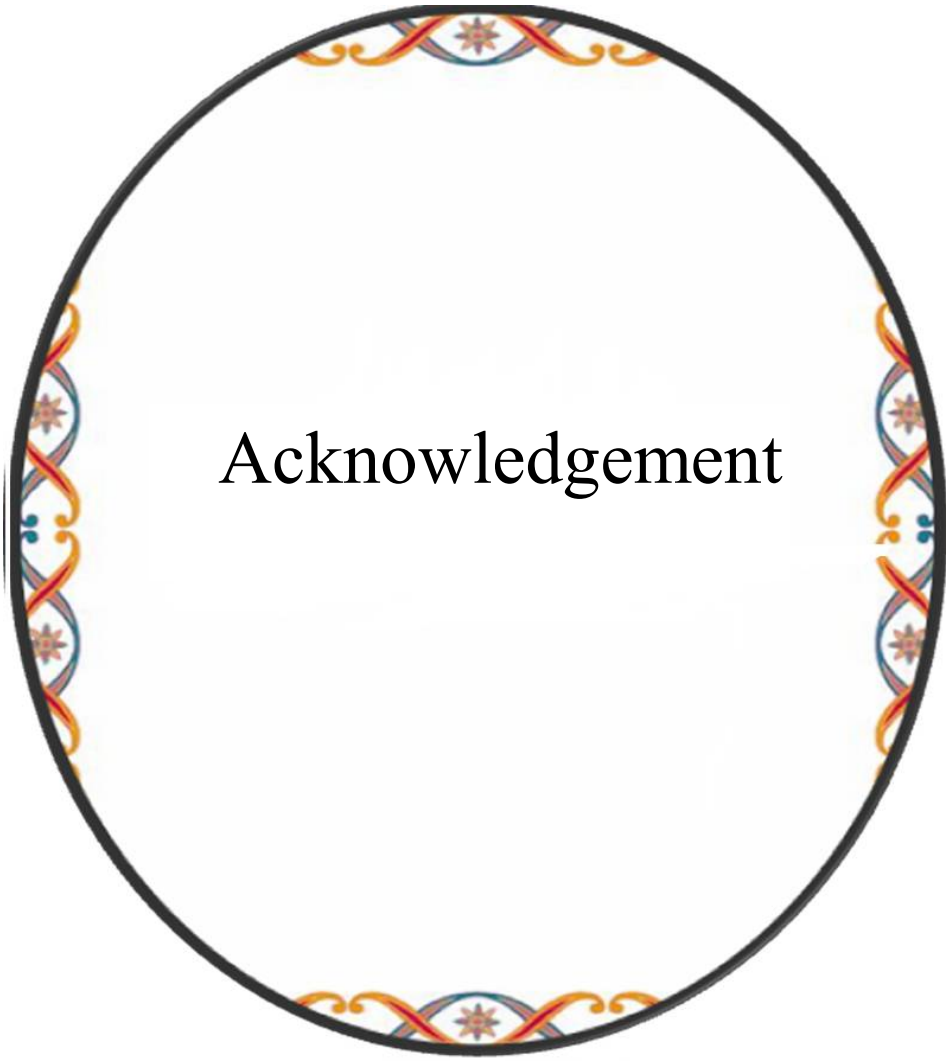
Approval of Faculty Council

/ /2018

Approval of University Council

/ /2018


بسم الله الرحمن الرحيم
الْحَمْدُ لِلّهِ الَّذِى هَدَانَا لِهَـذَا
وَمَا كُنَّا لِنَهْتَدِى لَوْلا أَنْ
هَدَانَا اللّهُ
سورة الأعراف اية(٤٣)



Acknowledgement

Acknowledgement

First, I thank Allah the Beneficent, the Merciful, for completing this work.

I would like to give my thanks to:

Prof. Dr. Hosnia Mohamed Abu-Zeid, professor of Nuclear physics at Physics Department, Faculty of Women for Arts, Science, and Education, Ain Shams University, for her supervision , honest guidance, deep encouragement and trustful help and continuous helpful discussions leading always towards more perfection and achievement of this work.

Prof. Dr. Abou Bakr Ramadan, Professor of Radiological and Environmental Measurements, Nuclear and Radiological Regulatory Authority, for proposing the research topics and supervising all steps of this work. Also, I appreciate much his constructive comments, fruitful discussions, continuous support and trustful help through the experimentation and writing the thesis.

Dr. Thanaa Mohamed Abd-Elmaqsood associate professor of Nuclear Physics at Physics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, for her supervision and deep encouragement.

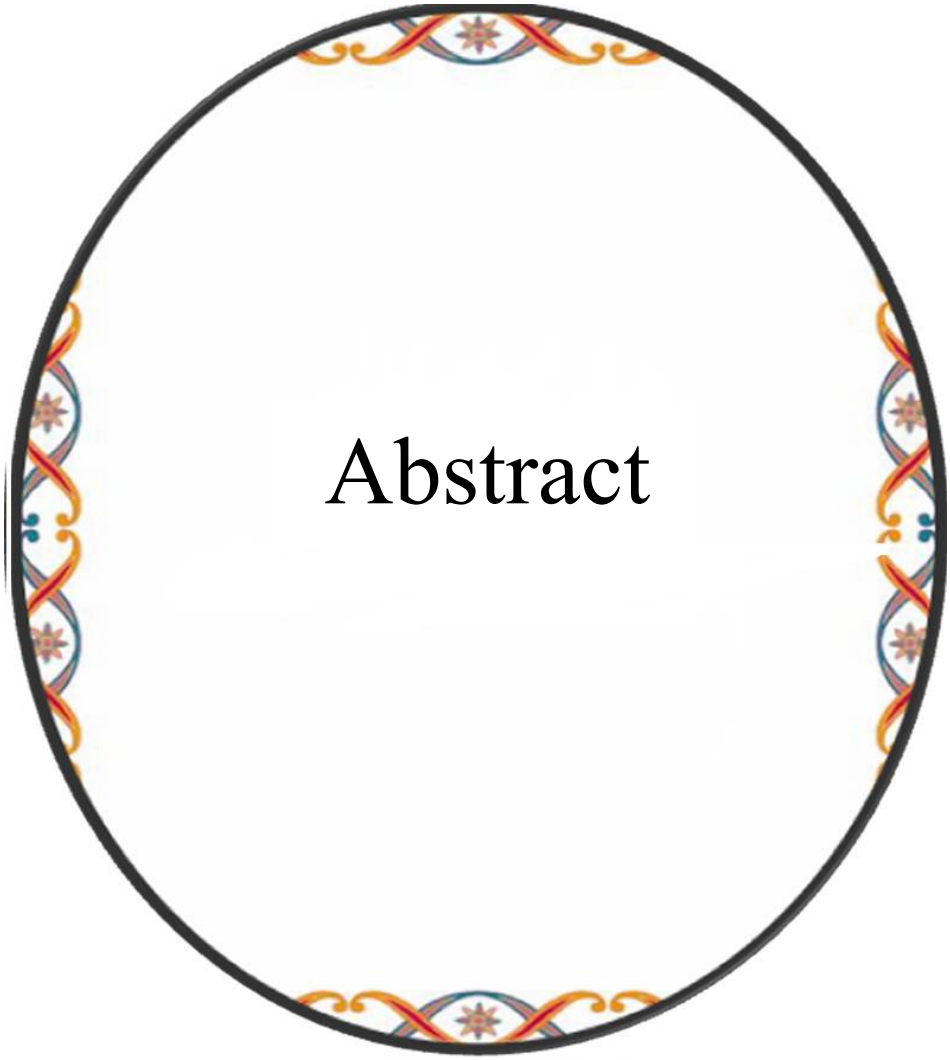
Dr. Shadia Mohamed Talaat associate professor of Nuclear physics at Physics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, for her deep guidance and kind supervision.

Dr. Hanan Awad Sayd associate professor of Nuclear Physics at Physics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, for her deep guidance and kind supervision.

My lovely family for their continuous support and encouragement during my research.

I would also like to thank the head of Physics department, Faculty of Women for Arts, Science and Education, Ain Shams University for provided guidance and support in completing my Ph.D.


Dedication
For my loving family
My wife
My daughter, Habiba
My son Mohammad
My Father
And
My Brothers



Abstract

Abstract

The distributions of natural radioactivity along El-Salam Canal were calculated using a hyper pure germanium (HPGe) detector. Four types of samples were investigated: water, plant, soil and shore sediment samples.

15 water samples ,15 plant samples, 14 soil samples and 10 shore sediment samples were collected over the length of El-Salam Canal from the intake west of the Suez Canal at kilo 219.000 on Damietta branch upstream Damietta Dam and Lock where the canal is extended south east towards El-Manzala Lake. Then the canal goes southward till it meets El-Serw drain, samples were collected before and after El-Serw drain. It further passes eastwards, then southwards to the fringes of Al-Manzala Lake till it meets Hadous drain, samples were also collected before Hadous drain and after the mixture of El-Serw and Hadous drains. It runs eastward till the Suez Canal at kilo 27.800 south of Port Said. The canal extends finally, with a length of 62 km, in areas of Rabaa and Ber Al-Abd that are of arenaceous nature which is the ending point of the canal.

For water samples, the average activity concentration values for naturally occurring radionuclides are within the world average ranges, which are 7.56 ± 2.01(10-35), 3.42± 0.78(10-30) and 39.97 ± 4.44 (100-400) Bq/kg for ^{238}U (^{226}Ra), ^{232}Th and ^{40}K, respectively.

Relationships between the concentration of ^{238}U (^{226}Ra) with both ^{232}Th and ^{40}K are weak correlation for water samples, while there is a good correlation between ^{232}Th and ^{40}K. The averages of $^{238}U/^{40}K$ and $^{232}Th/^{40}K$ ratios are 0.32 and

0.08, respectively, the world averages for both quotients being 0.084 for $^{238}U/^{40}K$ and 0.10 for $^{232}Th/^{40}K$.The $^{232}Th/^{226}Ra$ activity ratio shows great scattering in the elemental correlation curve because of the absence of some ^{232}Th and ^{238}U (^{226}Ra) activities (under detection limits) for water samples

The total hazard index ($H_{ex}+H_{in}$) for water samples is less than unity. The calculated values of H_{ex} ranged from 0.003 ± 0.001mSv/yr to 0.09 ± 0.009 mSv/yr with an average value of 0.04 ± 0.01mSv/yr. The calculated values of H_{in} ranged from 0.003 ± 0.001 mSv/yr to 0.14 ± 0.04 mSv/yr, with an average value of 0.06 ± 0.01mSv/yr.

The radium equivalent values for the water samples never exceeded the maximum allowed value for Ra_{eq} (370 Bq/kg). The Ra_{eq} ranged from 7.60 ± 6.05to 33.42 ± 6.39Bq/kg with a mean value of 11.67 ± 3.85 Bq/l.

The annual effective dose for water samples was ~ 0.09 mSv y^{-1}, which is below the permissible dose equivalent of 1 mSv y^{-1} .

$I_{\gamma r}$ is ranged from 0.01 ± 0.002Bq/kg to 0.024± 0.031 Bq/kg with an average of 0.11 ± 0.02Bq/kg which is less than unity.

For plant samples, The results indicate that the activity concentration average values of naturally occurring radionuclides in the plant samples are within the UNSCEAR recommended world average values except for ^{40}K which is high., which are 13.6 (10-35), 11.9 (10-30) and 682.0 (100-400) Bq/kg for ^{238}U (^{226}Ra), ^{232}Th and ^{40}K, respectively.

Relationships between the concentrations of ^{238}U (^{226}Ra), ^{232}Th and ^{40}K for plant samples show some scatter in the

concentrations of ^{232}Th and ^{238}U versus the ^{40}K content. The concentrations of ^{232}Th and ^{238}U (^{226}Ra) increase with increases in the ^{40}K content, also the scattering of the concentrations of ^{232}Th and ^{238}U to the ^{40}K content increase. The average of $^{238}U/^{40}K$ and $^{232}Th/^{40}K$ ratios are 0.03and 0.02, respectively which are within the UNSCEAR recommended world average values.

The Ra_{eq} ranged from 48.75 ± 19.91to197.25 ± 33.93Bq/kg. The radium equivalent mean value for plant samples was 70.75 ± 19.68 Bq/kg, which is within the permissible limit of 370 Bq/kg.

The total hazard index ($H_{ex}+H_{in}$) for plant samples is less than unity. The calculated values of H_{ex} ranged from 0.03 ± 0.013mSv/yrto0.53 ± 0.033mSv/yr, with an average value of 0.22 ± 0.03mSv/yr. The calculated values of H_{in} ranged from 0.04 ± 0.013mSv/yr to 0.58 ± 0.046 mSv/yr, with an average value of 0.26 ± 0.05 mSv/yr.

The annual effective dose for plant samples was ~ 0.6 mSv y^{-1}, which is below the permissible dose equivalent of 1 mSv y^{-1}.

I_γ is ranged from 0.09 ± 0.019Bq/kg to 1.54 ± 0.088 Bq/kg with an average of 0.66± 0.06Bq/kg .

For soil samples, The results indicate that the activity concentration average values of naturally occurring radionuclides in the collected soil samples were within the world average ranges, which are 15.06 (10-35), 12.09 (10-30) and 260.22(100-400) Bq/kg for ^{238}U (^{226}Ra), ^{232}Th and ^{40}K, respectively.

The concentration correlations between (^{238}U vs.^{40}K) and (^{232}Th vs.^{40}K) are positive with coefficients 0.76 and 0.65,

respectively. The average of $^{238}U/^{40}K$ and $^{232}Th/^{40}K$ ratios are 0.05and 0.04, respectively, which are within the UNSCEAR recommended world average values .The $^{232}Th/^{226}Ra$ activity ratio shows no scattering in the elemental correlation curve.

The total hazard index ($H_{ex}+H_{in}$) for soil samples is less than unity. The calculated values of H_{ex} ranged from 0.03 ± 0.006 to 0.24 ± 0.013 mSv/yr, with an average value of 0.14 ± 0.01mSv/yr. The calculated values of H_{in} ranged from 0.03 ± 0.006 to 0.31 ± 0.017 mSv/yr, with an average value of 0.18 ± 0.01mSv/yr.

The Ra_{eq} ranged from 11.38 ± 5.07 to 89.09 ± 11.01Bq/kg. The radium equivalent mean value for soil samples was 52.39 ± 9.11 Bq/kg, which is within the permissible limit of 370 Bq/kg.

I_γ is ranged from 0.08 ± 0.018 Bq/kg to 0.66± 0.035 Bq/kg with an average of 0.40 ± 0.02Bq/kg which is less than unity.

The annual effective dose for soil samples was ~ 0.2 mSv y^{-1}, which is below the permissible dose equivalent of 1 mSv y^{-1}.

For Shore Sediment samples, The results indicate that the activity concentration average values of naturally occurring radionuclides in the shore sediment samples are within the world average values, which are 16.18 (10-35), 13.66 (10-30) and 264.42(100-400) Bq/kg for ^{238}U (^{226}Ra), ^{232}Th and ^{40}K, respectively .

There is good correlations between ^{238}U (^{226}Ra) with both ^{232}Th &^{40}K and between ^{232}Th &^{40}K for shore sediment samples. The averages of $^{238}U/^{40}K$ and $^{232}Th/^{40}K$ ratios are 0.051and 0.041, respectively. These results are within the

world average values recommended by .$^{232}Th/^{226}Ra$ activity ratio shows best fit in the elemental correlation curve.

The total hazard index ($H_{ex}+H_{in}$) for shore sediment samples is less than unity. The calculated values of H_{ex} ranged from 0.04 ± 0.005 mSv/yr to 0.29 ± 0.012 mSv/yr, with an average value of 0.15 ± 0.01 mSv/yr the values of H_{ex} of all samples studied in this work are less than unity. The calculated values of H_{in} ranged from 0.05 ± 0.005 mSv/yr to 0.38 ± 0.017 mSv/yr, with an average value of 0.19 ± 0.01 mSv/yr the values of H_{in} of all samples studied in this work are less than unity.

None of The radium equivalent values for shore sediment samples ranged from 15.80 ± 5.59 to 109.53 ± 10.50 Bq/kg, with an average of 56.06 ± 9.30 Bq/kg which is within the permissible limit of 370 Bq/kg.

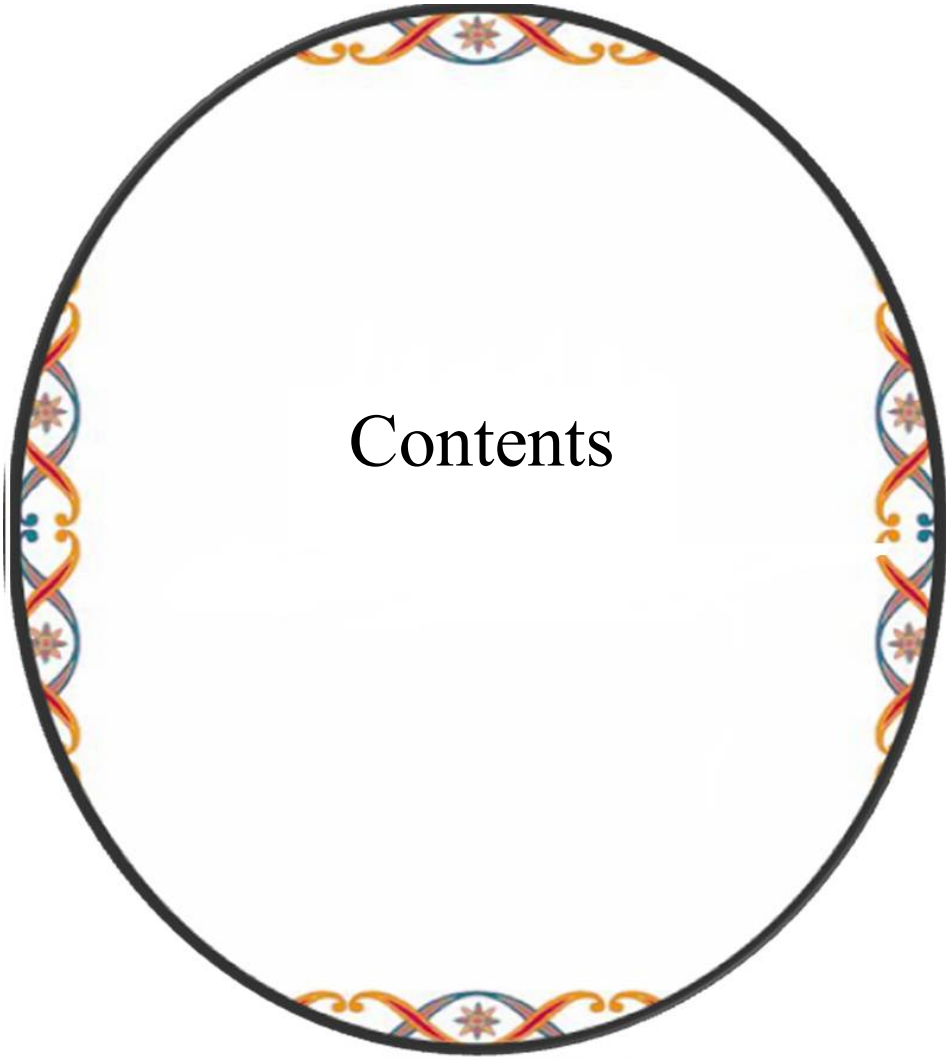
I_γ is ranged from 0.12 ± 0.011Bq/kg to 0.81± 0.033Bq/kg with an average of 0.42± 0.31Bq/kg which is less than unity.

The annual effective dose for shore sediment samples was ~ 0.2 mSv y^{-1}, which is below the permissible dose equivalent of 1 mSv y^{-1}.

The transfer factors (TF) for ^{238}U, ^{232}Th, are going to unity 0.96, 0.98, respectively and for ^{40}K is greater than unity 2.78, this due to the high concentration for ^{40}K in plant samples.

The chemical analyses of El-Salam Canal irrigation water showed that the water from the chemical analyses view permissible for plants. Sodium adsorption ratio (SAR) values

of El-Salam Canal water followed class 1, low sodium hazards, use for sodium sensitive crops, whereas, the drainage water was high sodium hazard for plants. Largest source of salts in water of El-Salam Canal from Hadous drain water because this drain contain highest salt , cations and anions which is greater than the El-Serw drain.



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