بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In The Name Of Allah, The Beneficent The Merciful
Dedication

To my mother

Father

Sisters

Brothers

Colleagues

To all those whom I love
Acknowledgment

All praises are for ALMIGHTY ALLAH, the most Benevolent, the most Compassionate, whose blessings and graciousness flourished my ideas and endowed me with the strength required to complete this work. My humble respects are for the Holy Prophet (Peace Be Upon Him) who enlightened our scruples with the essence of faith in ALMIGHTY ALLAH and emphasized to seek knowledge, from cradle to the grave, for betterment of oneself and the humanity at large.

The work reported in this thesis has been carried out in Nuclear Instrumentation at the Seibergdorf, Vienna under the external supervision Mr. Ian Darby through the financial support of International Atomic Energy Agency (IAEA). I am extremely grateful to Mr. Ian Darby accepting to act as my external supervisor, encouragement, fruitful suggestion generous support throughout the course of this work.

I would like to express my sincere thanks and appreciation to my home supervisors Prof. Isam Salih Mohamed Musa and Dr. Ahamed Alhassen Elfaki for his useful guidance, encouragement and advice throughout the course of this thesis, without which this work would be extremely difficult.

I also place on record, my sense of gratitude to one and all, who directly or indirectly, have I met their hand in this venture.
# Contents

Contents ........................................................................................................ IV
Dedication ....................................................................................................... II
Acknowledgment ........................................................................................ III
List of Tables ................................................................................................. VI
List of Figures ............................................................................................... XIII
Abstract ......................................................................................................... XV
Arabic Abstract .......................................................................................... XVI

CHAPTER ONE ............................................................................................ 1

INTERDUCTION ......................................................................................... 1

1.1 General statement of the problem ......................................................... 2
1.2 General objective of Study ................................................................. 3
1.3 Specific Objectives ............................................................................. 3
1.4 Thesis layout ....................................................................................... 4

CHAPTER TWO .......................................................................................... 6

LITERATURE REVIEW ............................................................................... 6

2.1 Interduction ......................................................................................... 6
2.2 Environmental radioactivity ............................................................... 7

2.2.1 Radioactivity level in Rocks ......................................................... Error! Bookmark not defined.
2.2.2 Radioactivity level in Soil ............................................................. Error! Bookmark not defined.
2.2.3 Radioactivity levels in staple food and vegetation ......................... Error! Bookmark not defined.
2.3: Previous Studies: ............................................................................. Error! Bookmark not defined.

CHAPTER THREE ....................................................................................... 5

Material and Methods ................................................................................ Error! Bookmark not defined.

1.3 Gamma-spectrometric analysis .......................................................... 25
3.2 The study area ................................................................................... 25
3.3 Sample Collection and Preparation .................................................. 26
3.3.1 Soil samples ................................................................................ 26
3.3.2 Rocks samples ............................................................................. 26
3.3.3 Staple food and vegetation Samples ................................................................. 26
3.4 Derivation of the Gamma Dose Rates in Air Outdoors ............................................. 1
  3.4.1 Dose rate conversion factors (DRCFs) ............................................................
  2.5 Calculation of Absorbed Dose Rate in Air ....................................................... 2
CAHPTER FOUR ................................................................. 34
  Result and Discussion ............................................................................................. 33
  Conclusion ............................................................................................................. 59
  Appendix ............................................................................................................... 60
Reference ..................................................................................................................
LIST OF TABLES

Table (1.2): Typical activity concentration of $^{40}$K, $^{238}$U and $^{232}$Th in common rocks and estimated absorbed dose in air 1 m above the surface (UNSCEAR, 1977)………………11

Table (2.2): Average activity concentrations of $^{40}$K, $^{238}$U and $^{232}$Th in various types of soil and estimated absorbed dose in air 1 m above the surface……………………….12

Table (3.1): Table Location names with their coordinates in soil samples - North Kordofan .... 26

Table (3.2): Location names with their coordinates in soil samples - South Kordofan .......... 28

Table (3.3): Location names with their coordinates in rock samples

Jable Kordfan and Jable Dalanj ............................................................... 30

Table (3.4): Conversion factors for different Radionuclide’s as deduced by MC, Beck et al., Saito and Jacob, recent results from various Monte Carlo technique obtained by Clouvas et al, and UNSCEAR values in units of nGy h$^{-1}$ Bq$^{-1}$kg ......................... 32

Table (4.1): Activity concentration (Bq kg$^{-1}$) of $^{238}$U, $^{232}$Th, $^{40}$K and $^{137}$Cs in soil samples North Kordofan State.............................................................. 37

Table (4.2): Activity concentration (Bq kg$^{-1}$) of $^{238}$U, $^{232}$Th, and $^{40}$K in soil samples South kordofan ................................................................. 37

Table (4.3): Activity concentration (Bq kg$^{-1}$) of $^{238}$U, $^{232}$Th and $^{40}$K in rock samples North kordofan and South Kordofan ..................................................38

Table (4.4): Activity concentration (Bq kg$^{-1}$) of $^{238}$U, $^{232}$Th and $^{40}$K in foodstuff samples south Kordofan ......................................................... 38

Table (4.5): Activity concentrations (Bq kg$^{-1}$) of gamma emitters from $^{238}$U, $^{232}$Th series, $^{40}$K and $^{137}$Cs in soil samples North Kordofan ..................................................38

Table (4.6): Activity concentrations (Bq kg$^{-1}$) of gamma emitters from $^{238}$U, $^{232}$Th series and $^{40}$K in soil samples South Kordofan ................................................... 39

Table (4.7): Activity concentrations (Bq kg$^{-1}$) of gamma emitters from $^{238}$U, $^{232}$Th series and $^{40}$K in Rocks samples - North and South Kordofan ................................. 40
Table (4.8): Activity concentrations (Bq kg\(^{-1}\)) of gamma emitters from \(^{238}\)U, \(^{232}\)Th series and \(^{40}\)K in foodstuff samples South Kordofan ........................................... 40

Table (4.9): Comparison of absorbed dose rate in air at 1 m height (derived using UNSCEAR DRCFs) with similar data from Sudan and different Countries ...................45

Table (4.10): Areas of high natural radiation background (UNSCEAR 2000) .............. ............46

Table (4.11): Statistical summary of absorbed dose rate in air at 1 m height (nGy h\(^{-1}\)) (mean and range) due to \(\gamma\)-emitters from \(^{238}\)U, \(^{232}\)Th and \(^{40}\)K with their relative contribution to the total absorbed dose rate and the annual effective dose (\(\mu\)Sv\(^{-1}\)) in North kordofan using different DRCFs in Soil sample............49

Table (4.12): Statistical summary of absorbed dose rate in air at 1 m height (nGy h\(^{-1}\)) (mean and range) due to \(\gamma\)-emitters from \(^{238}\)U, \(^{232}\)Th series and \(^{40}\)K with their relative contribution to the total absorbed dose rate and the annual effective dose (\(\mu\)Sv\(^{-1}\)) in North kordofan using different DRCFs in Soil samples...............50

Table (4.13): Statistical summary of absorbed dose rate in air at 1 m height (nGy h\(^{-1}\)) (mean and range) due to \(\gamma\)-emitters from \(^{238}\)U, \(^{232}\)Th and \(^{40}\)K with their relative contribution to the total absorbed dose rate and the annual effective dose (\(\mu\)Sv\(^{-1}\)) in South kordofan using different DRCFs in Soil samples......................... .... 51

Table (4.14): Statistical summary of absorbed dose rate in air at 1 m height (nGy h\(^{-1}\)) (mean and range) due to \(\gamma\)-emitters from \(^{238}\)U, \(^{232}\)Th series and \(^{40}\)K with their relative contribution to the total absorbed dose rate and the annual
effective dose (µSv y\(^{-1}\)) in south kordofan using different DRCFs in Soil samples ..................52

Table (4.15): Statistical summary of absorbed dose rate in air at 1 m height (nGy h\(^{-1}\))
(mean and range) due to γ-emitters from \(^{238}\)U, \(^{232}\)Th and \(^{40}\)K with their relative
contribution to the total absorbed dose rate and the annual effective dose (µSv/y)
in Rocks samples using different DRCFs ............................................................... 52

Table (4.16): Statistical summary of absorbed dose rate in air at 1 m height (nGy h\(^{-1}\))
(mean and range) due to γ-emitters from \(^{238}\)U, \(^{232}\)Th series and \(^{40}\)K with their relative
correlation to the total absorbed dose rate and the annual effective dose (µSv/y)
in Rocks samples using different DRCFs ............................................................... 52

Table (4.17): Statistical summary of absorbed dose rate in air at 1 m height (nGy/h)
(mean and range) due to γ-emitters from \(^{238}\)U, \(^{232}\)Th and \(^{40}\)K with their relative
contribution to the total absorbed dose rate and the annual effective dose (µSv/y)
in food stuff samples using different DRCFs ....................................................... 53

Table (4.18): Statistical summary of absorbed dose rate in air at 1 m height (nGy h\(^{-1}\))
(mean and range) due to γ-emitters from \(^{238}\)U, \(^{232}\)Th series and \(^{40}\)K with their relative
contribution to the total absorbed dose rate and the annual effective dose (µSv y\(^{-1}\)) in food stuff samples using different DRCFs .......................54

Appendix

Table (1): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides
from \(^{238}\)U, \(^{232}\)Th and \(^{40}\)K as derived using MC DRCFs and Annual effective dose (µSv/y)
in soil samples (North Kordofan) .............................................................................61
Table (2): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using MCNP DRCFs and Annual effective dose ($\mu$Sv/y) 
in soil samples (North Kordofan)……………………………………………………………………..62

Table (3): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using GEANT DRCFs and Annual effective dose ($\mu$Sv/y) 
in soil samples (North kordofan)……………………………………………………………………..62

Table (4): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using UNSCEAR DRCFs and Annual effective dose ($\mu$Sv/y) 
in soil samples (North kordofan)……………………………………………………………………..63

Table (5): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using MC DRCFs and Annual effective dose ($\mu$Sv/y) 
in soil samples (South Kordofan) ………………………………………………………………………..64

Table (6): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using MCNP DRCFs and Annual effective dose ($\mu$Sv/y) 
in soil samples (South kordofan)……………………………………………………………………..65

Table (7): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using GANT DRCFs and Annual effective dose ($\mu$Sv/y) 
in soil samples (South kordofan)……………………………………………………………………..65

Table (8): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using UNSCEAR DRCFs and Annual effective dose ($\mu$Sv/y) 
in soil samples (South kordofan)……………………………………………………………………..66

Table (9): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from 
$^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using MC DRCFs and Annual effective dose ($\mu$Sv/y) 
in Rocks samples……………………………………………………………………………………………..67
Table (10): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using MCNP DRCFs and
Annual effective dose ($\mu$Sv/y) in Rocks samples

Table (11): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using GANT DRCFs and
Annual effective dose ($\mu$Sv/y) in Rocks samples

Table (12): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using UNSCEAR DRCFs and Annual effective dose ($\mu$Sv/y) in Rocks samples

Table (13): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using MC DRCFs and Annual effective dose ($\mu$Sv/y) in foodstuff samples

Table (14): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using MCNP DRCFs and Annual effective dose ($\mu$Sv/y) in foodstuff samples

Table (15): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using GANT DRCFs and Annual effective dose ($\mu$Sv/y) in foodstuff samples

Table (16): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ as derived using UNSCEAR DRCFs and Annual effective dose ($\mu$Sv/y) in foodstuffs samples

Table (17): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclide from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using MC DRCFs and
Annual effective dose (µSv/y) in soil samples (North Kordofan) ………………71

Table (18): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using MCNP DRCFs and

Annual effective dose (µSv/y) in soil samples (North Kordofan) ………………72

Table (19): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using GANT DRCFs and

Annual effective dose (µSv/y) in soil samples (North Kordofan) ………………73

Table (20): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using UNSCEAR DRCFs and

Annual effective dose (µSv/y) in soil samples (North Kordofan) ………………73

Table (21): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclide from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using MC DRCFs and

Annual effective dose (µSv/y) in soil samples (South Kordofan) ………………74

Table (22): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using MCNP DRCFs and

Annual effective dose (µSv/y) in soil samples (South Kordofan) ………………75

Table (23): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using GANT DRCFs and

Annual effective dose (µSv/y) in soil samples (South Kordofan) ………………76

Table (24): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using UNSCEAR DRCFs

and Annual effective dose (µSv/y) in soil samples (South Kordfan) … …………76

Table (25): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}$U, $^{232}$Th series and $^{40}$K as derived using MC DRCFs

XI
Table (26): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using MCNP DRCFs

and Annual effective dose ($\mu$Sv/y) in Rocks samples

Table (27): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclide from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using GANT DRCFs

and Annual effective dose ($\mu$Sv/y) in Rocks samples

Table (28): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using UNSCEAR DRCFs

and Annual effective dose ($\mu$Sv/y) in Rocks samples

Table (29): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using MC DRCFs

and Annual effective dose ($\mu$Sv/y) in foodstuff samples

Table (30): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclide from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using MCNP DRCFs

and Annual effective dose ($\mu$Sv/y) in foodstuff samples

Table (31): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using GANT DRCFs

and Annual effective dose ($\mu$Sv/y) in foodstuff samples

Table (32): Absorbed dose rates in air at 1 m height (nGy/h) due to gamma emitting nuclides from $^{238}\text{U}$, $^{232}\text{Th}$ series and $^{40}\text{K}$ as derived using UNSCEAR DRCFs

and Annual effective dose ($\mu$Sv/y) in foodstuff samples
LIST OF FIGURES

Figure (2.1): The uranium ($^{238}$U), thorium ($^{232}$Th), and actinium ($^{235}$U) decay series …… 9

Figure (3.1): Study area (North and South Kordofan States, Sudan) display sampling locations ……………………………………………………………………………… 25

Figure (4.2): Average activity concentrations of $^{238}$U, $^{232}$Th series, $^{137}$Cs and $^{40}$K in Soil samples from North kordofan ……………………………………… 41

Figure (4.3): Average activity concentrations of $^{238}$U, $^{232}$Th and $^{40}$K in Soil samples from South Kordofan ………………………………………………… 42

Figure (4.4): Average activity concentrations of $^{238}$U, $^{232}$Th series and $^{40}$K in Soil samples from South Kordofan ……………………………………… 42

Figure (4.5): Average activity concentrations of $^{238}$U, $^{232}$Th and $^{40}$K in rock samples …………… 43

Figure (4.6): Average activity concentrations of $^{238}$U, $^{232}$Th series and $^{40}$K in Rocks samples ………………………………………………………………………… 43

Figure (4.7): Average activity concentrations of $^{238}$U, $^{232}$Th and $^{40}$K in Foodstuf samples……………………………………………………………………………… 44

Figure (4.8): Average activity concentrations of $^{238}$U, $^{232}$Th series and $^{40}$K in foodstuff samples……………………………………………………………………… 44

Figure (4.9): Predictive map for Absorbed Dose (displays values between 18.5 and 48.2) ……47

Figure (4.10): Predictive maps of $^{238}$U ……………………………………………………….47

Figure (4.11): Predictive maps of $^{232}$Th ………………………………………………… 48

Figure (4.12): Predictive maps of $^{40}$K ……………………………………………………48

Figure (4.9): Relative contribution of $^{238}$U, $^{232}$Th and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in soil samples-North kordofan ………………….55
Figure (4.10): Relative contribution of $^{238}$U, $^{232}$Th series and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in Soil samples - North Kordofan ……55

Figure (4.11): Relative contribution of $^{238}$U, $^{232}$Th and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in soil samples - South Kordofan …………… 56

Figure (4.12): Relative contribution of $^{238}$U, $^{232}$Th series and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in Soil samples - South Kordofan ……… 56

Figure (4.13): Relative contribution of $^{238}$U, $^{232}$Th and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in rock samples…………………………………… 57

Figure (4.14): Relative contribution of $^{238}$U, $^{232}$Th and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in rock samples …………………………… 57

Figure (4.15): Relative contribution of $^{238}$U, $^{232}$Th and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in food stuff samples……………………………………… 58

Figure (4.16): Relative contribution of $^{238}$U, $^{232}$Th and $^{40}$K to the total absorbed dose rate in air as calculated using different DRCF in foodstuff …………………………………………58
ABSTRACT

The aim of this study is to assess the natural environmental radioactivity level and evaluation doses calculations. Total 114 Samples were collected contain soil, rock and some foodstuff from different locations around South and North Kordofan states. The radioactivity concentration of $^{238}$U, $^{232}$Th, $^{40}$K and $^{137}$Cs have been determined using $\gamma$-ray spectrometry NaI(Tl) detector. Moreover, the absorbed dose rates ate in air at a height of 1m from the ground was calculated using four sets of dose rate conversion factors and the corresponding annual effective dose were estimated. The average value of $^{238}$U, $^{232}$Th, $^{40}$K and $^{137}$Cs in the soil samples from South Kordofan were found to be 22.83, 25.11, 284.31 and 0.28 Bq.kg$^{-1}$ respectively.

For South Kordofan. Activity concentrations $^{238}$U, $^{232}$Th, $^{40}$K and $^{137}$Cs in the soil samples, were came out to be 22.08, 28.99, 319.16 and 1.38 Bq.kg$^{-1}$ respectively. Predictive maps were constructed for both area for $^{238}$U, $^{232}$Th, $^{40}$K and absorbed dose using GIS program which showed a trend of increase to the Maintains area for soil Sample. Corresponding, for Foodstuff the average activity concentration of natural nuclides $^{238}$U, $^{232}$Th and $^{40}$K fallout nuclide $^{137}$Cs was 4.6, 4.4 and 326 Bq.kg$^{-1}$ respectively. Also activity concentrations of $^{238}$U, $^{232}$Th and $^{40}$K in rocks samples was 23.56, 29.57 and 330.58 Bq.kg$^{-1}$ respectively. The obtained results were found to be less than the corresponding global values reported in the UNSCEAR publications for normal background areas.

The absorbed dose rate in air at a height of 1m from the ground was calculated using four sets of dose rate conversion factors and the corresponding annual effective dose was estimated. On the average, the values obtained were: 25.60, 25.26, 26.57 and 29.61 nGy.h$^{-1}$ for soil samples North Kordofan, 26.08, 28.05, 32.88 and 31.00 nGy.h$^{-1}$ for soil samples South Kordofan, 28.80, 28.42, 33.95 and 33.34 nGy.h$^{-1}$ for rock samples, 5.53, 5.48, 5.00 and 6.16 nGy.h$^{-1}$ for Foodstuff samples, and annual effective dose were: 31.20, 30.99, 32.60 and 41.72 $\mu$Sv.y$^{-1}$ for the soil samples North Kordofan, 37.16, 34.42, 38.53 and 39.81 $\mu$Sv.y$^{-1}$ for the soil samples South Kordofan, 38.19, 34.88, 39.60 and 40.92 $\mu$Sv.y$^{-1}$ for rock samples and 7.89, 6.72, 6.13 and 7.56 $\mu$Sv.y$^{-1}$ for Foodstuff samples, respectively for DRCFs (MC, MCNP, GEANT and UNSEAR). These values lie within the areas very close worldwide range for high background radiation. The obtained data can be used in baseline data for any future studies for the establishment of radiation map for Sudan.
المستخلص

أجرت هذه الدراسة لتقييم مستوى النشاط الإشعاعي الطبيعي وحساب الجرعات في بعض المناطق من ولايتي شمال وجنوب كردفان. تم جمع وتعقيم 114 عينة من التربة والصخور والغذاء الرئيسي. قياس تركيز النشاط الإشعاعي لكل من اليورانيوم، الثوريوم، البوتاسيوم والسيزيزم باستخدام مطياف نقاط. ومن ثم قياس الجرعة الإشعاعية المتصلة وذلك باستخدام أربعة أطقم من تحويل معدل الجرعة الفعالة. ووجدت أن تركيزات النظائر في بعض المناطق تصل إلى 88.23، 81.11، 821.31، 4.82 بيكيرل/كجم على التوالي.

وباستخدام نظام المعلومات الجغرافية (GIS) تم إعداد خرائط توضيح تركيزات اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم، وكذلك الجرعات الإشعاعية التي تبلغ 88.42، 82.22، 312.13، 1.32 بيكيرل/كجم على التوالي.

وقد حددت تركيزات الغذاء الرئيسي لكل من اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم 1.31، 1.12، 3.83 بيكيرل/كجم على التوالي.

تم حساب الجرعات الإشعاعية الممتدة في الهواء على ارتفاع 1 م من سطح الأرض وذلك باستخدام مجموعة من ثوابت تحويل معدل الجرعة (DRCFs)، كما تم حساب الجرعة الفعالة السنوية. النتائج تشير إلى أن تركيزات النظائر في بعض المناطق تصل إلى 88.42، 82.22، 312.13، 1.32 نانوغرام/ساعة على التوالي. وجدت أن هذه النتائج تقع ضمن مجال المدي.

وباستخدام نظام المعلومات الجغرافية (GIS) تم إعداد خرائط توضيح تركيزات اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم، وكذلك الجرعات الإشعاعية التي تبلغ 88.42، 82.22، 312.13، 1.32 بيكيرل/كجم على التوالي.

وقد حددت تركيزات الغذاء الرئيسي لكل من اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم 1.31، 1.12، 3.83 بيكيرل/كجم على التوالي.

وقد حددت تركيزات الغذاء الرئيسي لكل من اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم 1.31، 1.12، 3.83 بيكيرل/كجم على التوالي.

وقد حددت تركيزات الغذاء الرئيسي لكل من اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم 1.31، 1.12، 3.83 بيكيرل/كجم على التوالي.

وقد حددت تركيزات الغذاء الرئيسي لكل من اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم 1.31، 1.12، 3.83 بيكيرل/كجم على التوالي.

وقد حددت تركيزات الغذاء الرئيسي لكل من اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم 1.31، 1.12، 3.83 بيكيرل/كجم على التوالي.

وقد حددت تركيزات الغذاء الرئيسي لكل من اليورانيوم، الثوريوم، البوتاسيوم وثانيال السيزيزم 1.31، 1.12، 3.83 بيكيرل/كجم على التوالي.

وقد حددت تركيا...
العالمي ذات الخليفة الإشعاعية. نتائج البحث التي تم الحصول عليها يمكن استخدامها كبيانات اساسية لبناء خرطة اشعاعية للسودان مستقبلاً.