Sudan University of Sciences and Technology

College of Graduate Studies

Assessment of Radiation Dose Level at Blue Nile Shore inTutiIsland

تقويم مستوى الاشعاع على شاطئ النيل الازرق في جزيرة توتي

Thesis Submitted for Partial Fulfillment of theRequirements of M. Sc. Degree

in Nuclear Medicine

By

Amel Kamal Ali Mustafa

Supervised By

Associate Prof. Dr: Mohammed Ahmed Ali

2015

Dedication

To
Soul my parents
Who
Taught me how to make my future.
To
My brothers and sisters for their valuable supports
To
My colleagues at work
I dedicate this work

Acknowledgement

After the glorification, prayers and thanks to Allah, I'm so indebted with great thanks and respect to my supervisor Dr. Mohammed Ahmed Ali, whose sincere guidance with the idea of the thesis illuminating the pages of this research.

Also my thanks and appreciations to those people who helped and supported meduring the writing of this work are worth mentioned.

Finally deep thank s to Mustafa Enayet who support me and believe in me and always stand beside me And make the impossible be possible.

Abstract

This study was conducted in Blue Nile Shore at TwotiCityto estimate the exposure level of radiation at the Blue Nile river shore in Khartoum state during April 2012.

The monitoring of radiation was carried out using Giggler Muller survey mater covering a distance of 50 m where people usually entertain themselves and chatting.

The ultimate goal of this study was to estimate the radiation dose level and radioactivity at the Blue Nile bank and increase the culture of the radiological safety as well as concept of radiation protection .the results showed that the radioactivity is under below the natural radioactivity background at all different point. The surface dose was 0.05□Sv/h for all points and the dose increases with depths at 25, 50 and 75 cm to be 0.089, 0.11, 0.12 and 0.13Sv/h respectively. The average exposure increases from 0.05□Sv/h at the surface to 0.07□Sv/h at 25 cm, 0.09 at 50 cm and 0.1 Sv/h at 75 cm.

The average exposures per year were 7.78, 10.43, 12.67 and 14.78Sv at the surface, 25 cm, 50 cm and 75 cm respectively.

الخلاصة

أجريت هذه الدراسة على ضفاف النيل الأزرق بمدينة الخرطوم جوار كبرى توتى في شهر أبريل للعام 2012م, الهدف من هذه الدراسة تقدير الجرعةالإشعاعيةوالخلفيةالإشعاعيةعلى ضفاف النيل الأزرق ورفع مستوى الثقافة والسلامة الإشعاعية ومفهوم الوقاية من الإشعاع .

أظهرت النتائج أنالجرعةالإشعاعيةطبيعية في جميع النقاط.مقدار الجرعة الإشعاعية على السطح كانت 0.05 مايكروسيفرت فى الساعة وعند جميع النقاط, والجرعة تزيد كلما ذاد العمق, وكانت قيمه الجرعة على عمق 25, 50 و75 سم هي 0.089 و 0.11 و 0.12 مايكروسيفرت في الساعة على التوالي . متوسط التعرض الاشعاعى يزيد من 0.05عند السطح الى 0.07 مايكروسيفرت عند 25 سم ,0.09 عند 50 سم و 0.1 مايكروسيفرت عند 75 سم. وجد متوسط التعرض في السنه 7.78 و 10.43 و 12.67 و 14.78 مايكروسيفرت فى السنة عند السطح و 25 و 50 و75 سم على التوالي.

List of Abbreviation

DNA	Deoxy-nuclear Acid
RNA	Ribo-nuclear Acid
ICRP	International Commission on Radiological Protection
WHO	World Health Organization.
MPD	Maximum Permissible Dose

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Chapter One

Introduction

1.1 Background

Theissueofradioactivityandtheenvironmenthasbeentaken seriouslyworldwideduringthepast fifty yearsandspeciallyduringthe lastdecadeand nowadaysmost ofthe countrieshavecontinuous monitoringprogramsforradioactivity,doserate evaluationand annual doseassessment (MatolinandSideris, 1996; Boetter andThompson, 1996). InSudan, the programfor measurementofnaturalradioactivityand countryradiationmap startedin1985 and thisstudyisconsideredto bethefirstattempt related to environmental radioactivity measurement at Blue Nile river shore in Khartoum state, and the location of survey was in TotiBergearea.Other region inSudan mainly the western part was surveyed by using gamma spectrometry and the radiationlevels was found to be significant due to phosphate deposits.(Nour and Sam 1993).

We need to make survey when there were an accident medical, industrial and nuclear pomp. The survey is soimportant to determine the contamination.

The hazards of ionizing radiation exposure could be obviously in damaging the sensitive structures of the cell such as Deoxy-nuclear Acid DNA and Ribo-nuclear Acid RNA which may lead to formation of mutation also.And the general types of radiation effects could be enumerated as:

- Cell death deterministic, somatic, clinically attributable in the exposed individual.
- Cell transformation stochastic, somatic and hereditary epidemiologically attributable in large population.
- Bothantenatalsomaticandhereditary expressed in the fetus, in the live born or descendants.

The deterministic Health Effect as Lens opacities, skin injuries, infertility, epilating, etc. while the stochastic as cancer, genetic effect.

The deterministic (threshold/ non-stochastic) refers to existence of dose threshold value (below this dose, the effect is not observable) and the severity of the effect increases with dose. The best examples of threshold dose for deterministic effects are: cataracts of the lens of the eye 2 - 10 Gy, male Sterility 3.5-6 Gy, Female2.5- 6 Gy, TemporarySterility of male 0.15Gy and female0.6Gy.(IAEA)1996).

While the Stochastic Effects(non-threshold) characterized with the following criteria's:

- No threshold.
- Probability of the effect increase with dose.
- Generally occurs with a single cell

The exposure of human to natural sources of radiation is a continuous characteristic to which all life on earth is submitted. The two main factors that contribute to the naturalexposure are the cosmic radiation and the natural decay of radionuclide present in soil that produces gamma-beta radiation in the environment, the principal characteristic of the exposure to cosmic rays is the weakly dependence on latitude but a strong dependence on altitude..(IAEA)1996).

For example, the magnitude of absorbed dose rate in the air at sea level is 32 nGy/hcompared to about 4μGy/h at 12 Km of altitude.

Several regions of the terrestrial crust are characterized as high natural radioactivity level referred to the background values found in the literature. This is often due to the high radionuclide concentration in soil. Some of these regions are located in countries as Brazil, India, Iran, China, Italy, France, Madagascar and Nigeria. These regions present aconsiderable variation in the exposure to natural sources of radiation that can be credited to factors as altitude (in the case of cosmic rays) and variable concentration of radionuclides in environmental

compartments (Uranium and Thorium in soil, Radium and Polonium in food and Water and Radon in air).

The International Corporation for Radiation Protection ICRP (series X) has issued a system for radiation dose limitation in terms of three components:

- The justification of the practice: in which No practice should be adopted unless its introductionproduces a positive net benefit.
- The optimization of radiation protection: in which all exposures should be kept as low as reasonably achievable,economic and social factors being taken into account.
- The dose limits for individuals: in which the dose equivalent to individuals should not exceed thelimits recommended for the appropriate circumstances by ICRP.

Justification:

The expression "positive net benefit" invokes the idea ofcost-benefit analysis. However, the choice between practices will depend on many factors, only some of which will be associated with radiation protection. Therefore, more general decision-making methodologies would need to be applied to decisions on the justification of practices. In any case there is a need to ensure that the total detriment from a practice is appropriately small in relation to the expected benefit of the practice .(IAEA)1996).

Since any exposure to radiation is assumed to involve somedegree of risk, all exposures should be kept as low as reasonably achievable, i.e. the protection should be optimized. The optimization applies for doses below the dose limits andtherefore non-stochastic effects are precluded. For the stochastic effects the mathematical expectation of the amount of harm in an exposed group of people is proportional to the collective effective dose equivalent .(IAEA)1996).

1.2 Hypothesis of the Study:

There is a hypothetical idea about a considerable radiation exposure level at the Shore of Blue Nile River in Khartoum.

1.3 Problem of the Study:

The BN shore at Tooti zone is considered as one of the contaminated zone by precipitated radionuclide that emitted by the water from Ethiopian mountains. The earth crust type could determine the type of radioactive element.

The presence of population for entertainment is such zone could lead to considerable exposure, however it will in evitable to measure and determine such exposure in order to estimate the radiation sickness based on the MPD.

1.4 Objectives of the study:

- To measure the exposure level at Blue Nile River bank in depth and surface profile.
- To determine the annual exposurelevel for personal.
- To determine the Non-stochastic effects due to radiation exposure.

1.5 Thesis outline:

The backbone of the following thesis will formed of five chapters. Chapter one will deal with the general introduction about the research background, scope, problem statement, objectives of the study and thesis outline. Chapter two will cover the previous studies and related literatures review. Chapter three will contain the methodology of the study. Chapter four will show the results and discussion. And chapter five will cover the conclusion, recommendations and references.

Chapter two

Literature Review

The caring of environment, radiation exposure level and radiation monitoring studies has drawn the attention of researchers and scientists in Sudan and specially the scope of radiation exposure level from terrestrial radioactivity. The following chapter will enumerate some of previous studies related to such issue.

One study carried out by(Sam et al, 1993)in east of Sudan titled as Radioactivity levels in the red seaCoastal environment in Sudan aiming to measurethenaturalandfalloutradionuclidein marine surface sediments,seagrassand algae collected fromtheSudanesecoastal waters ofthe Red Sea using highresolution spectrometry, radio chemicalseparationandcr-spectrometry.The activity levels ofuranium isotopes, thoriumisotopes were determined in the samples.And after the comparisonof the dataonnaturalradionuclidefromcoastalmarine sedimentswiththosecollectedfrom30 kmofshore (Sanganeb atoll)reveals thatbothanthropogenicand terrestrialinfluxfromthehinterlandisneligible. However, values for Ra-226 and Po-210 are higher in the sediments of Port Sudan harbor relative to those from the adjacent fringing reefs.

Uranium content is higher in shallow-water sedimentsand the authigenic fractionconstitutes 1206 on the average. The disequilibrium in sediments indicates rapid rate ofsedimentation at the sampling sites. The activity levelsdetected insedimentscollectedfromthe Port Sudan harbor areaarefairlyhighas compared with valuesfromothersampling locations. Onthebasis of individualdata,thevariationsareinsignificant with regardtothe uptake ofnaturalradionuclidesby marine speciesconsideredinthis study.

Another study was carried out by (Babikir et al, 2009)in Elgash River: the measurementsofsome naturalradionuclide insoilsamples collectedfromElgashareain easternSudan have been carriedout usinghigh

resolution gamma-spectrometry.Activity concentrations for Ra, Ra and K were found tobeinrangefrom13 to 31, 13to60and283to 46lBq/kgrespectively.Dose rates due to gamma radiationfromthegroundwerecalculated using conversionfactor(DRCF),andwerefoundto befrom24to 48 nGy/hwithanaverageof 38 nGy/h which correspondsto annualdoseequivalentof230µSv. These dataindicatethatthelevelsof radioactivityinthesurveyed arealie withintheworldwiderange of normalbackgroundradiation .

The studies of natural radioactivity level in Sudan also extend to western regions, in this realm, the natural radionuclide content of phosphatedeposit satUro and KuruninEasternNubbamountainsinthestate of Kordofan (Western Sudan)and soils radioactivity has beendeterminedchemically and using gamma spectrometry. The analyses were performed for natural uranium and thorium, Po-210,Ra-226 and K-40.The data indicate that U-238 and its decay products contribute primarily to the high nature radioactivity of phosphate ores at maximum, they found an activity concentration of 2600 Bq/Kg natural U-238 from the values obtained, the dose rate over agricultural areas, resulting from the use of ground rock phosphate at fertilizer estimated under extremely conservative assumption, result in an additional external radiation exposure for member of the population of 5.42 $*10^{-1}$nGy/a and $1.13*10^{-9}$nGy/afor Uro andkurunrock phosphate, respectively. These result shows that the natural radionuclides contained in Uro and kurun ground rock phosphate contribute very little to the average terrestrial radiation exposure to the population.

Another study was carried out byHajo et al, 2009to study radon in ground water and physicochemical parameters in Khartoum state,this study was conducted primarily to measure and map radon activity concentration in wells within water supply network of Khartoum state.Ground water samples were collected before and after autumn and analyzed using low level c-spectrometry equipped with HPGe-detector.Radon activity concentration was found in range of 1.58-345.10Bq/L with an average value of 59.20+_6.60 Bq/L .Upon comparing the

Radon concentration values obtained with EPA it was found they were far below the maximum contamination level of EPA with the exception five samples. Physicochemical water parameters were measured and no correlation was noted between radon concentration and these parameters. The overall annual effective dose for adults due to Radon ingestion is less than WHO recommended reference dose level for most except 14 samples.

Another study carried out by Adam et al,(2007) in title of Assessment of Absorbed Dose Rate in Air over Plowed Arable Lands inSinnarState, Central Sudan.

The absorbed gamma-dose rate in air at a height of 1 m above ground level was calculated from activity concentrations of gamma-emitting radionuclides in arable soil samples collected from eight locations within Sinnar State using the published Dose Rate Conversion Factors. Measurements were carried out using high-resolution gamma-spectrometry. On average, the activity concentrations obtained were 38+8 (232Th), 17+2 (226Ra), 174+19 (40K) and 0.9+0.2 Bq/ kg for the fallout radionuclide 137Cs. The average value obtained here for 232Th is slightly higher than the corresponding world-average. The calculated absorbed dose rate in air at 1 meter high from all sample locations were in the ranges from 31 to 47 nGy/ h, with an average value of 39±7 nGy/h. which is a characteristic of normal background radiation areas. The corresponding annual effective dose was 47.8±6 mSv/ y. The major contribution to the total absorbed dose rate comes from 232Th, which amounts to 61%. Recalculation of the absorbed dose rate-based gamma-energies of individual nuclides from uranium and thorium decay series and 40K showed that the greater part of the absorbed dose from the uranium series is due to 214Bi, whereas for the 232Th series it is equally attributed to 228Ac and 208Tl.

Chapter Three

Materials and Method

3.1 Materials:

- Radiation Detector RADOS-120.A portable survey meter with an internal energy-compensated GM detector, theRadiographer also features automatic dead time compensation anti-saturation circuit and HV and battery checks.
- Length Meter.
- Drill

3.2 Method:

The field of sample collection was the Blue Nile beach behind Toti barge using detector RADOS_120 and Meter, in older to measure radiation dose. The dose measured from surface, 25cm step and 50 cm depth for five points.

3.2.1 Accuracy and calibration:

All devices that were used in a radiation survey has been calibrated at the secondarystandard dosimetry laboratory in Sudan atomic energy commission, calibration factor of theCANBIRA-RA DIOGM was0.89 and the calibration factorof RADOS-120 was 0.88.

3.2.2 Data Analysis:

The collected data has been analyzed using excel soft ware in a form of bars and table.

Totebridge (area of measurement).

Sample Ionization Chambers

Chapter Four

Results

4.1 The results:

The following chapter is dealing with the result of radiation exposure doses measurements from terrestrial sediment radioactive materials at the Shore of Blue Nile River in Khartoum state.

The measurements were at five points at the sandy area along the shore each 10 meter distance far from other i.e. the distance was 50 meters and up to 75 cm in depth profile in step of 0, 25, 50 and 75 cm.

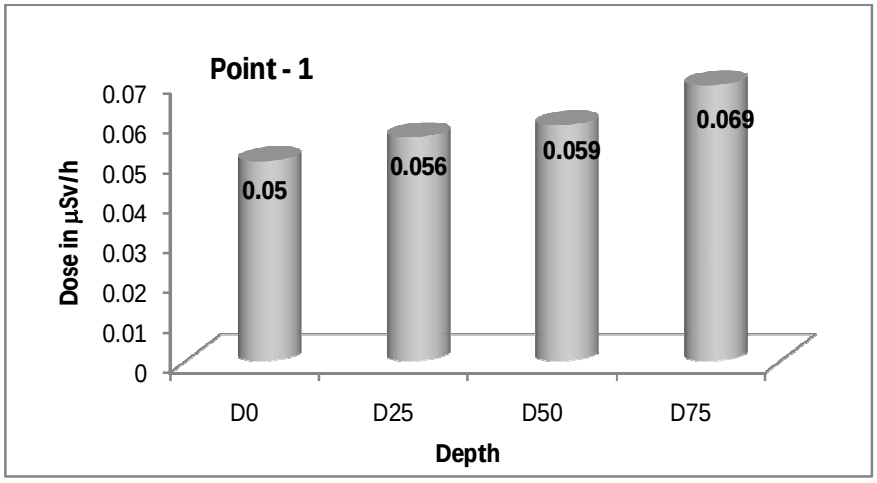

Figure 4.1 shows the exposure dose in Sv/h at point-1 versus the depth in cm.

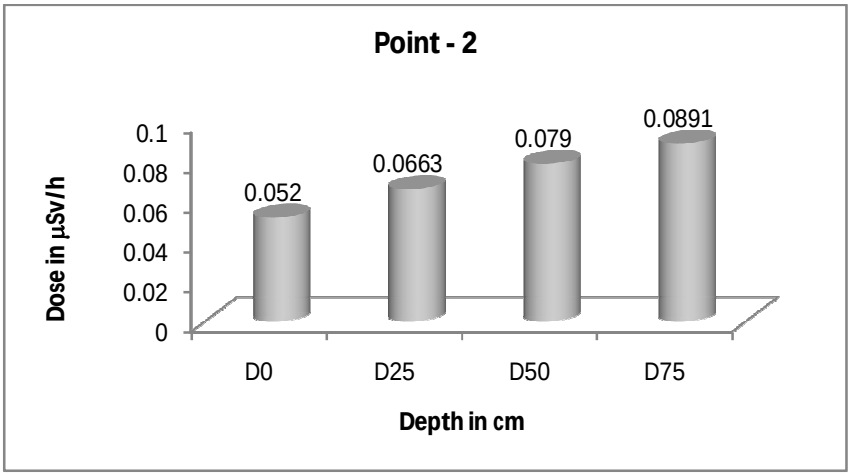

Figure 4.2 shows the exposure dose in Sv/h at point-2 versus the depth in cm.

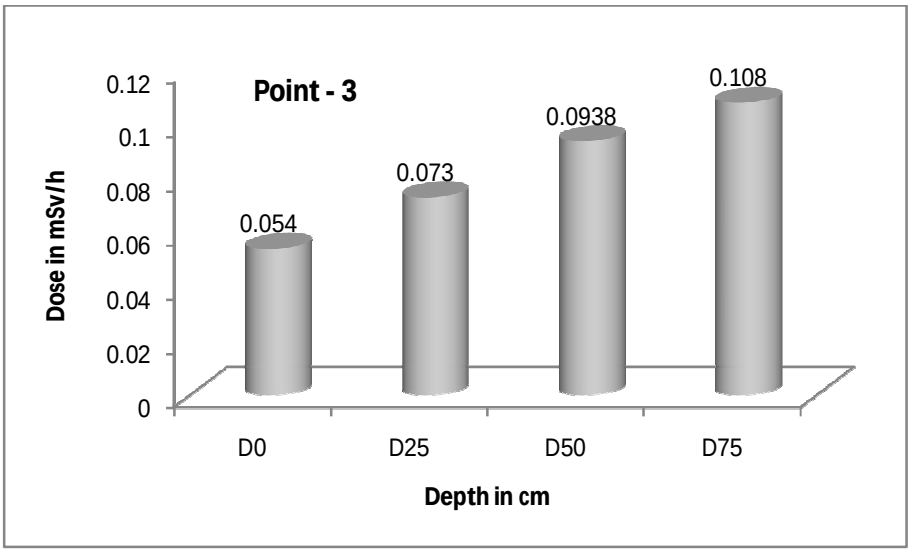

Figure 4.3 shows the exposure dose in Sv/h at point-3 versus the depth in cm.

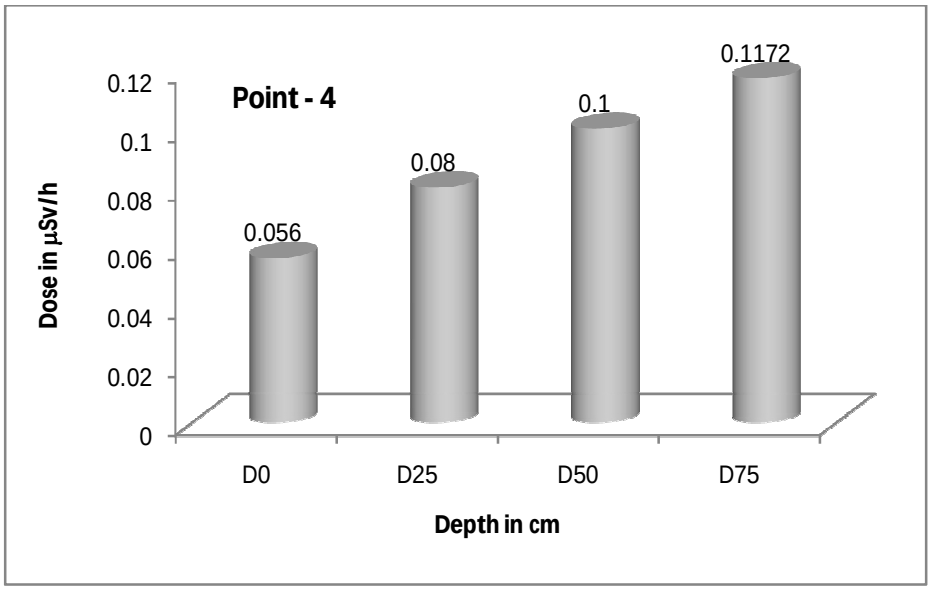

Figure 4.4 shows the exposure dose in Sv/h at point-4 versus the depth in cm.

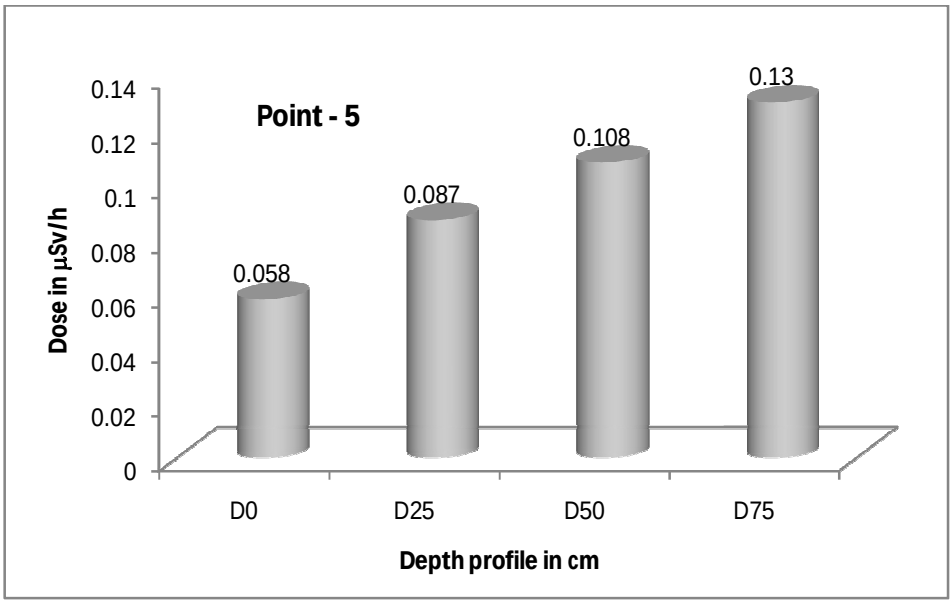

Figure 4.5 shows the exposure dose in Sv/h at point-5 versus the depth in cm.

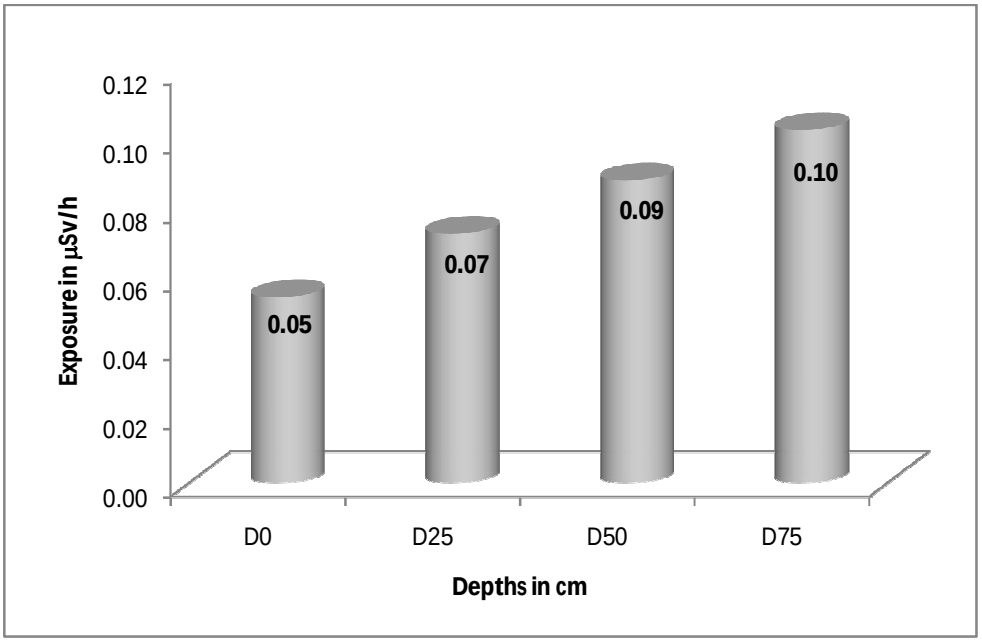

Figure 4.6 shows the average exposure in Sv/h versus depth in cm.

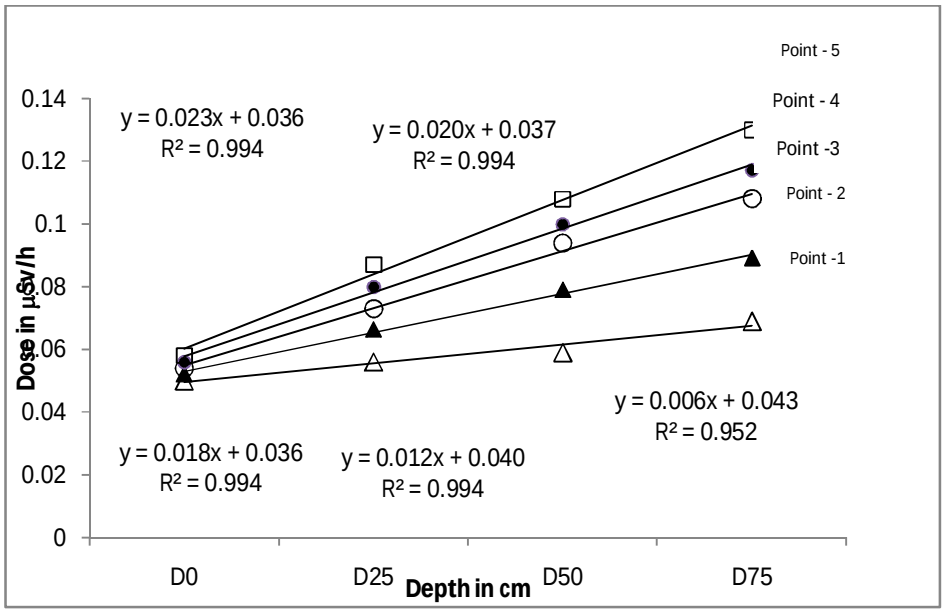

Figure 4.7 shows the correlation between the exposure dose in Sv/h and the depth profile in cm

Chapter Five

Discussion ,Conclusion and Recommendation

5.1 The Discussion

The results and analysis showed that at point (1) in Figure (4.1), the surface dose was 0.05 □Sv/h and increases following the depth profile to be 0.07□Sv/h at depth 75 cm.

Same result was shown at points (2), (3), (4) and (5) in Figures (4.2, 4.3, 4.4 and 4.5) in which the surface dose was 0.05□□Sv/h for all points and the dose increases with depths at 25, 50 and 75 cm to be 0.089, 0.11, 0.12 and 0.13□Sv/h respectively.

In Figure 4.6 shows the average exposure in □Sv/h versus depth in cm. in which the average exposure increases from 0.05□□Sv/h at the surface to 0.07□□Sv/hat 25 cm, 0.09 at 50 cm and 0.1 □Sv/h at 75 cm. and from the general calculation the researcher deduced that the average exposures per year were 7.78, 10.43, 12.67 and 14.78□Sv at the surface, 25 cm, 50 cm and 75 cm respectively.

The existence of radioactivity at the shore of Blue Nile ascribed to the sources and tributaries of the Nile which came from Ethiopian Hills and due to long distance of water flow would lead to precipitation of such radioactive elements at depths.

When the average exposure of dose at the surface compared with the maximum permissible dose MPD stated by ICRP 60 (1 mSv/year), the researcher deduced that it is still below than the MPD hence the relative radiation considered to be as stochastic effects.

Figure 4.7 shows the correlation between the exposure dose in □Sv/h and the depth profile in cm. such result showed the linear relationship between the depth and the dose was significant at $R^2 = 0.98$ indicating the effect of precipitation of the radioactive elements at the shore. Also the exposure level was increase from

the outer point of measurement (pint-1) towards the mid of the Nile i.e. to (point-5).

5.2 Conclusion:

After the finishing of this study, the researcher would like to conclude that:The analysis reveals that the surface dose was 0.05 Sv/h and increases following the depth profile to be 0.07□Sv/h at depth 75 cm ,The average exposure increases from 0.05□□Sv/h at the surface to 0.07□□Sv/hat 25 cm, 0.09 at 50 cm and 0.1 □Sv/h at 75 cm,The average exposures per year were 7.78, 10.43, 12.67 and 14.78□Sv at the surface, 25 cm, 50 cm and 75 cm respectively and The linear relationship between the depth and the dose was significant at R^2 = 0.98

5.3 Recommendations:

- The degree of the amount of the radiation dose at B.N. shore it is bellow of the annual dose,there is no risk and the visitors can stay at the shore.
- The radiation dose increase with amount of radionuclide, through the measurements there is no stochastic and non-stochastic health effects existence.

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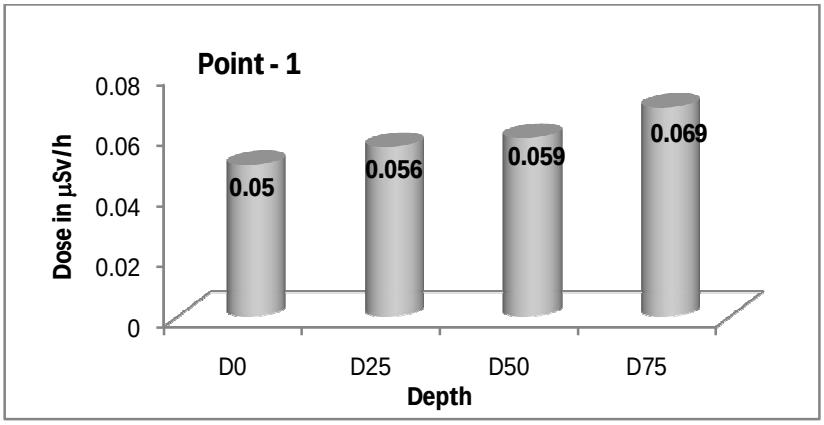
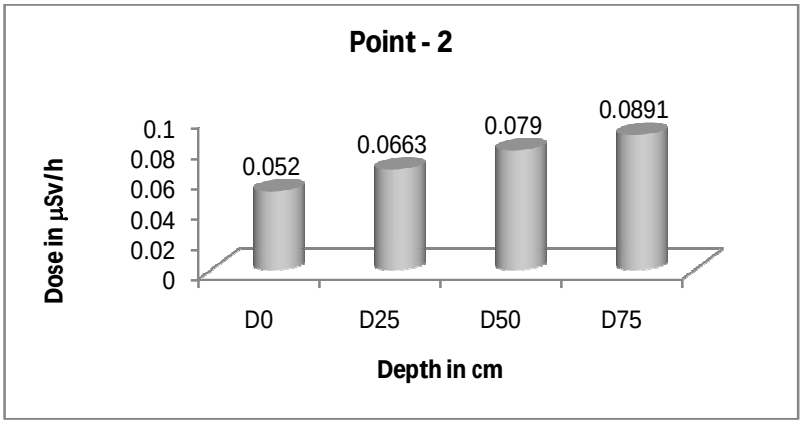
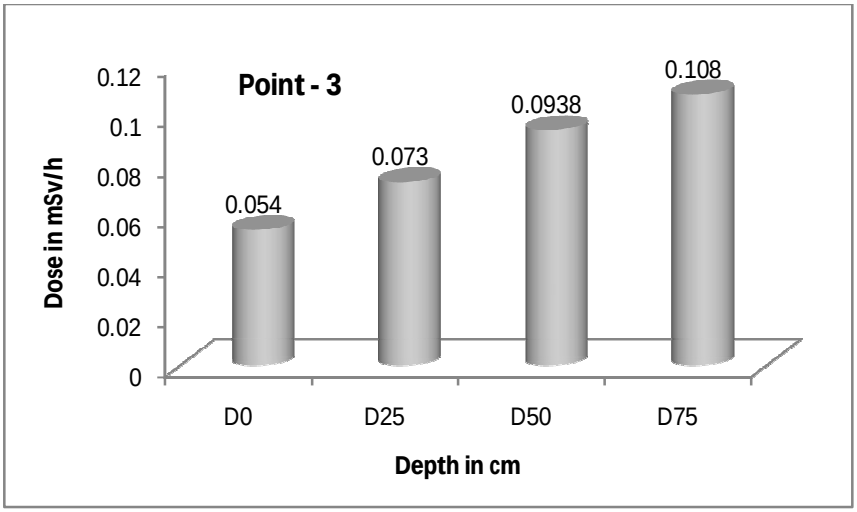
Appendixes



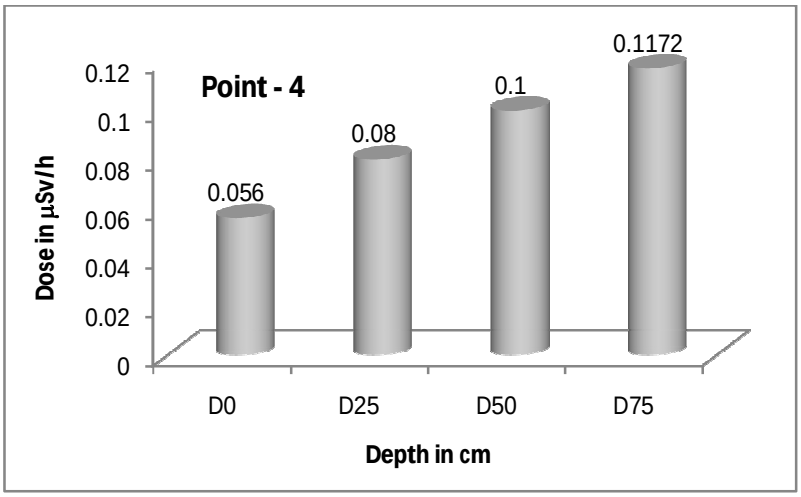
shows the exposure dose in Sv/h at point-1 versus the depth in cm.



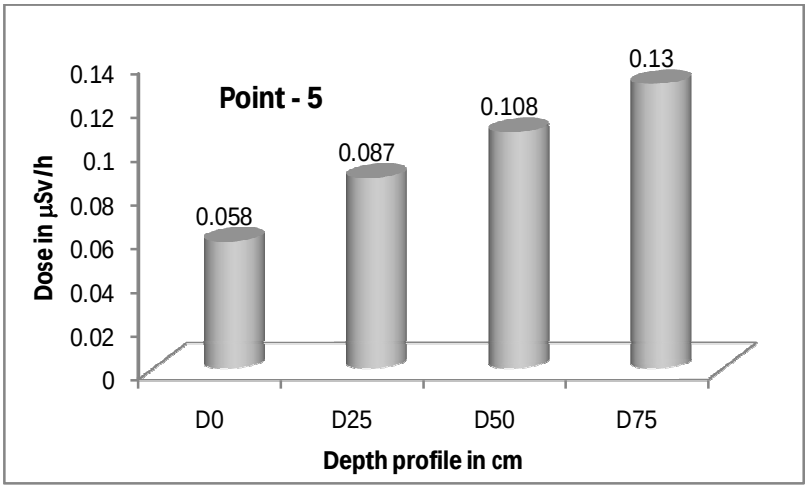
shows the exposure dose in Sv/h at point-2 versus the depth in cm.



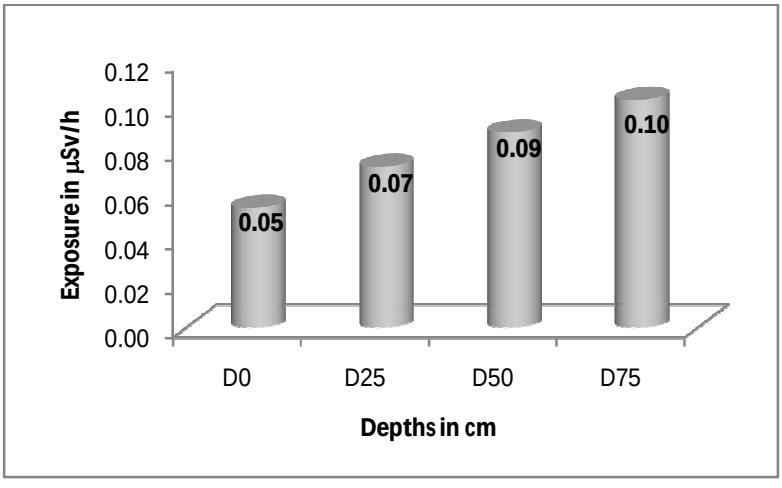
shows the exposure dose in Sv/h at point-3 versus the depth in cm.



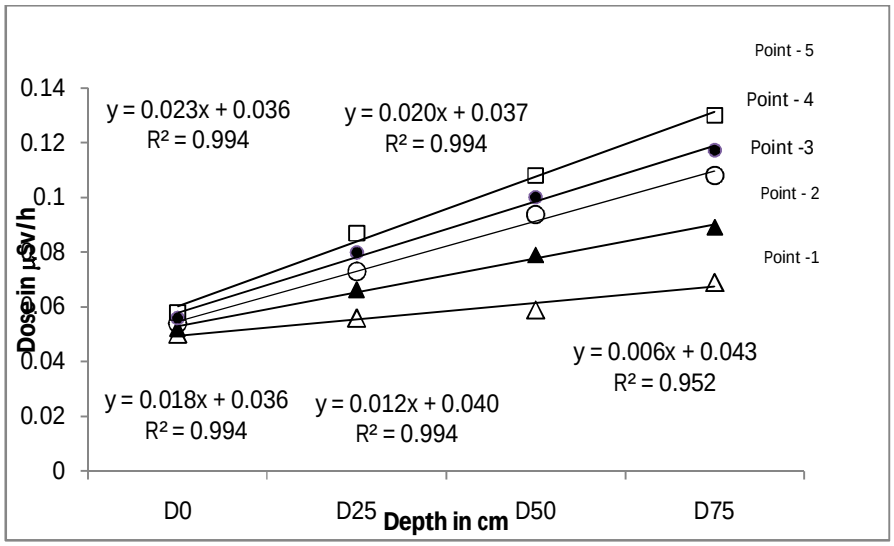
shows the exposure dose in Sv/h at point-4 versus the depth in cm.



shows the exposure dose in Sv/h at point-5 versus the depth in cm.



shows the average exposure in Sv/h versus depth in cm.



shows the correlation between the exposure dose in Sv/h and the depth profile in cm