ASSESSMENT OF RADIOACTIVITY LEVELS AND BIOGENIC EFFECTS OF COASTAL ENVIRONMENT OF UNUMHERIN COMMUNITY IN DELTA STATE, NIGERIA

BY

GODFREY USIAKA AIMUA

(18PCE02035)

JUNE, 2021

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B.Sc (Hons) in Physics (Edo State University, Ekpoma)

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF PHYSICS, COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (M.Sc) IN INDUSTRIAL PHYSICS (APPLIED GEOPHYSICS), COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY, OTA, NIGERIA

JUNE, 2021

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfilment of the requirements for the award of the degree of Master of Science (M.Sc.) in Industrial Physics (Applied Geophysics) of the Department of Physics, College of Science and Technology, Covenant University, Ota, Nigeria.

Mr. John A. Philip …….

(Secretary, School of Postgraduate Studies) Signature and Date

Prof. Akan B. Williams ……...

(Dean, School of Postgraduate Studies) Signature and Date

DECLARATION

I, **AIMUA GODFREY U.** (18PCE02035) declare that this research was carried out by me under the supervision of Dr. Maxwell Omeje, of the Department of Physics, College of Science and Technology, Covenant University, Ota, Nigeria. I attest that this dissertation has not been presented either wholly or partially for the award of any degree elsewhere. All sources of data and scholarly information used in this dissertation are duly acknowledged.

AIMUA GODFREY U. ……..

Signature and Date

CERTIFICATION

I certify that this project titled **"ASSESSMENT OF RADIOACTIVITY LEVELS AND BIOGENIC EFFECTS OF COASTAL ENVIRONMENTS OF UNUMHERIN COMMUNITY IN DELTA STATE, NIGERIA"** is an original research work carried out by **AIMUA GODFREY (18PCE02035)** of the Department of Physics, Covenant University, Ota, Nigeria under the supervision of DR. MAXWELL OMEJE**.** I have examined and found the work acceptable as part of the requirements for the award of Master of Science degree in Industrial Physics (Applied Geophysics)

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(Head of Department) Signature and Date

Prof. Elijah O. Oyeyemi

External Supervisor ……

Signature and Date

Prof. Akan B. Williams ……

(Dean, School of Postgraduate Studies) Signature and Date

DEDICATION

This work is dedicated to **God, Almighty JEHOVAH JIREH** for making it possible for me to start and finish the studies, establishing my career on the right tract. It is equally dedicated to all scientists and individuals working towards world development, peace and reaching out to the lost in the advancement of God's kingdom both through prayers and evangelism. I give God thanks, Praise, Glory, Honour and Adoration.

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ABBREVIATION

AEDR	-	Annual Effective Dose Rate
AUI	-	Activity Utilization Index
AEDR	-	Annual Effective Dose Rate
Bq/Kg	-	Becquerel per Kilogramme.
Bq/L	_	Becquerel per Litre
CEDS	-	Centre for Entrepreneurship Development Studies
CNSC	-	Canada Nuclear Safety Commission
D	-	Dose rate
ELCR	-	Excess Lifetime Cancer Risk
E – M	-	Electromagnetic Waves Spectra
EPA	-	Environmental protection agency
EF	-	Exposed Frequency
GM	-	Geiger Muller
GPS	-	Geographical positioning system
IR	-	Ingestion Rate
IAEA	-	International Atomic Energy Agency
ICRP	-	International commission on radiological protection
LSI	-	Langelier Saturation Index
PI	-	Permeability Index
PPB	-	Parts per Billions
PPM	-	Parts per Millions
PSI	-	Pound per Square Inch

% Na	-	Percentage Sodium
RAD	-	Radiation Absorbed Dose
REM	-	Roentgen Equivalent Man
SI	-	International system of units
SAR	-	Sodium Absorption Ratio
MH	-	Magnessium Hazards
NRC	-	Nuclear Regulatory Commission
NORM	-	Naturally Occurring Radioactive Materials.
238U	-	Uranium – 238
TENORMs	-	Technologically Enhanced Naturally Occurring Radioactive Materials
232Th	-	Thorium – 232
40K	-	Potassium - 40
UNSCEAR	-	United Nations Scientific Committee on the Effect of Atomic Radiation
WHO	-	World Health Organisation

GLOSSARY

Radioisotopes

A radioactive decay occurs when a radioisotope is said to transform from one to another resulting in the emission of some forms of radiation. Radioactive tracers emit gamma radiation that gives diagnostic information of the functions and anatomy of specific organs of people's metabolism. For industrial usage, Radioisotopes derived from plutonium-238 are used for environmental detection and analysis of pollutants and for studying the movement of both groundwater and surface water in streams (WNA, 2016 -2020).

Uranium (U): Nature and Source of Uranium-238

Uranium is a natural radioactive element with an unstable nucleus, as the element is constantly in a state of decay, thereby seeking for more arrangement that is stable. It was uranium element that made it possible for the discovery of radioactivity (WNA, 2020).

Thorium (Th): Nature and Source of Thorium-232

Thorium (Th) is a naturally occurring slightly radioactive metal element belonging to the actinoid series in the periodic table. The soil has an average total of about 6 parts per million (ppm). Thorium is almost totally insoluble, which explains why it can be found abundantly in sands, but not in the seawater, in contrast to the uranium (WNA, 2020).

Potassium (K)

Potassium is a mobile fluid litholite element present in the ocean and earth crust (Arevalo *et al.*, 2016). It is an essential element that is metabolic in nature for both plants and animals.

Product Material as used in the Atomic Energy Agency

Any given radioactive material except for the special nuclear material yield in or made radioactive by and on exposure to the radiation incident to the process of producing or using.

Collective Dose is the sum of the individual doses that can be received in any given period by a specified population from the exposure to a specified source of the radiation.

Committed Dose Equivalent is the dose equivalent to the organs or tissues of the reference (T) that can be received from any intake of the radioactive material by any person during the 50-y period after the intake of the dose.

Committed Effective Dose Equivalent is the sum of the total of the products, for each of the body organ or the tissue that can be irradiated, out of the applicable weighting factor and then the committed dose that is equivalent to the organ or the tissue.

Curie (Ci) is the conventional unit of the activity of the disintegration per second.

Radiation Dose is the generic term that means the absorbed dose, the dose equivalent, the effective dose equivalent, the committed dose equivalent, the committed effective dose equivalent, or the total effective dose equivalent.

Dose Equivalent can be referred to the product of the absorbed dose in the tissue, the quality factor, and all other necessary modifying factors at the location of interest.

Effective Dose can be referred to the sum of the weighted equivalent doses to all the tissues and the organs of the body (ICRP 1991).

Effective Dose Equivalent is the sum of the products for each of the body organ or the tissue that is irradiated, of the dose equivalent to the organ or tissue and the applicable weighting factor.

Equivalent Dose: In any radiation protection material, the absorbed dose is averaged over any tissue or any organ, rather than a point, as is the case for the dose equivalent and then weighted for the radiation quality that is of interest.

External Dose rate is the dose that is received from any radiating sources outside of the body in the material sources outside of the body in the material.

Exposure is the very quantity that can be used to express an external ionizing radiation, or to indicate presence of any radionuclides or any radiation that is affecting an individual or the populations.

Becquerel (Bq): The SI unit of the activity is the becquerel. 1 Bq equals 1 disintegration per second.

ABSTRACT

This study investigates the radioactivity distributions and bioaccumulation of microbial in the coastal polluted areas of Unumherin Community in Niger Delta, South-South, Nigeria. The measurement of outdoor gamma dose rates and the activity concentrations of ^{40}K, ^{238}U, ^{232}Th in the air of the study area was measured using calibrated hand-held gamma detector, (RS-125 Gamma-Spec) and NaI (Tl) gamma spectroscopy. The in-situ measurements were combined with the laboratory analysis of sediments, water and fish species from the same area using NaI (Tl) gamma spectroscopy. For fungal and bacterial culture, 1 ml of 10^3 dilutions were plated on molten sabouraud dextrose agar (SDA) at 25 ^0C for 5 to 7 days and 0.1 ml of 10^3 dilutions of the homogenates were inoculated in triplicates by pour plate technique on petri plates containing 15 ml molten nutrient and MacConkey agars at 37^0C for 24 to 48 hours. The results of the gamma dose rate indicates the hotspot at location 4 with a value of 100 nGy h^{-1}, almost twice higher that the recommended limits. The results revealed varying activities of the primordial radionuclides (^{40}K, ^{238}U and ^{232}Th) with average values higher than the recommended limits for the sediments and water. Geologically, this may be attributed to marine incursion of regional tectonic subsidence during transgression. Statistically, the correlation results confirmed that the enhanced outdoor dose rates at the polluted coastlines was caused mainly by ^{238}U, followed by ^{232}Th and then ^{40}K in magnitude. The results from the NaI (Tl) gamma detector revealed similar distribution observed in the in-situ measurements i.e. the activities of the primordial radionuclides were skewed (the distribution is mostly symmetric) in the range of -2 and +2. The highest activity concentrations of ^{40}K, ^{238}U and ^{232}Th from the polluted coastlines are 288.09, 96.49, 136.12 $Bqkg^{-1}$ for sediments and 257.31, 66.93, 96.57 $Bqkg^{-1}$ for water, respectively. The highest mean activity concentration ^{40}K and ^{238}U was observed in Catfish with values of 151.87 and 38.00 $Bqkg^{-1}$, whereas the highest activity for ^{232}Th was observed in Tilo Fish with a value of 89.02 $Bqkg^{-1}$. In comparison, all these values are higher than the recommended limits of 420.00, 32.00 and 45.00 $Bqkg^{-1}$ for ^{40}K, ^{238}U and ^{232}Th according to the United Nations Scientific Committee on the Effect of Atomic Radiation (UNCEAR). The estimated mean hazard indices for the sediments in the study area were higher than the recommended permissible limits according to International Commission on Radiological Protection (ICRP). Microbially, the accumulation of radioactive elements by fishes could be through ingestion and adsorption to surfaces, which culminate in speciation and mobility of radionuclides, alongside the feeding habits of fishes and other aquatic animals. The variability in the mean concentrations of the ^{40}K, ^{238}U, ^{232}Th among the fish species could be attributed to species-specificity, which is a strong factor that influences bioaccumulation and biohazard exposure to the aquatic life. **This study recommends further works on Geochemical and Biogeochemistry analysis to determine the toxicity changes for sediments, water and seafood in the same coastal environment.**

Keywords: Radioactivity, Microbial interaction, Marine water, Pollution, Niger Delta