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A Study of Carcinogenic radioactive Materials around the Residential Areas Near the Stores of Fertilizer and Pesticides, Aljazeera Agricultural Project using Gamma-ray Spectrometry

دراسة تأثير المواد المشعة المسرطنة حول المناطق السكنية بالقرب من مخازن الأسمدة والمبيدات لمشروع الجزيرة الزراعي باستخدام كاشف قاما

A Thesis Submitted for Fulfillments of Requirements for Degree of Doctor of Philosophy in Physics

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صدق الله العظيم

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DEDICATION

This work is dedicated to my parents, brother Al-Waleed, brother Eng. Hossam, my wife Saba, my son Muhammad and my daughter Malaz. And to all my brothers and sisters.

ABSTRACT

This study showed that the evaluation of radiological risk factors due to terrestrial radionuclide's in soil, about the stores of pesticides and fertilizers for Aljazeera agricultural project in Alhassahisa, Sudan, The problem was the spread of cancers and chronic diseases due to the widespread spread of radioactive materials in the Hasahisa area and the nearby places, which led to the pollution of the environment on a large scale due to the use of fertilizers and agricultural pesticides in the agricultural soil, to address the issue of the natural radioactivity of this area. Hence, levels of ^{226}Ra, ^{232}Th, ^{228}Ra, ^{40}K and ^{137}Cs in the soil were calculated (by using (gamma-ray spectrometry), and then the radiation risk parameters were calculated. its including radioactivity concentration Bqkg^{-1}, absorbed dose D, and effective annual dose E, its due to inhalation of radon (^{222}Rn) and consumption of potassium (^{40}K), radium (^{226}Ra), radium (^{228}Ra), thorium (^{232}Th) and mean activity concentrations The norms for the five primitive radionuclides were, respectively, 268.98 ± 5.22, 14.54 ± 0.2, 15.31 ± 1.54, 20.45 ± 0.96, and 0.34 ± 0.19 Bq kg^{-1}. This results somewhat normal distribution of the United Nations Scientific Committee on the Effects of Atomic Radiation. The results obtained indicate that some radiation risk factors appear to be unfavorable. The mean average absorbed dose (30.54 ± 2.71) nGyh^{-1} was a slightly normal distribution of the average value of 30.54 nGyh^{-1}, and the Average annual effective dose E (µSVyear^{-1}) (37.48 ± 3.32).) Svyear^{-1} was a slightly normalized distribution of the value of SVyear^{-1}its compared with the data of the United Nations Scientific Committee on the Effects of Atomic Radiation.

Radiation hazard parameters were was computed. These include excess lifetime cancer risk, annual gonadal dose equivalent hazard index, radium

equivalent activity and external hazard. Obtained result indicates that some of the radiation hazard parameters, the average value excess lifetime cancer risk (ELCR) 0.12×10^{-3} μSv, were found to be lower than the UNSCEAR reported value of 0.29×10^{-3} μSv (UNSCEAR 2000), and that of average annual gonadal dose equivalent hazard index 214.59 $\mu Svyear^{-1}$, the average value of AGDE in the region is the lower than worldwide average of 300 μSvy^{-1} (UNSCEAR 2000). the average radium equivalent Raeq ($Bqkg^{-1}$) 64.3 $Bqkg^{-1}$. The average external hazard index (H_{ex}) 0.18, the calculated Hex values for all the samples were found to be below unity, which does not cause harm to the populations of the investigated region. Radiation hazard parameters due to terrestrial radionuclide's in the soil samples were compared to the international values reported by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 2000) and previous studies on the region.

The study focuses light on the demand to develop a comprehensive program for radiation protection in Sudan and in agricultural projects that constantly use pesticides and fertilizers for regulatory oversight.

المستخلص

وضحت هذه الدراسة تقييم عوامل الخطر الإشعاعي بسبب النويدات المشعة الأرضية في التربة حول مخازن المبيدات والأسمدة لمشروع الجزيرة الزراعي بمنطقة الحصاحيصا بالسودان ،

انتشار السرطانات والأمراض المزمنة في المعضلة الرئيسية بسبب المواد المشعة في منطقة الحصاحيصا والأماكن المجاورة مما أدى إلى تلوث البيئة من استخدام الأسمدة والمبيدات الزراعية في المنطقة للتربة الزراعية بصورة كبيرة، و لمعرفة موضوع النشاط الإشعاعي الطبيعي لهذه المنطقة من خلال النتائج التجريبية لحساب مستويات الراديوم-226 و الثيريوم-232 و الراديوم-228 و البوتاسيوم-40 و السيزيوم-137 في التربة (باستخدام كاشف مطياف قاما) ، ومن ثم حُسبت عوامل خطر الإشعاع بما في ذلك تركيز النشاط الإشعاعي بالبيكريل/ كيلوجرام، والجرعة الممتصة D ، والجرعة السنوية الفعالة E ، بسبب استنشاق الرادون واستهلاك البوتاسيوم والراديوم-26،الراديوم-28 والثوريوم و متوسط تركيز النشاط الأشعاعي كانت معايير النويدات المشعة البدائية الخمسة ، على التوالي ، 268.98 ± 5.22 ، 14.54 ± 0.2 ، 15.31 ± 1.54 ، 20.45 ± 0.96 ، و 0.34 ± 0.19 بيكريل/ كجم . يستنتج من هذا التوزيع الطبيعي الذي تمت مقارنتة باللجنة العلمية للأمم المتحدة وأشيرت النتائج التي تم الحصول عليها إلى أن بعض عوامل الخطر الإشعاعي تبدو ملائمة وطبيعية. كان متوسط الجرعة الممتصة (30.54 ± 2.71) نانوقري/ساعه وهو توزيعًا طبيعيًاً لمتوسط القيمة 30.54 نانوقري/ساعة عند مقارنتها بالقيمة العالمية ، ومتوسط الجرعة الفعالة السنوية (37.48 ± 3.32) مايكروسيفرت/سنه وكان توزيعًا طبيعيًا مقارنة بالقيم العالمية. حُسبت معلمات خطر الإصابة بالسرطان مدى الحياة ، ومؤشر الخطر السنوي المكافئ لجرعة الغدد التناسلية ، والنشاط المكافئ للراديوم والمخاطر الخارجية للأشعاع ، وجد متوسط القيمة الزائدة لخطر الإصابة بالسرطان على مدى العمر (10^{-3} × 0.12) مايكروسفيرت ، وُجد أنها أقل من القيمة التي أبلغت عنها اللجنة الدولية البالغة 0.29 × 10^{-3} مايكروسفيرت، ومتوسط مؤشر الخطر السنوي المكافئ لجرعة الغدد التناسلية 214.59سيفرت/سنه ، و متوسط القيمة لها في المنطقة هو أقل من المتوسط العالمي البالغ 300 سيفرت/سنه ، ومتوسط مكافئ الراديوم 64.3 بيكريل/ كجم، ومتوسط مؤشر الخطر الخارجي للأشعاع 0.18 ، والقراءات المحسوبة لجميع العينات وجدت أقل من الوحدة ، والتي لا تسبب ضررًا لسكان المنطقة .

يوصي في نهاية هذا البحث عمل التحليل لعينات التربة في تلك المنطقة بأجهزة مختلفة او اخذ عينات اخري كالماء والحشائش او اللبن من تلك المنطقة وتحليلها ويتم مقارنتها بهذه الدراسة والدراسات العالمية الاخري.

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List of Abbreviations

HPGe	High Purity Germanium
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
IAEA	International Atomic Energy Agency
ICRP	International Commission for Radiological Protection
WHO	World Health Organization
H_{in}	Internal Hazard Index

List of Symbols

$Bq.kg^{-1}$	Becquerel per Kilogram
mSv	Millisievert (10^{-3} Sievert)
$nGy.h^{-1}$	Nano Gray per Hour
µ	Micro
Th	Thorium
K	Potassium
U	Uranium
A_{Ra}	Activity Concentration of the Radium
A_{Th}	Activity Concentration of the Thorium
A_{K}	Activity Concentration of the Potassium
ELCR	Excess Life Time Cancer Risk
AGDE	Annual Gonadal Dose Equivalent
$E(\mu sv.year^{-1})$	Annual Effective Dose Rates
$D\ (nGh^{-1})$	Absorbed Dose Rate
ND	Not Detectable
$A_c(Bqkg^{-1})$	Activity Concentration of the Radionuclide in the Smple
H_{ex}	External Hazard Index
NORM	Naturally Occurring Radioactive Materials

CHAPTER ONE

INTRODUCTION

1.1 Backgrounds to the Study

Aljazeera Agricultural Project was established in 1925, the oldest project in Sudan and the largest irrigated farm in the world with an area of 2.2 million acres. The project runs across the states of the Aljazeera and the White Nile and Sinner along a length of 300 km. The project aims to exploit Sudan's share of the Nile water, transform the traditional agricultural area into modern agriculture, and raise the standard of living and health services by absorbing 15,000 farmers.

Human beings have resorted to devising effective and practical methods for organic pesticides as a result of population growth and increased needs for food and agricultural crops. And the failure of natural factors and traditional methods to reduce damage caused by pests, the fertilizers are essential in agriculture as they supply nutrients to the farming fields. Although Fertilizers play an important role in the agriculture sector to increase crop productivity until fertilizers industries have spread from all over the world (Chandrajith, et al., 2010). Fertilizers are as indispensable as they may seem, though substances that cause serious environmental pollution are particularly apparent in agricultural soils. In order to increase the agricultural productivity needed by the growing population, the rates of use of chemical fertilizers have been increased and this may lead to excessive accumulation of toxic elements that are usually present in soil as effects. High levels of trace elements such as these in agricultural soils have become a problem because they can enter the food chain or seep into the groundwater causing some serious health problems [1]. Fence of streams, separate clean and dirty water in the farmyard, re-site for nutrients, tracks and ferries. Many farmers and farm managers are also highly trained and experienced, especially for large business operations, and are seen as part of AKIS7's knowledge and agricultural information systems able to innovate saving costs and environmentally beneficial practices by (Sun, et al., 2012) [2]. Examples of the most common nitrogen and other fertilizers $(NH_4)\ _2SO_4$ (21-0-0, 24% sulfur), ammonium nitrate $NH4NO_3$ (34-0-0), urea NH2CONH2 (46-0-0), urea Sulphur coated (0-0.6), urea formaldehyde (46-0-0. CH_2O), dolomite and lime (Ca Mg $(CO_3)_2$, potassium chloride (0-0-60) and triple superphosphate (0-46-0) But not exclusively, the following, sulfur in the soil reacts with water to produce sulfuric acid (H_2SO_4) in soil with increased calcium, and sulfuric acid reacts with calcium carbonate (calcium carbonate $CaCO_3$) to form gypsum which in anaerobic conditions forms H_2S with water (Faweya EB, et al., 2017) [3]. Nitrogen fertilizers (N), phosphorus (P), and potassium (K) are mainly formed which are the essential elements of plant growth. The phosphorus fraction is taken from phosphate rocks, which contain a relatively high proportion of occurring naturally ^{238}U, ^{232}Th, and ^{40}K and their radioactive daughters (Hassan NM, et al., 2017) [4]. One of the sources of radioactivity other than those of natural origin is mainly due to extensive use of fertilizers (Chauhan P, et al., 2013) [5]. Given the continuing requirement to increase food production, the use of phosphate fertilizers is essential for intensive agriculture today to achieve high returns. To maintain annual production in agriculture you must take care of the fields and provide the necessary micronutrients and nutrients needed for the crop, which we hope that we grow (Hegedus M, et al., 2017). And to provide essential nutrients in the soil, use of nitrogen fertilizers (N) and phosphate (P_2O_5) and potash (K_2O) in large quantities, and sometimes (especially in fast-developing countries), which leads to excessive use [6]. Although the contents of uranium are found to be very high in some fertilizer samples especially in triphosphate superphosphates. Most uranium applied by fertilizer can contaminate drinking water sources and even lower uranium concentrations in drinking water may cause kidney effects by (Chandrajith, et al., 2010) [1].

However, its negative impact makes it pollute the environment with pesticide residues in the living, human and animal environment (Chauhan P, et al., 2013). Pollution of human consumption of food, high incidence of acute and chronic poisoning and deaths due to pesticides, in addition to the high cost of pesticide control, especially in developing countries, Since phosphate fertilizers contain excessive amounts of radionuclide's and heavy metals, the use of prolonged mass can lead to a gradual contamination [5]. Ionizing radiation in the environment can be from natural or industrial sources, and industrial sources with the greatest extent in the use of chemicals that affect the environment of radioactive chemicals from pesticides and fertilizers they (Idriss H, et al., 2016) people are exposed to ionizing radiation from radionuclides in the different types of natural source because of the health risks associated with exposure to natural radionuclide's , organizations such as the International Local and International Radiation Protection Commission of the United States Environmental Protection Agency (USEPA) -have standards and legislation to limit such exposure [7]. The annual effective dose worldwide for exposure to normal radiation is 2.4 m sv. (Bai H, et al., 2017) [8]. However, the pesticides have negative and positive aspects as they encouraged the introduction of agricultural investment doors horizontal and vertical expansion and a decrease in losses as a result of pests (Smith, et al., 2017). Led to an abundance of agricultural food commodities for consumers and also reduced erosion and dumping of soil erosion using herbicides as an alternative to the machine the lack of clearly defined regulations for the management of soil animal waste and fertilizers the central government and provinces produce guidelines But these remain advisory and unenforceable [9]. as well as petroleum industries is the largest consumer of radioactive materials and also radiography in the field of medicine and industry (Faweya EB, et al., 2017), However, some possible negative and adverse effects of fertilizers in the contamination of cultivable lands by synthetic calcium magnesium and nitrogen fertilizers may occur due to unwholesome practices of manufacturers and legend do not inform farmers that these products undergo chemical reactions in the soil with attendant serious side effects on the environment soils, water, air and soil life [3]. Normal radioactivity is usually studied in order to obtain information about current levels of harmful contaminants discharged into the same environment or in living organisms (Chauhan P, et al., 2014). It is also important to understand the behavior of natural radionuclide's in the environment, because such information can use the parameter values associated with radiological assessments, Natural ionizing radiation is emitted as a result of spontaneous nuclear transitions from unstable radionuclide's that occur naturally in the earth's crust (ie the terrestrial origin), as well as those coming from outer space in the atmosphere (ie non-terrestrial origin) [10]. Intensive use of fertilizers can increase the amount of radionuclide's in soil and groundwater and ingest ingestion by humans through exposure pathways such as drinking water and food chain (Hassan NM, et al., 2017) [4]. This is due to the internal irradiation of the alpha particles lung-acting radon off spring and external irradiation of the body by gamma rays emitted from radionuclide's by the radioactive effect of soil fertilizer use. Radon is a carcinogen for humans and responsible for the main exposure to natural radiation by (Chauhan P, et al., 2014) [10]. Therefore the radiation emitted from fertilizer has the potential to cause cancer in individuals who have been exposed to high levels so that the monitoring of natural radioactivity in fertilizers has importance from the point of view of radiation protection by (Hassan NM, et al., 2017) [4]. The pesticide can reach the human through the skin, mouth or breathing, which requires wearing protective clothing. The pesticide can also reach the pet by skin or mouth by eating or drinking pesticide-contaminated substances, Workers of plants that produce fertilizers and those who use fertilizers in agriculture are exposed to gamma rays (external exposure) and alpha particles (internal exposure) emitted from radionuclide's from the series ^{238}U, ^{232}Th series, and ^{40}K (N. M. Hassan, et al., 2017). External exposure occurs directly from γ rays, while internal exposure occurs by α particle that results from the inhalation of radon and its strains. As a result, the dose -particle is delivered directly to the bronchial tissues, creating the potential for lung cancer [11]. Although Long-term radiation and inhalation of radionuclides have Exposures serious health effects such as chronic lung cancer and leukemia (Isinkaye MO,et al., 2015) [12]. For environmental laws that do not exist enforcement contrary to different areas and penalties are usually insufficient to ensure compliance and thus promoted by (Smith, et al., 2017) in studied the continuation of the first growth mentality and the judicial system remains largely "unable to provide strong protection of environmental rights against violations [9]. Natural radioactive materials under certain conditions can reach dangerous radiation levels (Chauhan P, et al., 2014). Therefore, it feels necessary to study natural radioactivity in the soil to assess the dose of the population in order to know the health risks and obtain a baseline for future changes in environmental radioactivity in human activities [10].

Artificial radionuclide's is nuclear weapons testing nuclear accidents medical and industrial applications and so forth About 87% of the radiation doses received by humans are from natural sources of radiation which comes from the radioactive isotopes that occur naturally from ^{238}U

and ^{232}Th and their offspring as well as ^{40}K by (Isinkaye MO,et al., 2015) [12]. Although natural uranium is found in soil, air, and water as well as in natural materials. The most abundant analog is non-238U (99.28%), which is known as the parent of the long radioactive decay series comprising 16 radioactive elements by (Saleh IH, et al., 2016) [13].

Phosphate rocks form the bulk of the rock material for the manufacture of phosphate fertilizers and some existing phosphorus chemicals (El-Bahi SM, et al., 2017) in studied it is known that natural phosphate contains various stable and radioactive elements which may be of environmental concern to the public [14]. The relatively large concentrations of natural radioactive elements present in phosphate fertilizers pollute the environment and agricultural land during cultivation (Einas H.O. et al., 2012) [15]. Thus, it is important to study the concentration of natural radioactivity in consumer products and estimate the environmental radioactivity by using gamma ray spectrometry by measuring the concentration of natural radioactive elements such as (^{238}U, ^{232}Th, ^{226}Ra and ^{40}K) and also calculating radiation doses and radiation hazards due to natural radionuclide's in phosphate rock And fertilizers by (El-Bahi SM, et al., 2017) [14]. Although the contents of uranium is very high and found in some samples of fertilizers especially in the triple super phosphate (Isinkaye MO,et al., 2015). Most can uranium applied by fertilizers that contaminate drinking water sources, but that the low concentrations of uranium in drinking water may cause kidney effects [12]. Concentrations of activity of ^{232}Th and ^{40}K in phosphate sedimentary rocks are much lower than those of ^{238}U, comparable to those typically observed in soil risks can arise from the use of rock materials in industrial plants especially in the production of phosphoric acid and fertilizers due to the release of dust and polluted waste into the environment. In phosphate rock the natural Uranium and thorium decay series are in equilibrium. During the industrial process this equilibrium and radionuclide migration will be disrupted into intermediate and final products and products according to the chemical melting the properties of each component, therefore, it is important to measure natural radioactivity not only in phosphate rocks but also in different types of fertilizers and byproducts (phosphate) which can also be used as agricultural gypsum to deal with salinity from manufacturers and end users (El-Bahi SM, et al., 2017) in stydied The main program carried out by a different radiation institute in order to build basic data on the concentration of radioactivity to be used as reference in the event of any radiation incident so many studies have been reported on radioactivity and radiation dose of public exposure has been carried out in different regions of Sudan for cases in the northern region the dose ranged from 44 - 53 nGy^{-1} absorption rate and the annual effective dose ranged from 53 to 65 μsvy^{-1} [14]. In addition, another study found that the radiation uptake rate ranged from 7.1 to 84.6 nGy h^{-1} and the annual effective dose ranged from 8.7-103.7 μSvy^{-1} by (Wisal B. Hassan., et al., 2013) [16]. In eastern Sudan, the absorbed dose rate ranged from 24-48 with an average value of 38 nGy h^{-1} in central Sudan it is estimated that the air intake dose at 1 m height is 31- 47 nGy h^{-1} and annual effective dose and 6 to 47.8 Svy^{-1}(Fadol N, et al., 2015) . In western Sudan a national environmental radiation monitoring program has been surveyed where the absorbed dose has been found to range from 500-7000 nGy h^{-1} [17]. Culture conservation by farmers or Non-governmental organizations that can promote these barely exist (Smith, et al., 2017), There is however great potential for improving the efficiency of agricultural practices while maintaining productivity and reducing risks to the environment for example improving soil management fertilizers chemical fertilizers and irrigation can be more than matching crop requirements and reducing the risk of losses to air and water [9].

1.2 Statement of the Problem

The problem was the spread of cancers and chronic diseases as a result of the widespread spread of radioactive materials in the Hasahisa area and the surrounding areas, which led to the pollution of the environment on a large scale as a result of the use of fertilizers and agricultural pesticides for long periods and excessive agricultural soil in the area, they (Isinkaye MO,et al., 2015). Everyone knows that the radioactive material can lead to health problems including cancer spread and chronic diseases all depending on the environment surrounding the person and the food that supports him entirely in his life Living organisms are constantly exposed to a wide range of ionizing radiation from a radioactive natural source and radionuclide's resulting from human activities known as artificial radionuclide's [12]. And all the vicinity of mankind food and drink and residence. This period witnesses recent spread of chronic diseases such as cancer and other barriers to humans and animals because of the proliferation of radioactive materials dramatically in some areas resulting in pollution of the environment broadly due to the incapability of man to get rid of the radioactive waste from the environment that threatens lives of all kids, it is well recognized that agricultural soils contaminated with mineral potential of various forms of fertilizers and agricultural chemicals that can easily enter the human body through the food chain toxic by (Chandrajith, et al., 2010) concerns about the entry of toxic heavy metals into the human food chain across all aspects of agricultural production have been given increasing attention in recent years. This is due to the potential health effects of some the trace elements present in the agricultural soil of the human body may be easily transported by food, Agricultural soils naturally contain trace elements that are essential for plant growth but these soils are also particularly vulnerable to degradation and pollution, trace elements may be provided in agricultural soils through agricultural practices such as fertilization irrigation pesticide use and disposal of organic waste [1].

Ground radiation in the soil may be dangerous to people depending on ways of transmission to people and internal and external exposure to gamma rays therefore it is very necessary to assess the concentration of natural radionuclide's in soil and water (Alnassar NA, et al., 2017) [18]. The aim of this project is to study the radio nuclides from the soil samples in the residential areas near the pesticides and fertilizers of the Gezira region of hassahisa stores. It has existed for more than half a century it is the core of the project unlike landslide landslides the tragedies caused by environmental pollution to a large extent much more subtle suddenly less failure but in the long run much more devastating to humans and the environment, There is now increasing scientific evidence that exposure to low levels of chemicals in studied (Dermatas, Dimitris. 2017) the general environment contributing to the burden of cancer society air, water and soil pollution mainly due to inadequate waste management and chemicals poses the greatest threat to disease and death in low- and middle-income countries [19]. In addition to the ingestion dose the rate of external dose can be estimated to be reasonable in some cases (eg, workers) Several methods can be used during estimating external doses of phosphate fertilizers one of the most common methods is to calculate the dose-absorbed rates as a result of gamma radiation in the air at 1 m above ground assuming a uniform distribution of PA-226, W-232 and K-40 based on the guidelines provided by UNSCEAR (Hegedus M, et al., 2017) [6]. World Health Organization (WHO) the Institute of Health Metrics and evaluation (IHME) and the Global Alliance for Health and

Pollution (GAHP) calculated that in 2012 exposure to contaminated soil, water and air resulted in an estimated 8.9 million deaths worldwide – 8.4 million of these deaths Occurred in low-income and middle-income countries by (Dermatas, Dimitris. 2017) some instruments are used in this project for the analysis of soil samples and verify the existence of the radioactive elements to the proliferation of chemical waste in the area the main motivation for this research is the spread of cancer in the residential areas located near those pesticides and fertilizer stores the disease has spread recently among a lot of villagers that inhabit the island within the project and near those stores of fertilizers and pesticides the chemicals and decomposition in the soil for many years leading to the soil around it and the surrounding environment pollution and this leads to the spread of radionuclide's significantly in those residential areas and that causes chronic diseases and cancer of the human beings in this region groundwater and soil pollution are closely related and as a result the methods used to purify soil indirectly affect groundwater and vice versa soil and groundwater are often threatened by pollution resulting from agricultural practices solid waste and disposal mining manufacturing and other industrial activities [19]. This significant research provides us with training and work in other areas having the same serious problems and bridges the gap of the lack of research dealing with this region.

1.3 Hypothesis of the study

From the site of pesticide stores of the project of the Aljazeera and at the station qureshi 4 kilometers north of hassahisa and in 1987 the great disaster of the largest environmental pollution known to Sudan and the African continent (Zaldivar R. 1977). Large amounts of barrels of poisonous pesticides, which have been banned because of their danger to living organisms and humans in particular these toxic substances contain

DDT and endosulfan (Dayana), which has been controversial around the world for the prohibition of contain carcinogenic deposits in the blood a statistically significant positive relationship between nitrate fertilizer exposure and gastric cancer mortality it was found that a study of the contamination of nitrate fertilizer in arable land was carried out in terms of the amount of nitrates used in the unit area (kg / ha) and the mortality rate in stomach cancer. The mortality rates of stomach cancer [20].

Due to the wrong storage in the open directly and for long periods led to the impact of barrels containing these deadly pesticides exposed to the heat of the sun and rain water led to the erosion of barrels by reverberations to the process of leaking large quantities of these pesticides on the ground directly people are exposed to ionizing radiation from radionuclide's found in different types of natural sources of which phosphate fertilizers are one of the most important sources radionuclide's in phosphate fertilizers belonging to the ^{232}Th series and ^{238}U as well as potassium isotopes of potassium (^{40}K) are the major contributors of natural terrestrial outdoor radiation (Ghosh D, et al., 2008) [21].

Cancer has become a widespread epidemic in the Aljazeera state to the extent that it became the first killer of the man of the Aljazeera project increased incidence of renal failure breast cancer repeated miscarriages and skin and eye allergies there are many reasons for the spread of the epidemic. The first is the accumulated causes of pesticide use over the years from the date of the Aljazeera project especially the aerial spraying of pesticides and parasitic plants vegetable and water sources as well as soil pollution however the pesticide graveyard is still active and is regularly sent in hazard warnings.

2 Objectives

The objective can be divided by:-

2.1 General objective

The main objective of this study is to investigate the carcinogenic radioactive materials of soil and water samples around the residential areas near the fertilizer stores and the pesticides for the agricultural Aljazeera project in Al-hassahissa area and its suburbs.

2.2 Specific objectives

1. Assessment of radionuclides from fertilizer and pesticide stores and comparison with ICRP
2. Evaluation of the concentration of uranium-238, thorium-232 and potassium-40 activity, levels of radioactive metals found in fertilizer residues and pesticides in soil
3. Determine a safe distance for the stability of the population of those fertilizers and pesticide stores, and should take into account the conditions in which they live near the population stores.
4. Identify the relationship between exposure to fertilizers and pesticides to radionuclide's for populations using data-related effects.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introduction in a few year go agreed dial of work has been done one

2.2 Surface Soil Quality

Considered soil factors and characteristics of the surface soil of the important components of agricultural environment. It supports the soil surface and subsurface to perform many of the functions of agriculture and human development. Understanding these factors would help to realize the values provided by our land and our land for mankind by (Usman, 2016) [22]. The environmental pollution and food safety of the most important issues of our time we have the (Lu Y, et al., 2015) in studied the effect of soil and water pollution in particular historically on the food which represents a significant threat to human health safety although the current use of pesticides is a less likely threat to the environment and human than ever before but these adverse effects are still a major long-term concern [23]. The good soil physical quality means that the availability of soil aeration and water are available and has a mechanical resistance is hostile to the proliferation of roots by (Tormena CA, et al., 2017) [24] Soil assessment by farmers and always in an agricultural perspective, However we will refer in this review that biological indicators are more sensitive to changes in other indicators (physical and chemical) and can describe the soil quality in the wider picture In this sense we must bear in mind that the demographic rapid development in all parts of the world may be tempted to make a high impact on soil quality especially if the "dynamic soil quality (That side of the soil quality of the characteristics of the soil which change as a result of the use of soil and management) should be quantified for this we need to provide sensitive and accurate tools to assess changes in they (Bastida F, et al., 2008) soil quality in a short time scale, Here we present an overview of the classic biological standards that can be used to assess soil and information that can be obtained through indicators of new tools and quality [25] A useful tool for assessing the effects of soil management on potential soil productivity and help managers Thasinala cropping conditions through administrative decisions management practices can improve crop productivity and soil potential by (Tormena CA, et al., 2017) [24]. Considered soil factors and characteristics of the surface soil of the important components of agricultural environment it supports the soil surface and subsurface to perform many of the jobs in agriculture economic and human developments by (Usman, 2016) [22]. Assessing soil quality (SQ) proactive process to evaluate the effects of soil management and crop biological chemical and physical soil health indicators by (Karlen DL, et al., 2014) [26]. It can refer to soil quality or soil ecosystem work because the organic material surface is essential for anti-corrosion (Franzluebbers AJ, 2002) [27]. Volatility is determined by the soil the main indicators of its own evaluation and guidelines could be developed for the management constraints and requirements necessary to improve productivity can be identified Site, Good understanding of the (Min XI, et al., 2015) volatility of the soil The task of crop production capabilities because it allows decision-makers and farmers to apply more rational agricultural techniques this rational crop management techniques include the application of fertilizers to produce higher crop yields as well as to reduce the risk of nutrient loss [28]. Cuts represent human origin in soil health the individual components of the quality of the soil a source of concern environmentally urgent a conference was held on "soil health biological management component of the quality of the soil" in the

United States in November 1998 to help raise awareness of the importance and usefulness of soil organisms as indicators of soil quality and soil health determinants it must be understandable and useful indicators for land managers who are the rulers end of the quality of the soil and the health of the soil (Doran JW, et al., 2000) in studies the living organisms visible such as earthworms insects and mold has historically met this standard Finally, indicators must be easy and inexpensive to measure but need to know the complexity of measuring the classification of organisms in the soil [29]. Due to the high agricultural pollution level is selected is to research and identify preventive measures against agricultural pollution of water systems is necessary measures may include both organizations and field applications by (PAVLIDIS, et al., 2018) [30]. Safe assumption that soil quality depends on many factors thus it is not reasonable to be based on assessments to two or less biological properties because it is unlikely to reflect they (Paz- Ferriro J,et al., 2016) the complexity of the systems therefore there is a recent evaluation of soil quality on the basis of many of the biological characteristics of the direction [31].

2.3 Soil Quality Indices

Soil quality indicator can be defined as a minimum set of parameters that when they are interconnected provide numerical data about the soil's ability to carry out one function or more soil quality indicator is a measurable property affect the soil's ability to do a particular job found all of the similarities and differences between the two points of view of the quality of the soil (farmers versus scientists), It was not the movement of they (Bastida F, et al., 2008) soil and waste on a large scale source of particular concern to farmers from the point of two of the views of view it can be considered that the soil texture the type of land and organic matter content thickness and color horizon and infiltration are indicators of soil quality [25]. Exposed to the quality of the soil threatened by the increase in population and the fact that most of the arable land is heavily used focused initial interest in this topic on determining soil quality but turned to how to measure the quality of the soil in the late nineties they (Paz-Ferriro J, et al., 2016) is general agreement that the biochemical properties of biological and microbiological and more convenient than the physical properties of the soil or chemical for the purpose of estimating changes in soil quality and thus soil degradation so far most used microbial biomass studies soil respiration and activities enzymatic for soil quality indicators [31]. The quality of the soil which is defined as the soil's ability to act appropriately in the natural environment or human systems and maintain the productivity of the plant animal and maintain human health and the environment, Although the concept of soil quality is relatively new but it has long been known that the soil naturally vary in terms of quality as a function of fundamental characteristics and this quality also depends on the type of use and management used, Moreover it may be appropriate to assess soil quality indicators in a timely manner suggesting improvement or stabilization or deterioration by (CHAVES, et al., 2017) [32]. Known as soil quality indicators to assess soil quality these are grouped sensitive to stress or disturbance by using numerical quality indicators obtained by several different types of road characteristics by (Rahmanipour F, et al., 2014) [33]. One way to integrate information from soil indicators process management decision is to develop soil quality index (Lima AC, et al., 2013) [34]

2.4 Sources of Soil Pollution

Soil quality is closely linked to agricultural production human health and environmental security by (Burges A, et al., 2015) [35]. Of all the pollutants in the soil form the heavy metal is a major concern because of the inherent toxicity bioaccumulation and persistence and the inability of the decomposition the heavy metal of granular materials when they are unwanted accidents or in the forms or concentrations of lead to adverse effects on human or ecosystem (He K, et al., 2017) in studies they although heavy metals rarely occur when toxic levels naturally but human activities intensive origin can radically change ride bikes chemical and bio-natural balances of some heavy metals [36]. It can contaminate soil and plants and enter the food chain, endangering human health risk by (Yan, et al., 2015) [37]. Polycyclic aromatic hydrocarbons (PAHs) are persistent organic pollutants have two rings Attack or more they (Morelay-Massei, et al., 2003) PAHs are prevailing in the environmental compartments such as the atmosphere surface sediments soil and water [38]. Regardless of their sources in the soil the accumulation of heavy metals can lead to the deterioration of the (Gao X, et al., 2010) soil quality reduces crop quality and productivity of agricultural products and thus adversely affect human and animal health and the ecosystem [39]. The surface soil of industrial land disposal sites related waste treatment is usually more polluted than those in other types of land uses including forest land and the protection of areas urban areas agricultural land and drinking water source the studies by (He K, et al., 2017) [36]. Functions include soil carbon changes nutrient cycling maintenance of the same structure regulation of biological groups activities are often such as mining agriculture forestry and waste disposal is responsible for (MORGADO, et al., 2018) studies the imbalance in the structure and functions of the soil by exposing the biological diversity functional ecosystem risk section [40]. The current situation is very serious in developing economies where waste management has badly for many years, Even if the waste collection properly often do not reach the legal disposal sites it has been neglected instead in they (CHAKRABORTY, et al., 2019) scattered and disorganized dumps. In addition to the current large number of waste unregulated dumps, often mixed industrial waste, municipal and hazardous together, which creates a toxic and dangerous conditions due to the mixing of many different types of waste [41].

2.5 Agricultural Sources

Agricultural pollution is a major concern for managers of environmental protection between pollutants nitrates and organic compounds phospholipids and pesticides from agricultural activities are the most common and dangerous to the environment and human health it has been many mitigation techniques to control these pollutants proposal from entering water systems agro forestry a common farming of crops and trees is one of these mitigation techniques can be seen that the roots of the trees in agro forestry systems able to reduce the remnants of nitrogen and phosphorus in the (PAVLIDIS, et al., 2018) soil from 20% to 100% and has the ability to reduce infiltration of pesticides and runoff in large quantities (up to 90% of surface runoff) and at the same time provide benefits additional ecological systems including control erosion improve soil quality and positive impacts on biodiversity [30].

2.5.1 Effective of Soil Pollution

Microbial community composition can result in the introduction of contaminated soil ecosystem to several types of general and specific changes in the composition of microbial community it is the function of contaminated concentration duration of exposure, and the ability of a compound to be analyzed by (MORGADO, et al., 2018) [40]. Cultivation of different crops systems provide positive and negative effects on the ecosystem of the soil services the direction of these effects depends on the management practices used for a particular system (Arriaga, et al.,

2017) the good management practices which include crop rotation and cover crops and reduced tillage will return economic and environmental benefits of positive on the ecosystems of the soil [42]. Interference of radioactive terrestrial and cosmic radionuclide's into the body through the food we eat and the water we drink and the air we breathe as with all chemicals the use of radionuclide's and eliminated by (NAJIB, et al., 2016) the body during normal metabolism some of radionuclide's degrade quickly but is replaced by inhalation or fresh inhalation degrade other radionuclide's more slowly have been concentrated in specific tissues of the body (such as radium in the bones) others are not easily absorbed by the gastrointestinal tract and is eliminated quickly [43]. Since the early twentieth century with the rise of the global consumption of the population and society the intensification of agriculture which have had a direct impact on the soil, water, air natural landscapes and biodiversity degradation continuous population growth which expects the united nations by (PAVLIDIS, et al., 2018) [30]. Among developing countries china is the largest exporter and importer of e-waste and receives about 70% of the total e-waste exported from developed countries other countries also imports such as Indian Pakistan they (CHAKRABORTY, et al., 2019) vietnam the Philippines and Malaysia are also a large amount of hazardous e-waste from developed countries [41].

2.5.2 Effective of Water Pollution

While water pollution began to receive the attention it deserves the contribution of agriculture requires more attention because current agricultural practices have an impact on the unprecedented water quality in some high-income countries it has overtaken agriculture pollution from settlements and built a leading factor in eutrophication in they (EVANS, et al., 2019) inland and coastal waters and the contamination of groundwater with nitrates and salts and can contribute to agriculture increased due to pollution to several fundamental factors including population growth changes in Demand for food and fuel and climate change [44]. Focused study of surface water pollution in the first place on the streams and lakes have been most of the scientific tools developed by regulatory agencies such as the US Environmental Protection Agency to protect the quality of water in this part of the surface of the Earth water application (WALKER, et al., 2019) water stored in reservoirs and lakes as well as water flowing permanently in the tables are subject to severe pressure and they are used in water agriculture industry and entertainment supplies can easily contaminate the water [45].

2.5.3 Naturally Occurring Radioactive Materials

Containing natural radioactive materials (NORMs) trace amounts of radionuclide's in the environment when the geological materials turbulent or converted from natural environments they (NAJIB, et al., 2016) provide improved concentrations of technically NORM higher than the radiation levels in the background because of human activities which may lead to a relative increase in radiation exposure and risks to the public and the environment radioactivity in the environment is mainly due to the presence of long-lived radionuclide's series of ^{238}U, ^{235}U and ^{232}Th and ^{40}K. supports distribution in the Earth's crust on the type of rock formation down the earth's crust [43]. Higher concentrations may arise as a result of human activities such as mining and metal processing in most NORM, there are several or all of the radioactive isotopes of the three primitive decomposition series (^{235}U, ^{238}U and ^{232}Th) in small concentrations in the natural matrix called the NORM artificially center sometimes TENORM an acronym for (KLU, et al., 2015) the natural radioactive materials improved technically [46]. Is NORM distributed widely and lead to natural background radiation varies depending on the location and height the underlying rock and soil properties on a site by

(MERDANOGLU, et al., 2006) [47]. In addition to NORMs terrestrial and cosmic sources, the introduction of natural radioactive materials technically improved (TENORM) radioactive man-made radionuclide's (artificial) in the environment because of the spread of various nuclear applications. These sources can contribute to the levels of radioactivity of natural background in a particular location by (KLU, et al., 2015) [46].

2.5.4 Sources of Natural Radiation

People are exposed in their daily lives to radiation natural radiation from space and ground soil and various materials containing radioactive material emitted humans are also exposed to radiation from medical and industrial applications that use radioactive sources radioactive materials and industrial However, they (TSILIKIS, et al., 2019) may come out of these radioactive sources from the control system and become an orphan sources because these sources of radiation are usually found inside the metal such as lead shields and iron [48]. However, although the active substances of pesticides tend to replace them with new materials less hazardous to the environment but the risk of residues and their metabolites are still ongoing and should be reduced as much as possible by (PAVLIDIS, et al., 2018) [30].

2.5.5 Terrestrial Radionuclide's

Radiation that originates on Earth terrestrial radiation is called found radionuclide's primitive (radioactive chemicals that existed when the Earth was formed about 4.5 billion years ago) worldwide in firearms and sedimentary rocks (NAJIB, et al., 2016) radionuclide's migrate to the soil, water, and even air as human activities such as uranium re-distribution of these radionuclide's extract radionuclide's include primitive radionuclide's produced when uranium decays and thorium series as well as potassium-40 and rubidium -87 [43]. Which led to the direct release of heavy metals in the environment waste from non-organic fertilizers and fungicides are another source of heavy metals that can be up to the waste dumps with the exception of some of the poorest developing countries in the world where there are less than (CHAKRABORTY, et al., 2019) the quantities of fertilizers used all other countries of fertilizer nutrients applied to agricultural soils [41].

2.5.6 Artificial Radionuclide's

If the polluter is very toxic or very high concentrations it can reduce the abundance of all existing soil microorganisms because of the decomposition of the cells or death in contrast if contaminated with the introduction of moderate concentrations can also be used as a source of carbon and energy for microbial soil you may notice a general increase (MORGADO,et al., 2018) in studied the abundance of micro-organisms (bacteria, fungi and proteins) [40]. Enters the contamination of natural and artificial radionuclide's in the environment to the human body through inhalation and ingestion and food is considered the main road by (HO, et al., 2018) [49]. Lead - 210 radionuclide's is very useful in environmental studies it can be used for vertical distribution in the soil in addition to Radium-226 to evaluate the escape of Radon-rate 222 of the earth (PADOVANI, et al., 2018) studied the data is very useful for assessing the annual dose for humans in addition the lead shows - 210 and its product decomposition Polonium - 210 in the most toxic radionuclide's group responsible for most of the internal radiation dose to humans [50]. Can occur environmental problems such as soil pollution water pollution and contamination of groundwater through the release of inorganic contaminants due to non-effective disposal of this waste is organic they (CHAKRABORTY, et al., 2019)

the methods used by developing countries such as the burning of electronic equipment in landfills application making these sites a major source of heavy metals in the surrounding environment [41].

2.5.7 Fate and Distribution of Radionuclide's in the Environment

Metal dispersion can be in the soil, water and air minerals in the aquatic environment soil and agricultural dispersed in surface water sediment by stability in the sediment and suspension Kdzeiat in surface water in the case of surface water and groundwater sediment and air availability the bioavailability is a complex function of many factors including total concentration characteristics (physical and chemical forms) for metals by (KLU, et al., 2015) [46]. Radiation comes from outer space from the ground and even inside our bodies radiation exists around us and was present since the birth of the planet this type of radiation is called background radiation emitting background radiation (which scientists called "background radiation everywhere") of each of the radioactive chemicals of natural and human (radionuclide's) There are some radionuclide's naturally occurring in the ground down our feet while (NAJIB, et al., 2016) in studied the atmosphere is produced by some other radiation from space entered the radionuclide's of man-made in the environment through activities such as medical procedures used radionuclide's to depict the body and generate electricity that use radioactive uranium as fuel [43]. Increasing awareness of environmental protection from radiation among workers in the mining site is necessary to enhance safety and health this is particularly important as a result of natural evolution in they (IDRISS, et al., 2018) different areas of scientific research for a better life human evolution is constantly looking into the ground to check the secrets of the universe and increase their wealth [51].

2.5.8 Radionuclide in the Body

Interference of radioactive terrestrial and cosmic radionuclide's into the body through the food we eat and the water we drink and the air we breathe as with all chemicals the use of radionuclide's and eliminated by the body during normal metabolism some of radionuclide's degrade quickly but is replaced by inhalation or fresh inhalation. Degrade other radionuclide's more slowly have been concentrated in specific tissues of the body (such as radium in the bones) others are not easily absorbed by the gastrointestinal tract and is eliminated quickly by (NAJIB, et al., 2016) [43]. Direct absorption through the aerial parts of the plants these radionuclide's when they accumulate over a period of time in food and water natural way direct exposure to the population of human beings when their consumption by (MUSTAKIM, et al., 2018) [52]. The radiation detection devices developed against the necks of the people measured exposure rates due to emissions resulting from the radioactive decay of gamma irradiation for 131 in the thyroid gland they (KUTSEN, et al., 2019) Because of the contamination of the external and internal radiation of persons subject to control gamma radiation contributed to many of the radionuclide's in different locations in the high exposure rates recorded by the detectors To accurately estimate the contribution of emissions from various internal and external parts of the body gamma rays [53].

2.5.9 Effect of Radiation on Human

Radioactive substances naturally occurring representing approximately 80% of human exposure to natural radiation which is the second leading cause of cancer after tobacco The long-term uranium exposure through inhalation has many health effects such as chronic lung disease and anemia leucopenia and necrosis of the (KLU, et al., 2015) in studied the mouth causes radium bone tumors and cranial nasal [46]. Heavy metals can pose a potential threat to human health through chronic exposure to contaminated soil particles and consumption of contaminated crops it reported that heavy metal contamination in the soil can promote the causes of mouth cancer the calculated risk index based on food consumption ingestion of soil and absorb much higher than one skin which indicates the presence of an adverse health effect is obvious on the population 87.5% of the risk came from eating and 10.5% of skin absorption and the remaining 2% resulting from ingestion of soil by (HUANG, et al., 2018) [54]. Resulted in the accumulation of toxic chemical contaminants and pathogens in the soil-borne soil to increase human exposure either through inhalation or skin contact or ingestion of soil or indirect exposure through food intake or drinking water, they (MERDANOGLU, et al., 2006) Therefore, it is important to develop tools to assess potential human exposure to pollutants and to determine concentrations of risk threshold meaningful in the soil in order to protect human health [47]. Constitute a serious contaminant fertilizer where it is washed in the rain or flooding rivers and various tables most fertilizers contain phosphate products potassium and nitrate this material nutrient for plants but some of them constitute a serious health hazard especially infants due to (NAJIB, et al., 2016) in studied the intervention of the chemical in the transfer of oxygen in the blood [43].

Radiation leads to human or any other material tissue damage through ionization of atoms ionizing radiation absorbed by human tissue has enough energy to remove electrons from the atoms that make up the tissue molecules very simple terms when an electron is shared by the atoms that form a molecular association is broken association offset and they (KUTSEN, et al., 2019) breaks down the molecule this process may occur by "injury" directly to these atoms or may result indirectly free radical formation due to the irradiation of neighboring molecule the most sensitive in the cell structure is the DNA molecule which carries the genetic blueprint of the cell and indeed the whole of the object if the damage is not repaired radioactive DNA the cells fail to survive or reproduce if cells remain insufficient loss of tissue or organ function may occur alternatively you may be repairing the damage is incomplete or incorrect until the cells continue to divide but to turn cancerous [53]. They also have the attention of agricultural researchers around the world because of their ability to maintain the quality and quantity of production at high levels at one time with the limit The environmental footprint of agriculture and support sustainable agriculture in tropical and temperate regions by (PAVLIDIS, et al., 2018) [30]. Alpha particles interact strongly with human tissue through the transfer of energy interact strongly beta less than alpha particles which allow them to travel farther through the tissue before the transfer of energy particles. The difference between the effects of alpha particles and beta is (KISS, et al., 1988) studied the concentration of tissue damage the alpha particles can damage many of the molecules on a short distance while the beta particles may damage the particles scattered over a greater distance the extent of damage depends on the energy of emitted alpha particles or individual beta [55].

2.5.10 Methods and Instrumentation for Assessment of Naturally Occurring Radioactive Materials (NORMS)

There are many different types of methods and tools available to measure ionizing radiation in environmental samples the methodology that should be used on the type of site and the stage of the project which is being investigated, and the levels will be determined by the contamination at the site and the specificity of the analysis required by (KLU, et al., 2015) [46]. Represent long-half-life radionuclides such as uranium at the present time along with other toxic trace elements important class of inorganic contaminants to be monitored human activities affect distribution of natural radioactivity on the ground resulting from the conversion of natural resources that contain natural radioactive material (NORM) sub-products found their way into the environment. In addition, radioactive materials naturally occurring technologically (TENORM) they (ESCARENO-JUAREZ, et al., 2019) also be produced through human activities are modifying the distribution of radionuclide's on the ground constantly. Finally affected natural accidents including geological and seismic events and the walls of the forest the distribution of natural radioactivity [56]. NORMs are substances that may contain any of the primitive radionuclide's or radioactive elements uranium - 238, thorium - 232, potassium - 40 occurring in nature and products of radioactive decay importance of long life of radioactive elements including uranium 238, thorium 232, potassium 40 and none of the decomposition of radioactive material products such as radium and radon these elements were always present in the earth's crust and within the tissues of all living organisms there NORM in a wide range of bulk commodities processes waste and commercial materials sand, mud, soil, rocks, coal, groundwater, oil in they (KLU, et al., 2015) addition to gas metal ores and minerals non-metallic including raw materials for fertilizers such as rock phosphate and apatite it includes metal ores found related to NORM tin tantalum niobium and rare copper gold and dust [46].

2.5.11 Gamma Spectrometry

Gamma radiation is a form of electromagnetic radiation or light emissions at a certain frequency resulting from the interactions of subatomic particles such as radioactive decay gamma radiation is generally regarded as a light has a higher frequency and energy as well as the shortest wavelength within the light spectrum as a result of higher content of energy the gamma rays capable of causing serious damage when absorbed by living cells by (NAJIB, et al., 2016) [43]. The use of high-resolution widely in identifying radionuclide's in environmental samples gamma spectrometer you can determine the concentration of radioactive substances that occur naturally by gamma rays account of the decay daughter NORM using the spectral analysis of standard gamma rays with (KLU, et al., 2015) in studied the detector HpGe techniques or Na I , It is possible to determine gamma emitters sample directly and to obtain qualitative and quantitative identification of the radionuclide in the sample all used this method to evaluate the various environmental samples radionuclide naturally occurring [46].

2.5.12 Characteristics of a Gamma Spectrum

There are a number of processes through which gamma rays interact with the material based on the way the reaction that causes full absorption or scattering (elastic or non-elastic) for gamma rays the possibility of a particular process of interaction on the energy of the photon falling and atomic number of the target material and the angle of scattering and engineering conditions depends in the intermediate energy that is considered in the scope of the current work by (SINGH, et al., 2018) [57]. There are three ways in which the gamma photon that interacts with the matter and you must understand each type of interaction to properly interpret the spectral data using either the gamma detector NaI (Tl) or HPGe the three patterns of interaction in the absorption and scattering of photoelectric and Compton pair production. Probability or cross-section for each of these reactions is a function of the energy of the gamma photon incident for the measurement of gamma-ray spectrum the absorption Photoelectric is the preferred method of interaction because it produces peak power images in full spectrum which is used to measure and identify radionuclide's if the photon interaction with the detector material by scattering Compton, there is a loss of energy from the photon incident which is transferred to an electron recoil because the energy loss is a function of the angle of scattering and all angles are possible this dispersion interaction leads to the continuity of Compton that is observed in the gamma spectrum as an increase in the background spectral by (NAJIB, et al., 2016) [43]. The pair production process absorbs all the photon gamma energy of the beam and creates an electron-positron pair within the active size of the detector. Then when the positron loses energy it will combine with an electron resulting in the annihilation of the charged particles and the release of two photons of annihilation with a capacity of 511 kV depending on the size of the detector any of the 511keV annihilation photons or both can escape the active size of the detector if each of the 25 photons of the active detector survives a "double escape peak" will be observed in the gamma spectrum located at 1022 kV below the full power peak it is also possible to obtain a "single escape peak" located at 511 kV below full power peak if only one of the annihilation photons escaped from the detector size by (NICHOLLS, et al., 1989) [58].

To make sure that detect low background used in measuring the spectrum of gamma-ray machines are usually surrounded by at least a shield of lead. Also (Tl) and HPGe in aluminum casing is used crystals used in each of NaI detectors these different materials about the detector interaction with radiation from the source of the sample and causing additional background structure in the gamma spectrum (FRIEDLANDER, et al., 1981) studied the facing the same reactions that occur inside the detector with these materials surrounding the reagent However, these external interactions reagent has a different effect on the background spectrum [59]. It can result in absorption of radiation by the photoelectric shielding against bullets and other materials to the surrounding reagent characteristic X-ray in the low power area in the gamma spectrum appearance for example X-rays and Kα Kβ always existed almost as part of the background in the gamma spectrum they (MOORE, et al., 1958) are shields to detect gamma and commercially lined with cadmium and copper are available to reduce the level of X-rays in the background. In addition to the X-ray Lead, can X-ray characteristic ends of any substance found near the source and the detector in a nice background [60].

2.5.13 Alpha Spectrometry

Alpha particles positively charged, a large-sized (for electrons) easily interact with the media that intersect with it and dissipate energy quickly for example it is stopped 5.5 MVA (typical of the energy emitted from many of actinides), and therefore protected by a few centimeters of air or about 0.04 mm of human tissue alpha particles are absorbed in the skin (i.e. the outer layer of the skin). Alpha particles do not penetrate the outer layer of dead skin and thus pose little radiation risk. However if inhaled or ingested alpha emitters may be very harmful to the internal tissues Alpha particles are highly ionized but have a very low penetration in the tissues the alpha cannot penetrate the upper layers of the skin of a particle (FRIEDLANDER, et al., 1981) in studied the However, if swallowed source emits alpha it can be severe health effects because alpha particles are the most harmful forms of radiation. Beta particles are less harmful but have greater penetration of alpha particles and can cause DNA mutation and cell damage. It has been harnessing the effects of this type of radiation in medical treatment of radiation to kill cancer cells [59].

CHAPTER THREE

MATERIALS AND METHOD

3.1 Study Area

Fertilizers and pesticides stores are located in Al-Jazeera agricultural project west of Alhassahesa city and in Qureshi station at 4 km north of Alhassahesa city. These stores are located on an area of about 2 kilometers from the land, and the number of these stores about eight stores very large area of one store 40 m in 120 and at a height of approximately six meters, and the distance between each Jabalon and the other approximately 20 meters

These stores have a wall from the north and south side only but from the west side and the way does not have a wall, as well as there are some residential areas very close to them as a Qurashi station located 500 meters from these stores in the south-west of these stores while the other residential areas farther compared In Qurashi Station Area there are also some random places that are almost adhered to these stores and used for food and tea vendors for the workers of these stores and those who cross the road and owners of heavy vehicles located in that place.

The stores can be show in figure 3.1.

Fertilizers and pesticides stores for Al-Jazeera agricultural project- Al-hasahissa

Figure 3.1: a picture of the stores of fertilizers and pesticides of the Aljazeera project in Alhassahisa

3.2 Sampling Sites

There are 80 Soil samples were collected from around the pesticide and fertilizer stores of the Gezira Agricultural Project near the town of Al-hassahisa, Gezira State central Sudan. An image of pesticide and fertilizer stores locations is shown in Figure 3.1.

Figure 3.2: Map of the stores of fertilizer and pesticides Aljazeera agricultural project

3.3 Sample Collection and Preparation

These samples were randomly taken from four locations in a direction north, south, east and west for pesticide and fertilizer stores for Al-Jazeera agricultural project near Alhassahisa city in Aljazeera state Sudan using Oker soil sampling device (20 -25) cm deep in the ground to obtain natural soil sampling locations were determined approximately 200 meters for each direction from the source 0.5 kg was taken for each sample from the four sides of the source samples were sorted and weighed to obtain a homogeneous fine powder Samples were then placed with half a kilogram Marinelli beakers and the beakers were sealed for a while about 4 weeks to reach secular equilibrium between the thorium and radium contents of the sample and their daughters (DIAB, H. M., et al., 2008) [61].

3.4 Gamma-Ray Spectroscopy

The quantitative study of the energy spectra of gamma-ray sources such as in the nuclear industry geochemical investigation and astrophysics most radioactive sources produce gamma rays which are of various energies and intensities when these emissions are detected and analyzed with a spectroscopy system a gamma-ray energy spectrum can be produced.

A detailed analysis of this spectrum is typically used to determine the identity and quantity of gamma emitters present in a gamma source and is a vital tool in radiometric assay. The gamma spectrum is characteristic of the gamma-emitting nuclides contained in the source just like in an optical spectrometer the optical spectrum is characteristic of the material contained in a sample.

The radioactivity analysis was performed at the laboratories of the Sudan Atomic Energy Commission (SAEC) by means of NaI(Tl) detector in gamma-ray spectrometer with builtin electronics connected to a computer through a universal serial bus interface the spectra were analyzed using ‘‘Win TMCA32 target’’ Gmbh, Germany software detector calibrations were performed using a source of multiple
radionuclide's in a similar container background level measured with empty beaker was deduced from both standard and samples in the analysis. Quality control was conducted with the aid of three referenced materials (RGK^{-1}, RGU^{-1} and $RGTh^{-1}$) fetched from the ‘‘International Atomic Energy Agency (IAEA).’’ Soil samples were counted for at least 3 h in order to obtain clear spectra with sufficient counting statistics the activity concentration of potassium (^{40}K) was evaluated from its 1461 keV gamma emission line that of ^{238}U was determined indirectly from the 295 eV (^{214}Pb) and 609.3 keV gamma ray energy (^{214}Bi). The activity

concentration of 232Th was derived from the 583 and 911 keV peaks of208Tl and 228Ac, respectively.

3.5 Components of a Gamma Spectrometer

The main components of a gamma spectrometer are the energy-sensitive radiation detector and the electronic devices that analyses the detector output signals such as a pulse sorter (i.e., multichannel analyzer). Additional components may include signal amplifiers; rate meters peak position stabilizers and data handling devices.

3.6 Detector

Gamma spectroscopy detectors are passive materials that are able to interact with incoming gamma rays the most important interaction mechanisms are the photoelectric effect the Compton effect and pair production. Through these processes the energy of the gamma ray is absorbed and converted into a voltage signal by detecting the energy difference before and after the interaction, The voltage of the signal produced is proportional to the energy of the detected gamma ray.

To accurately determine the energy of the gamma ray it is advantageous if the photoelectric effect occurs as it absorbs all of the energy of the incident ray absorbing all the energy is also possible when a series of these interaction mechanisms take place within the detector volume with Compton interaction or pair production a portion of the energy may escape from the detector volume without being absorbed the absorbed energy thus gives rise to a signal that behaves like a signal from a ray of lower energy this leads to a spectral feature overlapping the regions of lower energy using larger detector volumes reduces this effect.

3.7 Samples analysis

The figure shows the energies of the elements present in the soil samples according to the counting time for each element energy in the form of peaks as in the figure below

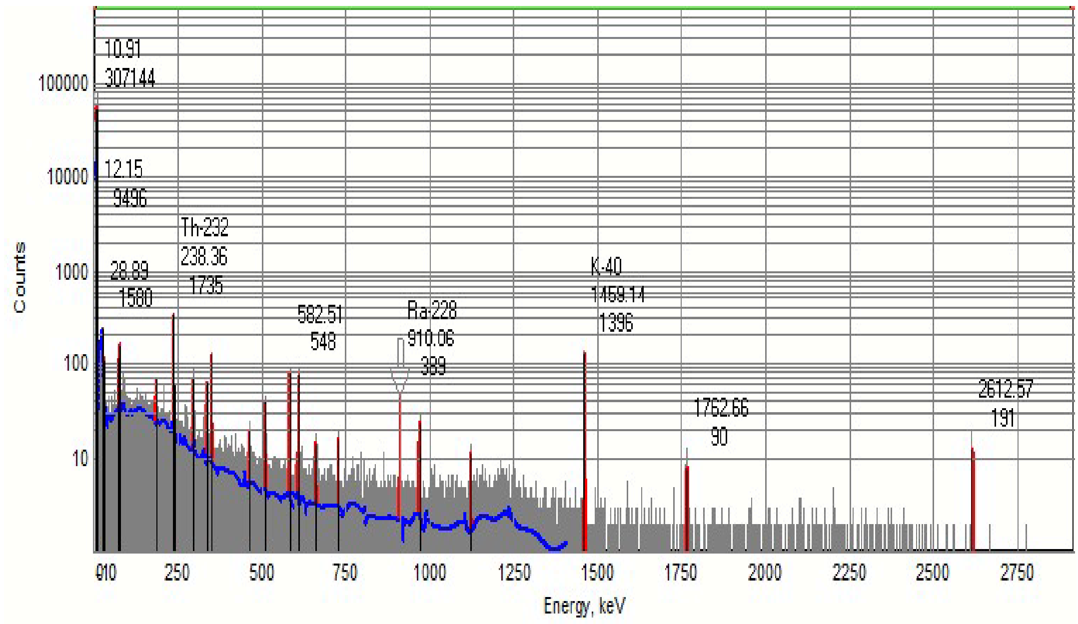


Figure 3.3: the sample analysis by Gamma-spectrum processing

The soil samples were crushed into a fine powder and sieved through a 100-lm sieve. The samples were then sealed in 500-ml plastic containers for approximately 4 weeks to allow radon (half-life 3.8 days) and its short-lived decay daughters 214Bi and 214Pb, to reach secular equilibrium with the long-lived 226Ra precursor in the samples the sample weights ranged to 500 g. A background sample was also prepared using a similar empty container multichannel analyzer which was used for data acquisition and analysis of gamma spectra. The spectrometer was tested for its linearity and then calibrated for energy using gamma sources supplied by the International Atomic Energy Agency Vienna. This was achieved by collection of spectra data from standard sources with energies in the range of 0.25–2.62 MeV. The channel numbers of the photopeaks corresponding to the different gamma energies were recorded after 900 s, and the energy-channel linear relationship was obtained. Activity concentrations of the samples were determined using the net area under the photo peaks using Eq.(3.1). The activity concentration ($Bq.kg^{-1}$) of ^{232}Th was determined from the photo-peaks of 208Tl (583 keV) and 228Ac (911 keV); that of ^{226}Ra was obtained from the gamma-lines of ^{214}Pb (352 keV) and ^{214}Bi (609 keV); and that of ^{40}K was measured directly from the photo-peaks at 1460 keV. This spectral analysis was performed with the aid of computer software Genie 2000 obtained from CANBERRA. The software uses an interactive photo-peak fit that corrects for interferences from various energies manual calculations were also performed to validate the results by defining the region of interest for each energy obtained for the sample and comparing it with the reference material (has the same matrix). The detection limit was required to estimate the minimum detectable activity in a sample, and it was (IDRISS, Hajo, et al., 2018) [51].

Figure 3.4: Analysis of Samples in the Laboratory Sudanese Atomic Energy Agency in Khartoum by Gamma-Ray Spectrometer.

3.8 Activity Concentration of the Soil

The activity concentrations in the soil the detection limit was required to estimate the minimum detectable activity in a sample and it was obtained using the equation given elsewhere detection limits obtained were 2.7 $Bqkg^{-1}$, 9.2 $Bqkg^{-1}$, and 0.2 $Bqkg^{-1}$ for ^{226}Ra and ^{232}Th, and ^{40}K, respectively (IDRISS, Hajo, et al., 2018) [51]

$$A_c\,(Bq/kg) = C_n / P_\gamma\, M\varepsilon \quad (3.1)$$

where A_c is the activity concentration of the radionuclide in the sample given in Bq/kg; C_n is the net count rate under the corresponding peak; P_γ is the absolute transition probability of the specific γ-ray; M is the mass of the sample (kg); and e is the detector efficiency at the specific γ-ray energy.

3.9 Calculation of Absorbed Dose Rate from Measured Activity Concentration for the Stores of Fertilizer and Pesticides, Aljazeera Agricultural Project

Radiation emitted by a radioactive substance is absorbed by any material it encounters. (UNSCEAR, 2008) has given the dose conversion factors for converting the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K into dose ($nGyh^{-1}$ per $Bqkg^{-1}$) as 0.461, 0.623 and 0.0414, respectively. Using these factors, the total absorbed dose rate in air is calculated as given in the Equation (3.2) (UNSCEAR, 2008).

$$D\,(nGyh^{-1}) = (0.461A_{Ra}) + (0.623A_{Th}) + (0.0414A_K) \quad (3.2)$$

where A_{Ra}, A_{Th} and A_K are the activity concentrations ($Bqkg^{-1}$) of radium, thorium and potassium, respectively in the samples (HILAL, M. A., et al., 2014) [63].

3.10 Calculation of Annual Effective Dose (E)

The estimation of the annual effective dose rates from the stores of fertilizer and pesticides depends on conversion coefficient from absorbed dose to effective dose as $0.7SvGy^{-1}$ and outdoor occupancy factor of 0.2 as proposed by (UNSCEAR, 2008). The effective dose rate in units of μSvy^{-1} was calculated by the following formula in equation (3.3) [62]

$$E(\mu Sv/year) = D\,(nGh^{-1}) \times 24h \times 365.25\,day \times 0.2 \times 0.7SvGy^{-1} \times 10^{-3} \tag{3.3}$$

3.11 Radium Equivalent Activity (Ra_{eq})

Radium equivalent in ($Bq\ kg^{-1}$) was calculated from equation (3.4) (NAJIB, M. U., et al., 2016) [43].

$$Ra_{eq} = A_{Ra} + 1.43A_{Th} + 0.077A_K \tag{3.4}$$

where A_{Ra}, A_{Th} and A_K are the activity concentrations in ($Bq\ kg^{-1}$) of ^{226}Ra (^{238}U), ^{232}Th and ^{40}K, respectively.

3.12 External Hazard Index (H_{ex})

Radiation exposure due to ^{226}Ra, ^{232}Th and ^{40}K may be external. This hazard defined in terms of external hazard index or indoor radiation hazard index and denoted by H_{ex}, can be calculated using the equation (3.5) (NAJIB, M. U., et al., 2016) [43].

$$H_{ex} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \tag{3.5}$$

Where A_{Ra}, A_{Th} and A_K are the activity concentrations ($Bqkg^{-1}$) of radium, thorium and potassium, respectively as obtained in the analyzed samples. The value of this index should be less than $1mSvy^{-1}$ in order for the radiation to be considered acceptable to the public.

3.13 Annual Gonadal Dose Equivalent (AGDE)

The AGDE was computed from ^{238}U, ^{232}Th and ^{40}K activity using equation (3.6) (UNSCEAR, 2000) [64].

$$AGDE(\mu Sv/year) = 3.09A_{Ra} + 4.18A_{Th} + 0.314A_{K} \quad (3.6)$$

3.14 Excess Life Time Cancer Risk (ELCR)

ELCR was estimated using equation (3.7) (IDRISS, Hajo, et al., 2018) [51].

$$ELCR = E \times DL \times RF \quad (3.7)$$

Here, ‘‘DL’’ is the life expectancy, 63 year for Sudan, (WHO 2015) and RF is the cancer risk factor for each Sievert, which is randomly assessed by the International Commission on Radiological Protection (ICRP) (1990) at 0.05 for the public .

CHAPTER FOUR

RESULT AND DISCUSION

4.1 Introduction

Spectroscopy was done in determining radionuclide's in soil samples by using the radiation spectra obtained from soil samples to obtain the concentration of radioactivity in units of Becquerel per kg, from of 40K, 226Ra, 228 Ra, 232Th, and 137Cs collected from the areas around the stores of fertilizers and pesticides for the Al-Jazeera agricultural project west of the city of hassahesa .

4.2 Activity Concentration for the Stores of Fertilizer and Pesticides, Al-Jazeera Agricultural Project

The activity concentration± standard deviation of the five fundamental radionuclide's ^{40}K, ^{226}Ra, ^{228} Ra, ^{232}Th, and ^{137}Cs were measured an average of 268.98 ± 5.22 $Bq.Kg^{-1}$, 14.54 ± 0.2 $Bq.Kg^{-1}$, 15.31 ± 1.54 $Bq.Kg^{-1}$, 20.45 ± 0.96 $Bq.Kg^{-1}$, and 0.34 ± 0.19 $Bq.Kg^{-1}$ respectively were obtained. The minimum activities for ^{40}K, ^{226}Ra, ^{228} Ra, ^{232}Th and ^{137}Cs were found to be 232 $Bq.Kg^{-1}$, 11.6 $BqKg^{-1}$, 15.31$Bqkg^{-1}$, 14.43 $Bqkg^{-1}$, 0 $Bqkg^{-1}$, while the maximum values were 321.75 $Bqkg^{-1}$, 18.33$Bqkg^{-1}$, 24.05$Bqkg^{-1}$, 27.28 $Bqkg^{-1}$, and 1.37 $Bqkg^{-1}$ respectively.

Tables 4.1, 4.2, 4.3, 4.4 shows the activity concentrations of the natural radionuclide's in all the sampling sides for south, north, east, west respectively. Table 4.5 shown the mean activity concentrations and the range for the five natural radionuclide's ^{40}K, ^{226}Ra, ^{228} Ra, ^{232}Th, and ^{137}Cs in all the sampling sides.

Table 4.1 Activity Concentration of the natural radionuclide's ^{40}K, ^{226}Ra, ^{228}Ra, ^{232}Th, ^{137}Cs. Measured in this work for south site.

Sample Code	K-40 (Bq.kg)	Ra-226 (Bq/kg)	Ra-228 (Bq/kg)	Th-232 (Bq/kg)	Cs-137 (Bq/kg)
SS1	249	16.9	12.9	16.1	0.98
SS2	235	13.2	10.4	15.3	0.86
SS3	336	20.3	17.7	17.5	0
SS4	305	15.1	15.2	19.4	1.35
SS5	330	17.1	15.9	16.6	2.22
SS6	293	18.4	14.2	15.3	0
SS7	280	17.2	14.5	16.8	0.88
SS8	274	15.5	15.2	21.6	0
SS9	260	15.5	15.2	22.7	0
SS10	267	16	13.5	15.7	1.07
SS11	272	15.2	22.3	20.7	0.95
SS12	279	14.8	13.5	20.8	0
SS13	280	15.8	15.3	15.4	0
SS14	246	13.9	20	20.9	0
SS15	254	16.2	25.3	20.2	0
SS16	303	16.3	14.1	20.3	0
SS17	240	11.8	10.2	23.8	0
SS18	284	13.7	14.2	25.1	1.64
SS19	231	14.8	20.2	23	0
SS20	265	13.8	13.2	25.1	0
MIN	231	11.8	10.2	15.3	0
MAX	336	20.3	25.3	25.1	2.22
AVERAGE	274.15	15.575	15.65	19.615	0.4975
STDV	29.02	1.91	3.77	3.34	0.69

SS= samples taken from south location of source

Table 4.2 Activity Concentration of the natural radionuclide's ^{40}K, ^{226}Ra, ^{228}Ra, ^{232}Th, ^{137}Cs. Measured in this work for north site.

Sample Code	K-40 (Bq/kg)	Ra-226 (Bq/kg)	Ra-228 (Bq/kg)	Th-232 (Bq/kg)	Cs-137 (Bq/kg)
NS1	273	11.4	20.9	27.4	1.04
NS2	292	11.1	20.5	23.9	0
NS3	275	12.4	21	16.4	0
NS4	311	12.2	7.2	30.1	1.03
NS5	283	11	8.3	24.9	1.28
NS6	287	11.8	6.4	15.8	0
NS7	286	11.6	23.8	25.9	0
NS8	283	12.3	21.9	17.8	1.01
NS9	257	11	8.3	23.6	0.8
NS10	302	14.9	23.8	27.9	0.69
NS11	279	10.6	3	16.3	1.25
NS12	249	12.4	15.7	16.9	0
NS13	310	13.8	10.7	18.4	1.24
NS14	311	13.6	10.7	26.6	0
NS15	288	12.5	8.7	22.3	0
NS16	291	14.2	21.9	23	0.95
NS17	294	13.8	12	21.3	0
NS18	339	15.3	14.4	16	1.21
NS19	281	13.5	11.4	17.6	0
NS20	258	14.1	20	14.7	0
MIN	249	10.6	3	14.7	0
MAX	339	15.3	23.8	30.1	1.28
AVERAGE	287.45	12.675	14.53	21.34	0.525
STDV	20.97	1.39	6.65	4.82	0.56

NS= samples taken from north location of source

Table 4.3 Activity Concentration of the natural radionuclide's ^{40}K, ^{226}Ra, ^{228}Ra, ^{232}Th, ^{137}Cs. Measured in this work for east site.

Sample Code	K-40 (Bq/kg)	Ra-226 (Bq/kg)	Ra-228 (Bq/kg)	Th-232 (Bq/kg)	Cs-137 (Bq/kg)
ES1	288	13.4	16.3	21	0
ES2	258	13.4	15.1	24.7	0
ES3	269	12.8	9.6	26.7	0
ES4	239	16.5	20.1	23.2	0.58
ES5	261	17.9	13.2	18.3	0
ES6	246	17.9	22.9	15.6	0
ES7	243	14.7	11.9	19.5	0
ES8	228	14.2	20.8	12.8	0
ES9	262	14.8	15.3	31.4	0
ES10	260	15.2	14.1	29.3	0
ES11	233	16.5	12.1	13.5	0.9
ES12	271	20.3	14	23.1	0
ES13	331	16.4	16.7	23.4	0
ES14	264	17.5	13.7	21.8	0
ES15	267	15.4	11.1	16.8	0.81
ES16	265	14.6	12.5	22.6	0
ES17	222	18.2	24	22.9	0
ES18	251	19.8	21.1	16.2	0
ES19	304	14.9	15.3	16.5	0
ES20	291	16.5	15.2	20.9	0
MIN	222	12.8	9.6	12.8	0
MAX	331	20.3	24	31.4	0.9
AVERAGE	262.65	16.045	15.75	21.01	0.1145
STDV	26.24	2.08	4.03	4.96	0.28

ES= samples taken from east location of source

Table 4.4 Activity Concentration of the natural radionuclide's ^{40}K, ^{226}Ra, ^{228}Ra, ^{232}Th, ^{137}Cs. Measured in this work for west site.

Sample Code	K-40 (Bq/kg)	Ra-226 (Bq/kg)	Ra-228 (Bq/kg)	Th-232 (Bq/kg)	Cs-237 (Bq/kg)
WS1	248	14.5	20.4	25.3	0
WS2	270	17.4	22.6	20.6	0.81
WS3	263	15.5	11.9	16.4	0.73
WS4	239	13.3	18.7	19.6	0
WS5	281	13.9	21.5	16.9	1.08
WS6	251	14.1	12	19.4	0
WS7	235	13.7	18.8	16.4	0.71
WS8	253	15.6	14.2	18.2	0
WS9	248	14.2	12.9	22.2	0
WS10	277	16.6	10.6	16.5	0
WS11	237	14.7	7.4	17	0
WS12	269	16.4	20.2	22.2	0
WS13	232	13.9	21.1	21.8	0
WS14	275	11.8	23.1	23.8	0
WS15	267	12.3	22.4	25.3	0
WS16	233	11.2	4	14.9	0
WS17	245	11.8	6.1	18	0
WS18	256	12.9	22.2	17.6	0.73
WS19	227	11.8	9	22.2	0
WS20	227	11.6	7.1	22	0
MIN	227	11.2	4	14.9	0
MAX	281	17.4	23.1	25.3	1.08
AVERAGE	251.65	13.86	15.31	19.815	0.203
STDV	17.39	1.81	6.45	3.15	0.37

WS= samples taken from west location of source

Table 4.5 Mean Activity Concentrations for the five natural radionuclide's ^{40}K, ^{226}Ra, ^{228}Ra, ^{232}Th and ^{137}Cs measured in this work

Activity Concentrations (Bq/kg)

Site	**^{40}K (Bq/kg)**	**^{226}Ra (Bq/kg)**	**^{228}Ra (Bq/kg)**	**^{232}Th (Bq/kg)**	**^{137}Cs (Bq/kg)**
	Mean ± SD (Min - Max)	Mean ± SD (Min - Max)	Mean ± SD (Min - Max)	Mean ± SD (Min - Max)	Mean ± SD (Min - Max)
SS	274.15 ± 29.02 (231 - 336)	15.58 ± 1.91 (11.8 - 20.3)	15.65 ± 3.77 (10.2 - 25.3)	19.62 ± 3.34 (15.3 - 25.1)	0.4975 ± 0.69 (0 - 2.22)
NS	287.45 ± 20.97 (249 - 339)	12.68 ± 1.39 (10.6 - 15.3)	14.53 ± 6.65 (3 - 23.8)	21.34 ± 4.82 (14.7 - 30.1)	0.525 ± 0.56 (0 - 1.28)
ES	262.65 ± 26.24 (222 - 331)	16.05 ± 2.08 (12.8 - 20.3)	15.75 ± 4.03 (9.6 - 24)	21.01 ± 4.96 (12.8 - 31.4)	0.1145 ± 0.82 (0 - 0.9)
WS	251.65 ± 17.39 (227 - 281)	13.86 ± 1.81 (11.2 - 17.4)	15.31 ± 6.45 (4 - 23.1)	19.82 ± 3.15 (14.9 - 25.3)	0.203 ± 0.37 (0 - 1.08)
Average	268.98 ± 5.22 (232 - 321.75)	14.54 ± 0.29 (11.6 - 18.33)	15.31 ± 1.54 (6.7 - 24.05)	20.45 ± 0.96 (14.43 - 27.98)	0.34 ± 0.19 (0 - 1.37)

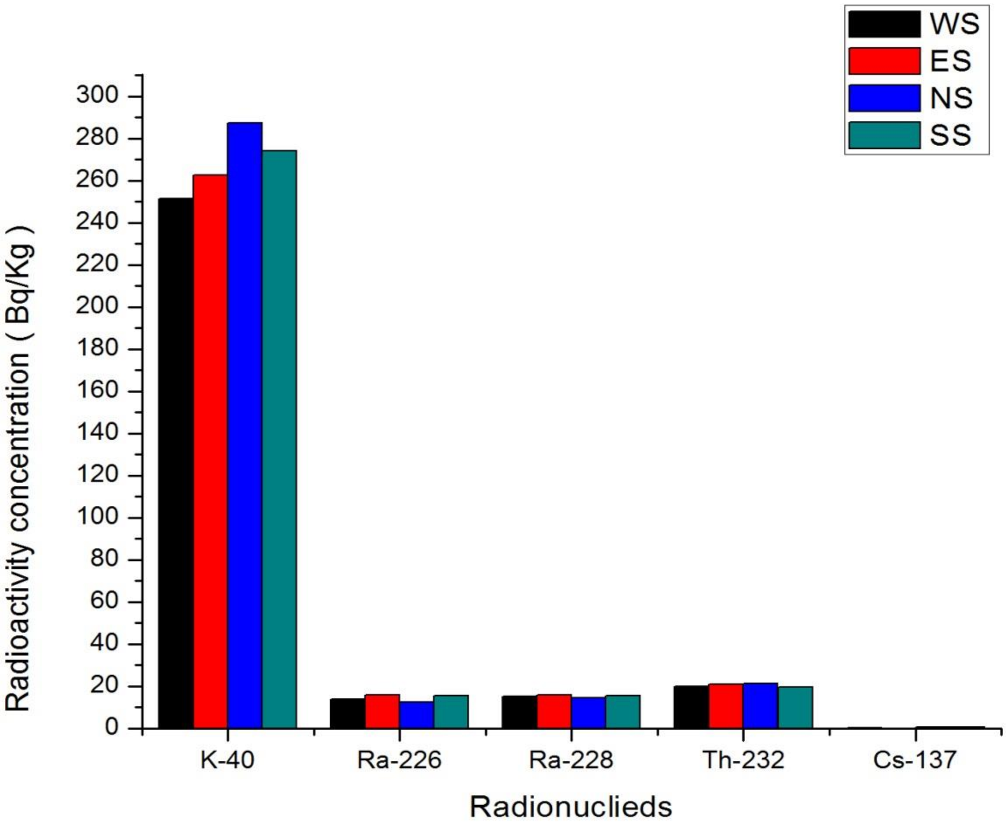


Figure 4.1 Activity concentrations of the natural radionuclide's ^{40}K, ^{226}Ra, ^{228}Ra, ^{232}Th and ^{137}Cs grounding stores samples measured in this work.

The concentration of radioactivity of the K-40 is high in the sample NS and low in the sample WS compared to other samples and its distribution is normal compared to local and global readings. The radioactivity Ra-226 is high in ES and low in NS and its distribution is normal compared to local and international readings. As well as the radioactivity of Ra-228 normal distribution in all samples compared to local and global readings, high in the sample ES and slightly lower in the sample NS The radioactivity of ^{232}Th is high in the NS sample and low in the SS sample and its distribution is normal compared to local and global readings.

As well as the concentration of radioactivity to pressure ^{137}CS very low in all samples compared to local and global readings.

Table 4.6 Comparison of ^{226}Ra, ^{232}Th, and ^{40}K concentrations in soil samples around Aljazeera project stores

Country	^{40}K Range Average	^{226}Ra Range Average	^{232}Th Range Average	^{228}Ra Range Average	^{137}Cs Range Average	Ref.
United States	100–700 370	8–160 40	4–130 35	ND	ND	64
Switzerland	40–1000 370	10–90 40	4–70 25	ND	ND	64
China	19–1800 440	2–440 32	1–360 41	ND	ND	64
Hong Kong	80–1100 530	20–110 59	16–200 95	ND	ND	64
India	38–760 400	7–81 29	14–160 64	ND	ND	64
Japan	15–990 310	6–98 33	2–88 28	ND	ND	64
Iran	250–980 640	8–55 28	5–42 22	ND	ND	64
Denmark	240–610 460	9–29 17	8–30 19	ND	ND	64
Malaysia	170–430 310	38–94 67	63–110 82	ND	ND	64
Egypt	29–650 320	5–64 17	2–96 18	ND	ND	64
Poland	110–970 410	5–120 26	4–77 21	ND	ND	64

Greece	12–1570 360	1–240 25	1–190 21	ND	1.8 – 11.1 6.45	64
Spain	25–1650 470	6–250 32	2–210 33	ND	10 - 60	64
Hungary	79–570 370	14–76 33	12–45 28	ND	ND	64
Sudan (Al-Ibedia)	0.2–419.8 136.8	2.7–18.5 7.5	9.2–51.9 20.7	ND	ND	7
Sudan (Alsopag)	321.4-1414.1 685.38	18.2–38 25.95	18.8–53.4 35.56	ND	ND	51
The current study	232 - 321.75 268.98	11.6 - 18.33 14.54	14.43 - 27.98 20.45	6.7 - 24.05 15.31	0 - 1.37 0.34	

ND: Not detectable

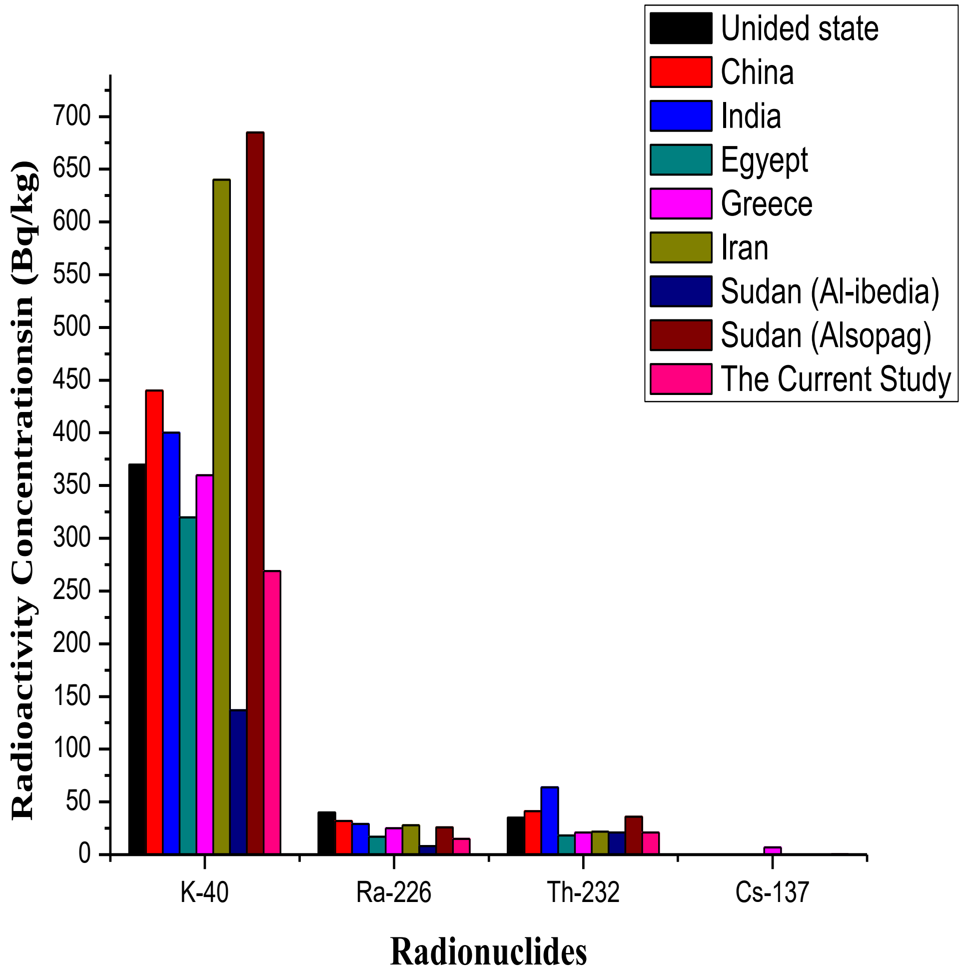


Figure4.2 Activity Concentrations of the Natural Radionuclide's for Local and Global Reading and Compared Current Study

4.3 Dose Rate

The total dose rates from the stores of fertilizer and pesticides, Aljazeera agricultural project were calculated for all the sampling sites. The total dose rate was found to be 31.31±0.98 $nGyh^{-1}$ with the minimum value being 29.86 $nGyh^{-1}$ and the maximum 32.06 $nGyh^{-1}$. Table 4.4 shows the average dose rates of (^{40}K, ^{226}Ra, ^{232}Th) 11.56 ± 0.22 $Bq.kg^{-1}$, 6.21 ± 0.12 $Bq.kg^{-1}$, 13.54 ± 0.64 $Bq.kg^{-1}$, respectively. the natural radionuclide's in all the sampling sites and the total dose in stores of fertilizer and pesticides. To calculate the average total dose rate we use the equation (3.2).

Table 4.7 Average dose rates of the natural radionuclide's and the total dose rates measured in this work for all sampling sites.

Site	**Dose Rates (nG/h)**					
	^{40}K	^{226}Ra	^{228}Ra	^{232}Th	^{137}Cs	TOTAL
SS	11.79	6.65	ND	12.98	ND	31.42
NS	12.36	5.41	ND	14.13	ND	31.9
ES	11.30	6.86	ND	13.9	ND	32.06
WS	10.82	5.92	ND	13.12	ND	29.86
Average	11.56 ± 0.22	6.21 ± 0.12	ND	13.54 ± 0.64	ND	31.31 ± 0.98

ND=Not detectable

It was found that the average total dose rate of radionuclide's there is little difference between the sites from which the samples were taken, and

Figure 4 shows the dose rates in which the radionuclides appeared. It was observed that the values for all sample sites fall within the range of global values ranging from 18 $nGyh^{-1}$ to 93 $nGyh^{-1}$, and this indicates their normal distribution in the samples.

The annual effective dose E (μSv $year^{-1}$). were determined to be range of 42.70 from 115.49 μSv $year^{-1}$ with an average of 37.48 ± 3.32 μSv. $Year^{-1}$. and minimum 29.4 μSv. $year^{-1}$, and maximum 45.72 μSv $year^{-1}$. It turns out that most of the values for the effective annual dose rate are much less than the permissible limit set by the International Committee for Radiation Protection by one mSv per year.

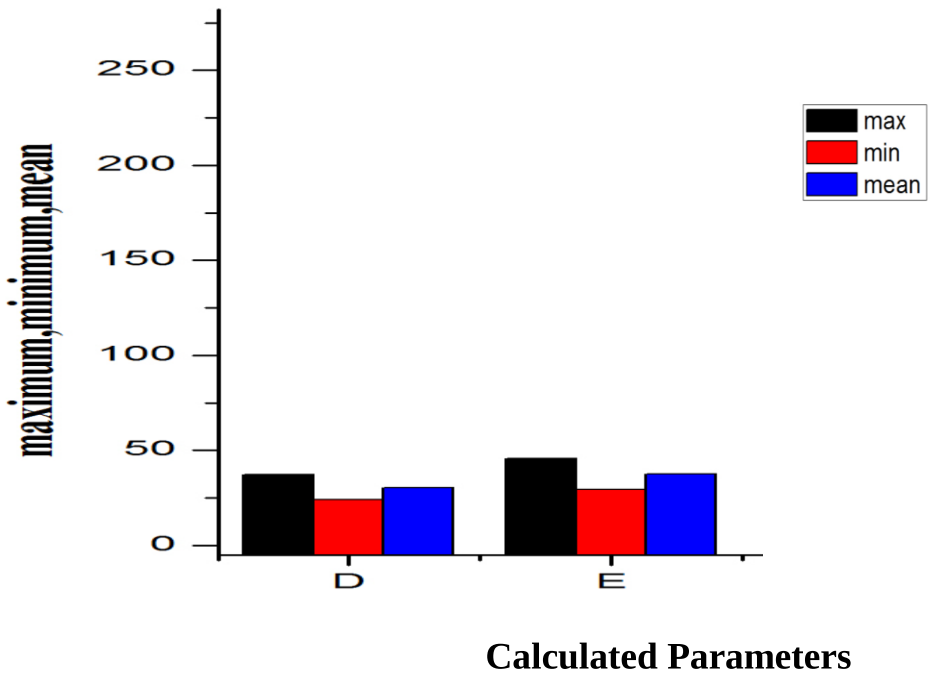


Figure 4.3 Statistical summary of risk indicator parameters: absorbed dose D(nGy h^{-1}), annual effective dose E (μSv. $year^{-1}$)

4.4 Radiation Hazard Parameters

Table 4.8 Radiation hazard parameters calculated from ^{238}U, ^{232}Th and ^{40}K in soil of around Aljazeera project stores from south site

Sample Code	D (nGy h^{-1})	E (μSv $year^{-1}$)	ELCR (10^{-3})	AGDE (μSv $year^{-1}$)	Raeq (Bq kg^{-1})	H_{ex}
SS1	28.13	34.52	0.11	197.71	59.10	0.16
SS2	25.35	31.11	0.10	178.53	53.17	0.14
SS3	34.17	41.94	0.13	241.38	71.20	0.19
SS4	31.67	38.87	0.12	223.52	66.33	0.18
SS5	31.89	39.13	0.12	225.85	66.25	0.18
SS6	30.14	36.99	0.12	212.81	62.84	0.17
SS7	29.99	36.80	0.12	211.29	62.78	0.17
SS8	31.95	39.21	0.12	224.22	67.49	0.18
SS9	32.05	39.34	0.12	224.42	67.98	0.18
SS10	28.21	34.62	0.11	198.90	59.01	0.16
SS11	31.16	38.25	0.12	218.90	65.75	0.18
SS12	31.33	38.45	0.12	220.28	66.03	0.18
SS13	28.47	34.94	0.11	201.11	59.38	0.16
SS14	29.61	36.34	0.11	207.56	62.73	0.17
SS15	30.57	37.51	0.12	214.25	64.64	0.17
SS16	32.71	40.14	0.13	230.36	68.66	0.19
SS17	30.20	37.07	0.12	211.31	64.31	0.17
SS18	33.71	41.37	0.13	236.43	71.46	0.19
SS19	30.72	37.69	0.12	214.41	65.48	0.18

SS20	32.97	40.46	0.13	230.77	70.10	0.19
MIN	28.21	34.62	0.11	198.90	59.01	0.16
MAX	34.17	41.94	0.13	241.38	71.46	0.19
AVERAGE	31.20	38.28	0.12	219.32	65.69	0.18
STDV	1.64	2.01	0.01	11.51	3.55	0.01

Table 4.9 Radiation hazard parameters calculated from ^{238}U, ^{232}Th and ^{40}K in soil of around Aljazeera project stores from north site

Sample Code	D ($nGy\ h^{-1}$)	E ($\mu Sv\ year^{-1}$)	ELCR (10^{-3})	AGDE ($\mu Sv\ year^{-1}$)	Raeq ($Bq\ kg^{-1}$)	H_{ex}
NS1	33.63	41.27	0.13	235.48	71.60	0.19
NS2	32.10	39.39	0.12	225.89	67.76	0.18
NS3	27.32	33.53	0.11	193.22	57.03	0.15
NS4	37.25	45.72	0.14	261.17	79.19	0.21
NS5	32.30	39.64	0.12	226.93	68.40	0.18
NS6	27.17	33.34	0.11	192.62	56.49	0.15
NS7	33.32	40.90	0.13	233.91	70.66	0.19
NS8	28.48	34.95	0.11	201.27	59.55	0.16
NS9	30.41	37.32	0.12	213.34	64.54	0.17
NS10	36.75	45.11	0.14	257.49	78.05	0.21
NS11	26.59	32.63	0.10	188.49	55.39	0.15
NS12	26.55	32.59	0.10	187.14	55.74	0.15
NS13	30.66	37.63	0.12	216.89	63.98	0.17

NS14	35.72	43.83	0.14	250.87	75.59	0.20
NS15	31.58	38.75	0.12	222.27	66.57	0.18
NS16	32.92	40.40	0.13	231.39	69.50	0.19
NS17	31.80	39.03	0.12	223.99	66.90	0.18
NS18	31.06	38.11	0.12	220.60	64.28	0.17
NS19	28.82	35.37	0.11	203.52	60.31	0.16
NS20	26.34	32.32	0.10	186.03	54.99	0.15
MIN	26.34	32.32	0.10	186.03	54.99	0.15
MAX	37.25	45.72	0.14	261.17	79.19	0.21
AVERAGE	30.84	37.84	0.12	217.29	64.84	0.18
STDV	3.49	4.28	0.01	23.87	7.75	0.02

Table 4.10 Radiation hazard parameters calculated from ^{238}U, ^{232}Th and ^{40}K in soil of around Al-jazeera project stores from east site

Sample Code	D (nGy h^{-1})	E (µSv $year^{-1}$)	ELCR (10^{-3})	AGDE (µSv $year^{-1}$)	Raeq (Bq kg^{-1})	H_{ex}
ES1	31.18	38.27	0.12	219.62	65.61	0.18
ES2	32.25	39.57	0.12	225.66	68.59	0.19
ES3	33.67	41.32	0.13	235.62	71.69	0.19
ES4	31.95	39.22	0.12	223.01	68.08	0.18
ES5	30.46	37.38	0.12	213.76	64.17	0.17
ES6	28.16	34.55	0.11	197.76	59.15	0.16
ES7	28.99	35.57	0.11	203.24	61.30	0.17

ES8	23.96	29.40	0.09	168.97	50.06	0.14
ES9	37.23	45.69	0.14	259.25	79.88	0.22
ES10	36.03	44.21	0.14	251.08	77.12	0.21
ES11	25.66	31.49	0.10	180.58	53.75	0.15
ES12	34.97	42.92	0.14	244.38	74.20	0.20
ES13	35.84	43.99	0.14	252.42	75.35	0.20
ES14	32.58	39.98	0.13	228.10	69.00	0.19
ES15	28.62	35.12	0.11	201.65	59.98	0.16
ES16	31.78	39.00	0.12	222.79	67.32	0.18
ES17	31.85	39.08	0.12	221.67	68.04	0.18
ES18	29.61	36.34	0.11	207.71	62.29	0.17
ES19	29.73	36.49	0.11	210.47	61.90	0.17
ES20	32.67	40.10	0.13	229.72	68.79	0.19
MIN	23.96	29.40	0.09	168.97	50.06	0.14
MAX	37.23	45.69	0.14	259.25	79.88	0.22
AVERAGE	31.32	38.44	0.12	219.57	66.23	0.18
STDV	3.56	4.37	0.01	24.40	7.94	0.02

Table 4.11 Radiation hazard parameters calculated from ^{238}U, ^{232}Th and ^{40}K in soil of around Al-jazeera project stores from west site

Sample Code	D (nGy h^{-1})	E (µSv $year^{-1}$)	ELCR (10^{-3})	AGDE (µSv $year^{-1}$)	Raeq (Bq kg^{-1})	H_{ex}
WS1	32.71	40.15	0.13	228.43	69.78	0.19
WS2	32.03	39.31	0.12	224.65	67.65	0.18
WS3	28.25	34.67	0.11	199.03	59.20	0.16
WS4	28.24	34.65	0.11	198.07	59.73	0.16
WS5	28.57	35.06	0.11	201.83	59.70	0.16
WS6	28.98	35.56	0.11	203.48	61.17	0.17
WS7	26.26	32.23	0.10	184.68	55.25	0.15
WS8	29.00	35.60	0.11	203.72	61.11	0.17
WS9	30.64	37.61	0.12	214.55	65.04	0.18
WS10	29.40	36.08	0.11	207.24	61.52	0.17
WS11	27.18	33.36	0.11	190.90	57.26	0.15
WS12	32.53	39.92	0.13	227.94	68.86	0.19
WS13	29.59	36.32	0.11	206.92	62.94	0.17
WS14	31.65	38.84	0.12	222.30	67.01	0.18
WS15	32.49	39.87	0.13	227.60	69.04	0.19
WS16	24.09	29.57	0.09	170.05	50.45	0.14
WS17	26.80	32.89	0.10	188.63	56.41	0.15
WS18	27.51	33.76	0.11	193.81	57.78	0.16
WS19	28.67	35.18	0.11	200.54	61.03	0.16

WS20	28.45	34.92	0.11	199.08	60.54	0.16
MIN	24.09	29.57	0.09	170.05	50.45	0.14
MAX	32.53	39.92	0.13	227.94	69.04	0.19
AVERAGE	28.79	35.34	0.11	202.24	60.78	0.16
STDV	2.14	2.63	0.01	14.71	4.72	0.01

Table 4.12 Average Radiation hazard parameters calculated from ^{238}U, ^{232}Th and ^{40}K in soil of around Aljazeera project stores

Sample Code	D ($nGy\ h^{-1}$) Mean ± SD (Min - Max)	E ($\mu Sv\ year^{-1}$) Mean ± SD (Min - Max)	ELCR (10^{-3}) Mean ± SD (Min - Max)	AGDE ($\mu Sv\ year^{-1}$) Mean ± SD (Min - Max)	Ra_{eq} ($Bq\ kg^{-1}$) Mean ± SD (Min - Max)	H_{ex} Mean ± SD (Min-Max)
SS	31.20 ± 1.64 (28.21 - 34.17)	38.28 ± 2.01 (34.62 - 41.94)	0.12 ± 0.01 (0.11 - 0.13)	219.32 ± 11.51 (198.90 - 241.38)	65.69 ± 3.55 (59.01-71.46)	0.18 ± 0.01 (0.16-0.19)
NS	30.84 ± 3.49 (26.34 - 37.25)	37.84 ± 4.28 (32.32 - 45.75)	0.12 ± 0.01 (0.10 - 0.14)	217.29 ± 23.87 (186.03 - 261.17)	64.84 ± 7.75 (54.99-79.19)	0.18 ± 0.02 (0.15- 0.21)
ES	31.32 ± 3.56 (23.96 - 37.23)	38.44 ± 4.37 (29.40 - 45.69)	0.12 ± 0.01 (0.09 - 0.14)	219.57 ± 24.40 (168.97- 259.25)	66.23 ± 7.94 (50.06 - 79.88)	0.18±0.02 (0.14-0.22)
WS	28.79 ± 2.14 (24.09 – 32.53)	35.34 ± 2.63 (29.57 – 39.92)	0.11 ± 0.01 (0.09 – 0.13)	202.24 ± 14.71 (170.05- 227.94)	60.78 ± 4.72 (50.45 - 69.04)	0.16 ± 0.01 (0.14 -0.19)
Total	30.54 ± 2.71 (23.96 – 37.25)	37.48 ± 3.32 (29.4 – 45.72)	0.12 ± 0.01 (0.09 – 0.14)	214.59 ± 18.62 (168.97- 261.17)	64.39 ± 5.99 (50.06 - 79.88)	0.18 ± 0.02 (0.14 -0.22)

The risk of cancer was calculated over the life of a human being, and the analysis of the samples in this research resulted in an explanation of the calculation of the rate of cancer elevation by Means of the medial relationship (1) of the ELCR, and the results obtained were (ELCR) ± standard deviation (0.12 ± 0.01) × 10^{-3}, with the lowest value is 0.09 x 10^{-3} and the maximum is 0.14 x 10^{-3}. It was found that the average value of this study is very small compared to the average value of the report of the United Nations Committee on the Effects of Atomic Radiation, which is 0.29 ×10^{-3} (UNSCEAR 2000) [19,e.tal, 27]. The reproductive system annual dose equivalent (AGDE) ± standard deviation (214.59 ± 18.62) $SVyear^{-1}$ was found, with a minimum value of 168.97 $Svyear^{-1}$ and a maximum of 261.17 $Svyear^{-1}$. The mean value of AGDE in all research samples is much lower than the global average of 300 μSv y^{-1} (UNSCEAR 2000). Any increase in this average causes bone disease and leukemia [19]. The mean value of Ra_{eq} radium equivalent ($Bqkg^{-1}$) ± standard deviation (64.3 ± 5.99) $Bqkg^{-1}$ was found, with a minimum value of 50.06 $Bqkg^{-1}$ and a maximum of 79.88 $Bqkg^{-1}$. And when comparing the average value of the radium equivalent with the average value (370 Bq kg^{-1}) of the United Nations Committee concerned with atomic radiation. The values were found for the average external hazard index (H_{ex}) ± standard deviation (0.18 ± 0.02), with the lowest value of 0.14 and a maximum of 0.22, the calculated Hex values for all samples were found to be less than unity, which does not pose a risk to the population working around those Stores around which samples are taken.

Figure 4.4 The average Radiation hazard parameters of natural radionuclide's in all the sampling sites and the average radiation hazard in stores of fertilizer and pesticides.

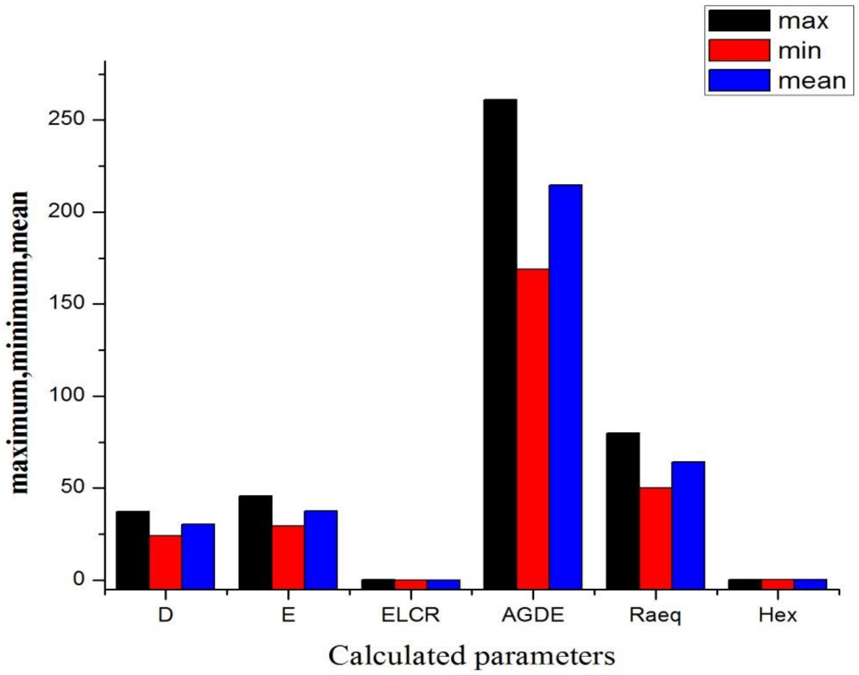


Figure 4.4: Statistical summary of risk indicator parameters: absorbed dose D(nGy h^{-1}), annual effective dose **E** (µSv $year^{-1}$), excess life time cancer risk **ELCR**, annual gonadal dose equivalent hazard index **AGDE** (µSv $year^{-1}$), radium equivalent $\mathbf{Ra_{eq}}$ (Bq kg^{-1}) and external hazard index $\mathbf{H_{ex}}$

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In the conclusion of this research, the concentration of radioactivity of radium nuclides radium 226, radium 228, thorium 232, potassium 40 and cesium 137 around the stores of fertilizers and pesticides for the Al-Jazeera agricultural project in hassahisa area was less than the average global natural levels for all radionuclide's, as well as the average for calculating the absorbed dose in this study, which is less than the average global value of the International Committee For the prevention of atomic radiation, as well as the average absorbed dose rate and the annual effect dose rate for this study is very small compared to the global average, and this indicates that the distribution of radionuclide's in soil samples for that area is a normal distribution. it was found that the values that we reached for estimates of average life time cancer risk of developing were very small compared to the average UN global value for atomic radiation protection, and the average value of the Annual gonadal dose equivalent is less than the average global value, and this indicates that the distribution of radionuclide's in The samples for this region have a normal distribution, as well as for the Radium equivalent activity , external hazard index, well below the global average readings. This indicates that the distribution of radionuclide's in soil samples for that region is normal.

In order to protect human health and the environment from the harmful effects of radionuclide's that result from the imposed use of fertilizers and pesticides on the soil, the supervisory authorities in the field of radiation protection must develop devices in the field and raise awareness of the optimal use of fertilizers and not overuse them.

5.2 Recommendations

1- This study should be expanded to all the contents of the area, including plants on which humans and animals live, in order to obtain a comprehensive assessment of the effects of fertilizers and pesticides on human and animal life.

2- Further examination of the level of radioactivity measured at all sampling sites around the fertilizer and pesticide stores of the Al-Jazeera Agricultural Project, in order to preserve the lives of citizens and workers who are permanently present around that area.

3- Close environmental monitoring is recommended by the authorities responsible for the use of fertilizers and pesticides for agriculture

REFERENCES

[1] Chandrajith, Rohana, R., Seneviratna, S., Wickramaarachchi, K., Attanayake, T., Aturaliya, T. N. C., & Dissanayake, C. B. "Natural radionuclides and trace elements in rice field soils in relation to fertilizer application: study of a chronic kidney disease area in Sri Lanka. J " Environmental Earth Sciences (2010): 60.1, 193-201.

[2] Li, Jianping, Cheng Sun, and Fei-Fei Jin. "NAO implicated as a predictor of Northern Hemisphere mean temperature multidecadal variability." Geophysical research letters 40.20 (2013): 5497-5502.

[3] Faweya EB, Ayeni MJ, Olowomofe GO, Akande HT. Estimation of radiation exposure in soils and organic (animal) and inorganic (chemical) fertilizers using active technique. International Journal of Environmental Science and Technology. (2017), 14:1-16.

[4] Hassan NM, Chang BU, Tokonami S. Comparison of Natural Radioactivity of Commonly Used Fertilizer Materials in Egypt and Japan. Journal of Chemistry. (2017), 2017:1-9.

[5] Chauhan P, Chauhan RP, Gupta M. Estimation of naturally occurring radionuclides in fertilizers using gamma spectrometry and elemental analysis by XRF and XRD techniques. Microchemical J. (2013), 106:73-8.

[6] Hegedűs M, Tóth-Bodrogi E, Németh S, Somlai J, Kovács T. Radiological investigation of phosphate fertilizers: Leaching studies. Journal of environmental radioactivity. (2017), 31(173):34-43.

[7] Idriss H, Salih I, Alaamer AS, Saleh A, Abdelgali MY. Environmental-Impact Assessment of Natural Radioactivity Around

a Traditional Mining Area in Al-Ibedia, Sudan. Archives of environmental contamination and toxicology. (2016), 4(70):783-92.

[8] Bai H, Hu B, Wang C, Bao S, Sai G, Xu X, Zhang S, Li Y. Assessment of Radioactive Materials and Heavy Metals in the Surface Soil around the Bayanwula Prospective Uranium Mining Area in China. International journal of environmental research and public health. (2017), 14(3):300.

[9] Smith, Laurence, et al. "Mitigation of diffuse water pollution from agriculture in England and China, and the scope for policy transfer. J " Land Use Policy (2017): 61, 208-219.

[10] Chauhan P, Chauhan RP. Variation in alpha radioactivity of plants with the use of different fertilizers and radon measurement in fertilized soil samples. Journal of Environmental Health Science and Engineering. (2014), 1(12):70.

[11] N. M. Hassan, N. A. Mansour, M. Fayez-Hassan, and S. Fares, “Assessment of radiation hazards due to exposure to radionuclides in marble and ceramic commonly used as decorative building materials in Egypt,” Indoor and Built Environment. (2017), 26 (3): 317–326.

[12] Isinkaye MO, Emelue HU. Natural radioactivity measurements and evaluation of radiological hazards in sediment of Oguta Lake, South East Nigeria. Journal of Radiation Research and Applied Sciences. (2015), 8(3):459-469.

[13] Saleh IH, Abdel-Halim AA. Determination of depleted uranium using a high-resolution gamma-ray spectrometer and its applications in soil and sediments. Journal of Taibah University for Science. (2016), 10(2):205-11.

[14] El-Bahi SM, Sroor A, Mohamed GY, El-Gendy NS. Radiological impact of natural radioactivity in Egyptian phosphate rocks, phosphogypsum and phosphate fertilizers. Applied Radiation and Isotopes. (2017), 123:121-127.

[15] Einas H.O., SalihI and A. Khatri Sam., GIS mapping and assessment of terrestrial gamma-radiation in Northern state, J. Radiation Protection Dosimetry. (2012), 3(151):1-11.

[16] Wisal B. Hassan., Habbaniand F.I and Shaded I.A., Investigations of environmental radioactivity in the northern state of Sudan, Sudan Journal of Science. (2013), 2(5).83-93.

[17] Fadol N, Salih I, Idriss H, Elfaki A, Sam A. Investigation of natural radioactivity levels in soil samples from North Kordofan State, Sudan. Research Journal of Physical Sciences . (2015), 3(7):1-7.

[18] Alnassar NA, Jaafar MS, Kabir NA. Determination of Concentrations of Natural Radionuclides in Soils and Water in Non-cultivated Sites in Seberang Perai, Malaysia J. of Applied Physics. (2017), 9(2):27-35.

[19] Dermatas, Dimitris. "Waste management and research and the sustainable development goals: Focus on soil and groundwater pollution." Research. (2017), 5(35):453–455.

[20] Zaldivar R. Nitrate fertilizers as environmental pollutants: positive correlation between nitrates (NaNO3 and KNO3) used per unit area and stomach cancer mortality rates. Experientia. (1977), 2(33):264-5.

[21] Ghosh D, Deb A, Bera S, Sengupta R, Patra KK. Measurement of natural radioactivity in chemical fertilizer and agricultural soil:

evidence of high alpha activity. Environmental geochemistry and health. (2008), 1(30):79-86.

[22] Usman S. Surface soil factors and soil characteristics in geo-physical milieu of Kebbi State Nigeria. Eurasian Journal of Soil Science. 2016 Jan 1;5(3):209-20.

[23] Lu Y, Song S, Wang R, Liu Z, Meng J, Sweetman AJ, Jenkins A, Ferrier RC, Li H, Luo W, Wang T. Impacts of soil and water pollution on food safety and health risks in China. Environment international. 2015 Apr 1;vol 77:5-15.

[24] Tormena CA, Karlen DL, Logsdon S, Cherubin MR. Corn stover harvest and tillage impacts on near-surface soil physical quality. Soil and Tillage Research. 2017 Mar 31; vol 166:122-30.

[25] Bastida F, Zsolnay A, Hernández T, García C. Past, present and future of soil quality indices: a biological perspective. Geoderma. 2008 Oct 31;147(3-4):159-71.

[26] Karlen DL, Stott DE, Cambardella CA, Kremer RJ, King KW, McCarty GW. Surface soil quality in five midwestern cropland Conservation Effects Assessment Project watersheds. Journal of soil and water conservation. 2014 Sep 1;69(5):393-401.

[27] Franzluebbers AJ. Soil organic matter stratification ratio as an indicator of soil quality. Soil and Tillage Research. 2002 Jul 1;66(2):95-106.

[28] Min XI, Bingzi ZH, Xiying HA, ZHANG J. Soil quality in relation to agricultural production in the North China Plain. Pedosphere. 2015 Aug 1;25(4):592-604.

[29] Doran JW, Zeiss MR. Soil health and sustainability: managing the biotic component of soil quality. Applied soil ecology. 2000 Aug 1;15(1):3-11.

[30] PAVLIDIS, George; TSIHRINTZIS, Vassilios A. Environmental benefits and control of pollution to surface water and groundwater by agroforestry systems: a review. Water resources management, 2018, 32.1: 1-29.

[31] Paz-Ferreiro J, Fu S. Biological indices for soil quality evaluation: perspectives and limitations. Land Degradation & Development. 2016 Jan;27(1):14-25.

[32] CHAVES, Henrique M. Leite; LOZADA, Clara M. Concha; GASPAR, Ricardo O. Soil quality index of an Oxisol under different land uses in the Brazilian savannah. Geoderma Regional, 2017, 10: 183-190.

[33] Rahmanipour F, Marzaioli R, Bahrami HA, Fereidouni Z, Bandarabadi SR. Assessment of soil quality indices in agricultural lands of Qazvin Province, Iran. Ecological indicators. 2014 May 1;40:19-26.

[34] Lima AC, Brussaard L, Totola MR, Hoogmoed WB, De Goede RG. A functional evaluation of three indicator sets for assessing soil quality. Applied Soil Ecology. 2013 Feb 1;64:194-200.

[35] Burges A, Epelde L, Garbisu C (2015) Impact of repeated single-metal and multi-metal pollution events on soil quality. Chemosphere 120: 8–15

[36] He K, Sun Z, Hu Y, Zeng X, Yu Z, Cheng H. Comparison of soil heavy metal pollution caused by e-waste recycling activities and

traditional industrial operations. Environmental Science and Pollution Research. 2017 Apr 1;24(10):9387-98.

[37] Yan, H., Yuan, S. Y., Li, M. Y., & Xiao, J. (2015). Evaluation of heavy metal contamination in agricultural topsoils in suburban Xuchang City, China. Environmental Earth Sciences, 74(3), 2475–2480.

[38] Motelay-Massei, A., Ollivon, D., Garban, B., Chevreuil, M., 2003. Polycyclic aromatic hydrocarbons in bulk deposition at a suburban site: assessment by principal component analysis of the influence of meteorological parameters. Atmos. Environ. 37, 3135–3146.

[39] Gao X, Chen C, Wang G, Xue Q, Tang C, Chen S (2010) Environmental status of Daya Bay surface sediments inferred from a sequential extraction technique. Estuar Coast Shelf Sci 86:369–378

[40] MORGADO, Rui G.; LOUREIRO, Susana; GONZÁLEZ-ALCARAZ, Maria N. Changes in Soil Ecosystem Structure and Functions Due to Soil Contamination. In: Soil Pollution. Academic Press, 2018. p. 59-87.

[41] CHAKRABORTY P., Mukhopadhyay, M., Shruthi, R., Mazumdar, D., Snow, D., & Wang, J. J. Biochar for Effective Cleaning of Contaminated Dumpsite Soil: A Sustainable and Cost-Effective Remediation Technique for Developing Nations. In: Environmental Biotechnology: For Sustainable Future. Springer, Singapore, 2019. p. 3-29.

[42] Arriaga, F. J., Guzman, J., & Lowery, B. (2017). Conventional Agricultural Production Systems and Soil Functions. In Soil Health and Intensification of Agroecosytems (pp. 109-125). Academic Press.

[43] NAJIB, M. U., Zakari, Y. I., Sadiq, U., Bello, I. A., Ibrahim, G. G., Umar, S. A., ... & Abdu, N. M. Radiological Assessment of Sediment of Zobe Dam Dutsinma, Katsina State, Northern Nigerian. Am J Eng Res, 2016, 5.3: 51.

[44] EVANS, A. E., Mateo-Sagasta, J., Qadir, M., Boelee, E., & Ippolito, A. Agricultural water pollution: key knowledge gaps and research needs. Current opinion in environmental sustainability, 2019, 36: 20-27.

[45] WALKER, D. B., Baumgartner, D. J., Gerba, C. P., & Fitzsimmons, K. Surface water pollution. In: Environmental and pollution science. Academic Press, 2019. p. 261-292.

[46] KLU, PROSPER KWAME. Assessment Of Health Risks Due To Toxic Metals And Naturally Occurring Radioactive Materials In The Birim River In East Akim Municipality Of The Eastern Region Ghana. 2015. PhD Thesis. University of Ghana.

[47] MERDANOĞLU, B.; ALTINSOY, N. Radioactivity concentrations and dose assessment for soil samples from Kestanbol granite area, Turkey. Radiation Protection Dosimetry, 2006, 121.4: 399-405.

[48] TSILIKIS, ı., Pantos, I., Zouliati, I., Koutras, A., Kalinterakis, G., & Syllaios, A. Radiological Risks From Potential Exposure of the Population to Radiation From Orphan Radioactive Sources. Health physics, 2019.

[49] HO, P. L., Hung, L. D., Minh, V. T., Van Chinh, D., Thanh, T. T., & Van Tao, C. Natural and artificial radionuclides in tea samples

determined with gamma spectrometry. Journal of Radioanalytical and Nuclear Chemistry, 2018, 1-5.

[50] PADOVANI, S., Mitsios, I., Anagnostakis, M., & Mostacci, D. Analysis of the vertical distribution and size fractionation of natural and artificial radionuclides in soils in the vicinity of hot springs. Radiation Effects and Defects in Solids, 2018, 173.9-10: 794-806.

[51] IDRISS, H., Salih, I., Alaamer, A. S., Al-Rajhi, M. A., Osman, A., Adreani, T. E., ... & Ali, N. I. Health risk profile for terrestrial radionuclides in soil around artisanal gold mining area at Alsopag, Sudan. Acta Geophysica, 2018, 66.4: 673-681.

[52] MUSTAKIM, R., Ferdous, J., Begum, A., & Islam, A. Natural Radionuclides Concentrations and Annual Effective Dose in Seasonal Fruits of Bangladesh. Nuclear Science, 2018, 3.3: 28 - 35.

[53] KUTSEN, S., Khrutchinsky, A., Minenko, V., Voillequé, P., Bouville, A., & Drozdovitch, V. Influence of the external and internal radioactive contamination of the body and the clothes on the results of the thyroidal 131 I measurements conducted in Belarus after the Chernobyl accident—Part 2: Monte Carlo simulation of response of detectors near the thyroid. Radiation and environmental biophysics, 2019, 58.2: 215-226.

[54] HUANG, Y., Chen, Q., Deng, M., Japenga, J., Li, T., Yang, X., & He, Z. Heavy metal pollution and health risk assessment of agricultural soils in a typical peri-urban area in southeast China. Journal of environmental management, 2018, 207: 159-168.

[55] KISS, J. J.; DE JONG, E.; BETTANY, J. R. The distribution of natural radionuclides in native soils of southern Saskatchewan, Canada. Journal of environmental quality, 1988, 17.3: 437-445.

[56] ESCAREÑO-JUÁREZ, E., Pardo, R., Gascó-Leonarte, C., Vega, M., Sánchez-Báscones, M. I., & Barrado-Olmedo, A. I. Determination of natural uranium by various analytical techniques in soils of Zacatecas State (Mexico). Journal of Radioanalytical and Nuclear Chemistry, 2019, 1135-1144.

[57] SINGH, M., Tondon, A., Sandhu, B. S., & Singh, B. Energy dependence of radiation interaction parameters of some organic compounds. Radiation Physics and Chemistry, 2018, 145: 80-88.

[58] NICHOLLS, R. D., Knoll, J. H., Butler, M. G., Karam, S., & Lalande, M. Genetic imprinting suggested by maternal heterodisomy in non-deletion Prader-Willi syndrome. Nature, 1989, 342.6247: 281- 285.

[59] FRIEDLANDER, Gerhart; KENNEDY, Joseph W.; MACIAS, Edward S. Nuclear and radiochemistry. John Wiley & Sons, 1981.

[60] MOORE, M. G.; EVANS, W. P. Mathematical correction for stress in removed layers in X-ray diffraction residual stress analysis. SAE Technical Paper, 1958.

[61] DIAB, H. M., Nouh, S. A., Hamdy, A., & El-Fiki, S. A. Evaluation of natural radioactivity in a cultivated area around a fertilizer factory. Journal of Nuclear and Radiation physics, 2008, 3.1: 53-62.

[62] UNSCEAR (United Nations Scientific Committee on the Effect of Atomic Radiation) (2008) Sources and effects of ionizing radiation. Report to the General Assembly, New York, United Nation

[63] HILAL, M. A., Attallah, M. F., Mohamed, G. Y., & Fayez-Hassan, M. Evaluation of radiation hazard potential of TENORM waste from oil and natural gas production. Journal of Environmental Radioactivity, 2014, 136: 121-126.

[64] United Nations. (2000). United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Effects and risks of ionizing radiations, 2.

APPENDICES

Appendix I: - **Natural radionuclide content in soil ,*Data not referenced are from UNSCEAR Survey of Natural Radiation Exposures***

Region / country	Population in 1996 (10^6)	*Concentration in soil (Bq kg^{-1})*							
		^{40}K		^{238}U		^{226}Ra		^{232}Th	
		Mean	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*
Africa									
Algeria	28.78	370	66 1 150	30	2 110	50	5 180	25	2 140
Egypt	63.27	320	29 650	37	6 120	17	5 64	18	2 96
North America									
Costa Rica	3.50	140	6 380	46	11 130	46	11 130	11	1 42
United States [M7]	269.4	370	100 700	35	4 140	40	8 160	35	4 130
South America									
Argentina	35.22	650	540 750						
East Asia									
Bangladesh	120.1	350	130 610			34	21 43		
China [P16, Z5]	1232	440	9 1 800	33	2 690	32	2 440	41	1 360
– Hong Kong SAR [W12]	6.19	530	80 1 100	84	25 130	59	20 110	95	16 200
India	944.6	400	38 760	29	7 81	29	7 81	64	14 160
Japan [M5]	125.4	310	15 990	29	2 59	33	6 98	28	2 88
Kazakstan	16.82	300	100 1 200	37	12 120	35	12 120	60	10 220
Korea, Rep. of	45.31	670	17 1 500						
Malaysia	20.58	310	170 430	66	49 86	67	38 94	82	63 110
Thailand	58.70	230	7 712	114	3 370	48	11 78	51	7 120
West Asia									
Armenia	3.64	360	310 420	46	20 78	51	32 77	30	29 60
Iran (Islamic Rep. of)	69.98	640	250 980			28	8 55	22	5 42
Syrian Arab Republic	14.57	270	87 780	23	10 64	20	13 32	20	10 32
North Europe									
Denmark [N5]	5.24	460	240 610			17	9 29	19	8 30
Estonia	1.47	510	140 1 120			35	6 310	27	5 59
Lithuania	3.73	600	350 850	16	3 30			25	9 46
Norway	4.35	850		50		50		45	
Sweden	8.82	780	560 1 150			42	12 170	42	14 94
West Europe									
Belgium	10.16	380	70 900			26	5 50	27	5 50
Germany	81.92		40 1 340		11 330		5 200		7 134
Ireland [M6]	3.55	350	40 800	37	8 120	60	10 200	26	3 60
Luxembourg	0.41	620	80 1 800			35	6 52	50	7 70
Netherlands [K2]	15.58		120 730		5 53	23	6 63		8 77
Switzerland	7.22	370	40 1 000	40	10 150	40	10 900	25	4 70
United Kingdom [B2]	58.14		0 3 200		2 330	37			1 180
East Europe									
Bulgaria	8.47	400	40 800	40	8 190	45	12 210	30	7 160
Hungary	10.05	370	79 570	29	12 66	33	14 76	28	12 45
Poland [J7]	38.60	410	110 970	26	5 120	26	5 120	21	4 77
Romania [I12]	22.66	490	250 1 100	32	8 60	32	8 60	38	11 75
Russian Federation	148.1	520	100 1 400	19	0 67	27	1 76	30	2 79
Slovakia	5.35	520	200 1 380	32	15 130	32	12 120	38	12 80
South Europe									
Albania	3.40	360	15 1 150	23	6 96			24	4 160
Croatia	4.50	490	140 710	110	83 180	54	21 77	45	12 65
Cyprus	0.76	140	0 670			17	0 120		
Greece	10.49	360	12 1 570	25	1 240	25	1 240	21	1 190
Portugal	9.81	840	220 1 230	49	26 82	44	8 65	51	22 100
Spain	39.67	470	25 1 650			32	6 250	33	2 210
Median		400	140 850	35	16 110	35	17 60	30	11 64
Population weighted average		420		33		32		45	

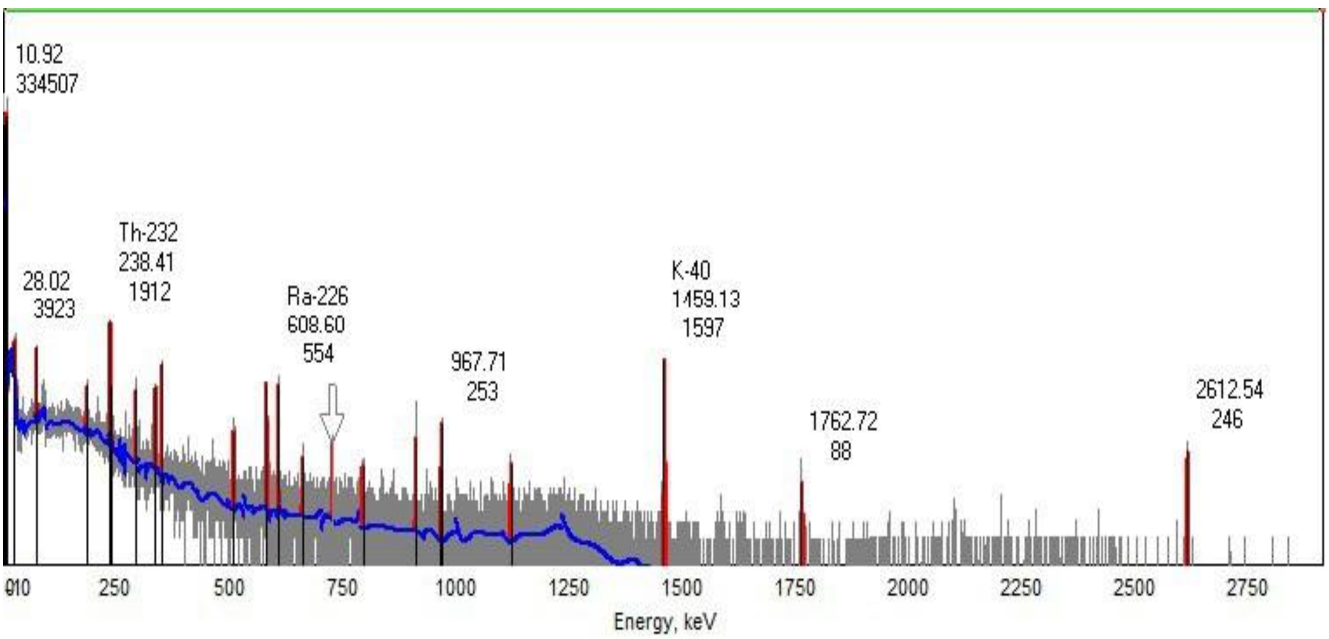
Appendix II:- **External exposure rates from terrestrial gamma radiation,** ***Data not referenced are from UNSCEAR Survey of Natural Radiation Exposures***

Region / country	*Population in 1996 (10^6)*	*Absorbed dose rate in air (nGy h^{1})*				*Ratio indoors to outdoors*
		Outdoors		*Indoors*		
		Average	*Range*	*Average*	*Range*	
Africa						
Algeria [B4]	28.78	70	20 133		14 2 100	
Egypt [H9, I13]	63.27	32	8 93			
Namibia [S12]	1.58					
Sudan	27.29	53	26 690			
North America						
Canada [G3, T14]	29.68	63	43 101			
Cuba [S13]	11.02	42	26 53			
Mexico [C8]	92.72	78	42 140			
United States [M8, O5]	269.4	47	14 118	38	12 160	0.8
South America						
Chile [S14]	14.42	51	21 83	61	25 105	1.2
Paraguay	4.96	46	38 53			
East Asia						
Brunei [L20]	0.30	33	3 70			
China [N3]	1232	62	2 340	99	11 420	1.6
– Taiwan Province [C11]	20	57	17 87			
– Hong Kong SAR [W12]	6.19	87	51 120	200	140 270	2.3
India [N11]	944.6	56	20 1 100			
Indonesia	200.45	55	47 63			
Japan [A7, A8]	125.4	53	21 77	53	21 77	1.0
Kazakstan	16.82	63	10 250	70	20 100	1.1
Korea, Rep. of	45.31	79	18 200			
Malaysia	20.58	92	55 130	96	65 130	1.0
Philippines [D3]	69.28	56	31 120			
Thailand	58.70	77	2 100	48	2 22	0.6
West Asia						
Iran (Islamic Rep. of)	69.98	71	36 130	115	70 165	1.6
Syrian Arab Republic	14.57	59	52 67			
North Europe						
Denmark [N5, S15]	5.24	52	35 70	54	19 260	1.0
Estonia	1.47	59	14 230			
Finland [A9]	5.13	71	45 139	73	22 184	1.0
Iceland [E4]	0.27	28	11 83	23	14 32	0.8
Lithuania	3.73	58	36 85	85	34 195	1.5
Norway [S16, S17]	4.35	73	20 1 200	79	20 1 250	1.1
Sweden [M9]	8.82	56	40 500	110	20 2 000	2.0
West Europe						
Austria [T5]	8.11	43	20 150			
Belgium [D4, S18]	10.16	43	13 80	60	32 90	1.4
France [M10, R3]	58.33	68	10 250	75		1.1
Germany [B5, W11]	81.92	50	4 350	70	13 290	1.4
Ireland [M11, M12]	3.55	42	1 180	62	10 140	1.5
Luxembourg	0.41	49	14 73			
Netherlands [J2, V1]	15.58	32	10 60	64	30 100	2.0
Switzerland	7.22	45	15 120	62	20 200	1.4
United Kingdom [G4, W5]	58.14	34	8 89	60		1.8
East Europe						
Bulgaria [V2]	8.47	70	48 96	75	57 93	1.1
Hungary [N14, N15]	10.05	61	15 130	95	11 236	1.6
Poland [B10, M3]	38.60	45	18 97	67	28 167	1.5
Romania [I12]	22.66	59	21 122	83	30 170	1.4
Russian Federation	148.1	65	12 102	74	24 147	1.1
Slovakia	5.35	67	24 154	79	36 180	1.2
South Europe						
Albania	3.40	71	20 350	100	20 300	1.4
Cyprus	0.76	18	9 52			

Greece	10.49	56	30 109	67	36 131	1.2
South Europe						
Italy [B6, C12]	57.23	74	3 228	105	0 700	1.4
Portugal [A10]	9.81	84	4 230	101	4 280	1.2
Slovenia	1.92	56	4 147	75	40 250	1.3
Spain [Q1, Q2]	39.67	76	40 120	110	57 180	1.4
Oceania						
Australia [C13, L7]	18.06	93		103		1.1
New Zealand [R4]	3.6			20	1 73	
Median		57	18 93	75	20 200	1.3 (0.6 2.3)
Population-weighted average		59		84		1.4

Appendix III:- gamma spectrum processing report from 31.1.2019

Nuclides/Lines	Area, [impulse]	Activity,Bq/kg	Relative uncertainty, %	MDA, Bq
K-40	1600	311	3	11.90
Th-232	1910	30.1	4	1.87
Ra-226	980	12.2	4	0.06
Ra-228	212	7.2	8	3.37
Cs-137	87	1.03	14	0.58



Appendix IX:- **Pictures of the stores of fertilizer and pesticides Aljazeera agricultural project**