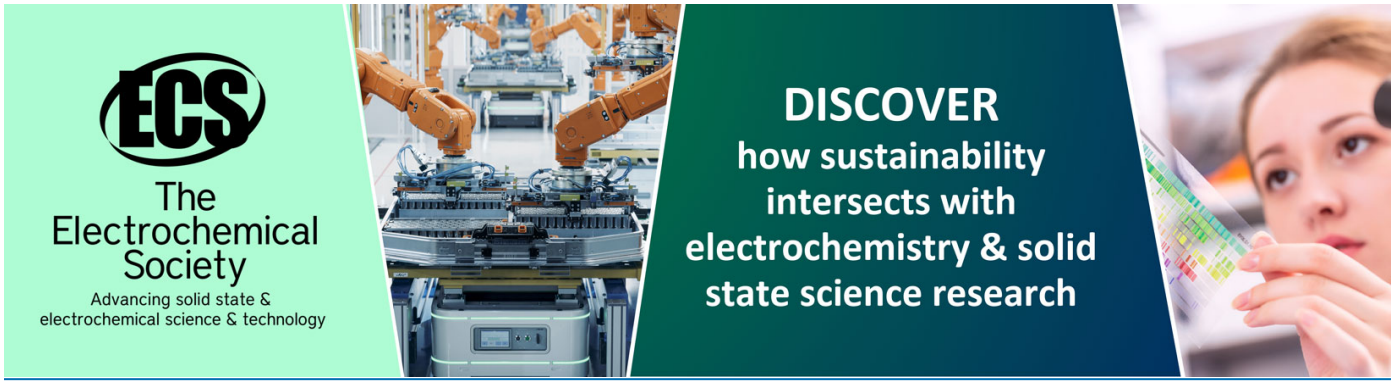
Spatial Distribution of Gamma Dose Rates in the Marine Environment of Unumherin Community in Niger Delta, South-South, Nigeria



Spatial Distribution of Gamma Dose Rates in the Marine Environment of Unumherin Community in Niger Delta, South-South, Nigeria

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Abstract. This work investigates the radioactivity distribution of coastal polluted areas of Unumherin Community in Niger Delta, Nigeria. The measurement of the outdoor dose rate of the polluted coastlines was carried out using calibrated hand-held gamma detector, (RS-125 Gamma-Spec). The spatial distribution of gamma dose rate indicates the hotspot at location 4 with a value of 100 nGy/h. Maximum and minimum values of the absorbed dose-rate was observed in location 4 with the value of 100 nGyh^{-1} and location 15 with the value of 2 nGyh^{-1}, respectively. This is an indicative that the risk of ionizing radiation exposures is much higher for location 4 than other locations. This higher value of 100 nGyh^{-1} is far more than the recommended limit of 59.00 and 84.00 nGyh^{-1} provided by UNSCEAR, 2000. The community requires much more radiological monitoring for the safety of human and ecosystem.

Keywords: Gamma Dose Rates, Marine Environment, Radioactivity, Nigeria.

1. Introduction

Naturally occurring radionuclides can be transferred from soil to plants, animals, after which, they are exposed to human in an ecosystem (Isinkaye & Emelue, 2015). Radionuclides could appear as toxic elements and undergo bi-accumulation and bi-concentration, resulting in adverse impact to human and its environs. Evaluation of radioactive elements in soil sediments in an environment is useful for the protection of human health against the radiation exposure and harmful effects (Uluturhan, Aynur & Yilmaz, 2011). The radioactive source in the coastal environment region of the marine environment may result from natural particles radiating from the crust of the earth, manifests from anthropogenic sources and other terrestrial ecosystems (Uluturhan *et al.*, 2011; Sylaios, Kamidis and Stamatis, 2012). Radioactivity levels in the coastal environment is mostly emanating from anthropogenic sources which can be attributed to mining and other major industrial activities (Nuraddeen, Ahmad, Muneer, Syazwan & Hamman, 2018; Sylaios *et al.*, 2012). Although the coastal region of West African is lacking behind in most of the major vital information about the operating systems in the industrial sectors such as; oil exploration, nuclear, mining, industrialization, productions in the offshore gas and agriculture, which could be attributed to the radioactivity levels of the environment in the West Africa coastal region (Nyarko *et al.*, 2011, Omeje *et al.*, 2020). The assessment of radiation exposure from the soil sediments to living organisms, including human may have either originated externally from background radiation or primordial radionuclides or the external radiation present in the soil (Jibril and Okeyode, 2012). Radiation from radon decay products that sometimes emanate from soil sediments internally affects the human respiratory tracks (Isinkaye *et al.*, 2015; Usikalu, Ajibola, Adagunodo and Akinpelu, 2018).

However, activity concentration of radionuclide in any natural ecosystem will results in understanding the health implication over the past years. These radionuclides penetrate the tissues of the marine species through different mechanisms, hence, penetrating the food chain through the ingestion of sea or marine food (Abbasi, 2019). There is need for an urgent background radiation assessment of the coastal region of the community in Niger Delta,South-south Nigeria

2. Geology and Geographical Location of the Study Area

The study area covers Unumherin community in Warri, Delta State of Nigeria fondly called "Glory of All Lands" in the Niger Delta as shown in Figure 1. It is geographically located between latitudes 4.264825º– 5.414860º North of Equator and between longitudes 5.372116º – 6.727176º East of Greenwich. The nature of the Atlantic Coast of Unumherin Community and the river Ethiope sediments shows access for fishing and drawing water for domestic usage (Omeje *et al.,* 2020). The area lie parallel to the coastline sediments region and basement of other Atlantic coastal region of Escravos, Forcados, Burutu and Agbaro which are located about some kilometres away from Unumherin Community and the Ethiope River. The deposits from the Atlantic Ocean and the Ethiope River comprises of mud, marsh and inner flats plain. Near the Ocean and river environments, it leads to the creeks and the bordering mangrove areas. Other surface features include vegetation, sediments structure and soil textures, which formed the characteristic of the environments near the coastal region and rivers (Mutiu *et al.,* 2013).

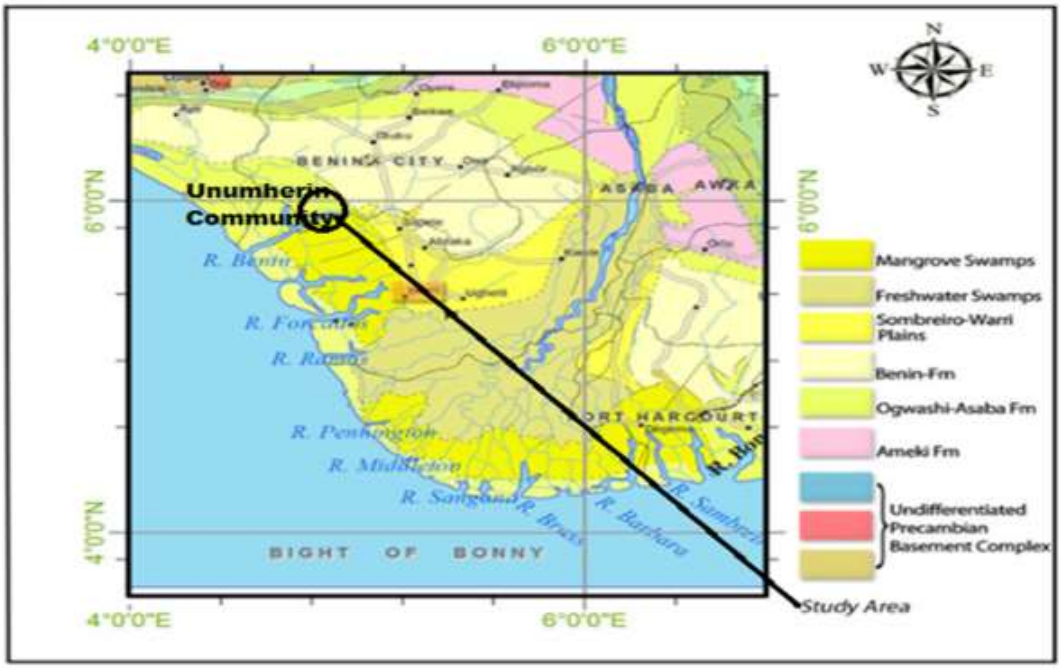

Figure 1. Geologic map of Niger Delta showing the study area (Source: (Adapted from NGSA, 2004) (Akpoborie, Oghenero and Aweto, 2014).

3. Methodology

3.1. In-situ Measurements using Super-Spec RS125 Gamma Spectrometer

The in-situ measurement of the background gamma dose-rates were carried out at 1 metre above the ground using Super spectrometry RS-125 gamma detector coated with 2.0 cm x 2.0 cm NaI crystal. For accurate measurement of gamma dose rate was carried out according to procedure of (Omeje *et al.,* 2020) was adopted. The background gamma dose rate level of the study area of Unumherin community was measured using hand-held portable radiation detector from Canadian Geophysical Inc., in the middle of dry season to estimate the variation of the radionuclides within the study area (Omeje *et al.,* 2020). The instrument is mostly suitable for the detection of dose exposure and naturally occurring radionuclides, with higher degree of accuracy and probable errors of about ± 5% (Omeje et al., 2020; Usikalu *et al.,* 2018).

The background gamma dose measurement uses assay mode of RS-125 Super SPEC which is acquired directly in nGyh^{-1}. RS-125 Super SPEC has a software utility for downloading the statistical record of field data from the field that is stored in the memory and further connection to the computer system through a USB or Bluetooth. Data measured are tabulated in an excel sheet as the coordinates are processed, georeferenced and interpolated by the use of an ArcGIS (version 10.8) for spatial distribution analysis.

The sampling location and the radiometric data are shown in the base map (Figure 2) and Table 1, respectively.

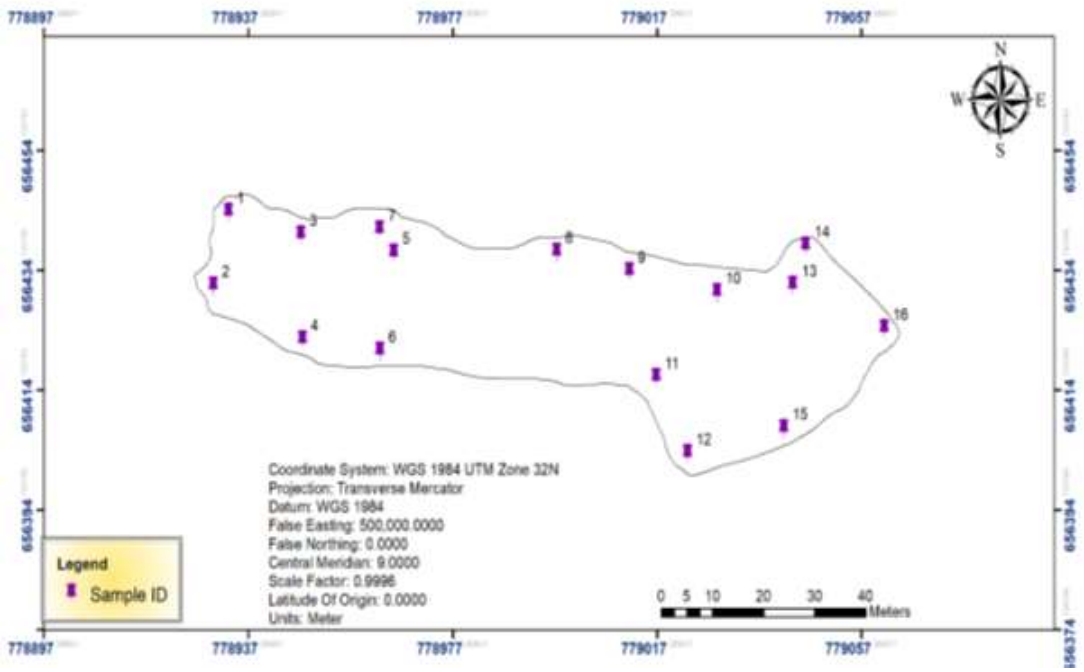

Figure 2. The Base map of Unumherin community showing the sampling points (Omeje *et al.*, 2020).

4. Results and Discussion

4.1. In-situ Activity Concentrations and Background Dose Rates Measured Using Super-Spec **RS-125 ϒ- Spectrometer**

The results of the in-situ measurement of gamma absorbed dose-rate was carried out in the polluted coastlines environment of Unumherin community in the Niger Delta region are presented in Table 1. The outdoor absorbed dose-rate (D_{out}) was obtained *in-situ* by use of RS-125 gamma spectrometer. Figure 3 provides the spatial distribution of the in-situ measured gamma dose rates. Maximum and minimum values of the absorbed dose-rate was observed in location 4 with the value of 100 nGyh^{-1} and location 15 with the value of 2 nGyh^{-1}, respectively. This is an indicative that the risk of ionizing radiation exposures is much higher for location 4 than other locations. This higher value of 100 nGyh^{-1} is far more than the recommended limit of 59.00 and 84.00 nGyh^{-1} provided by UNSCEAR, 2000.

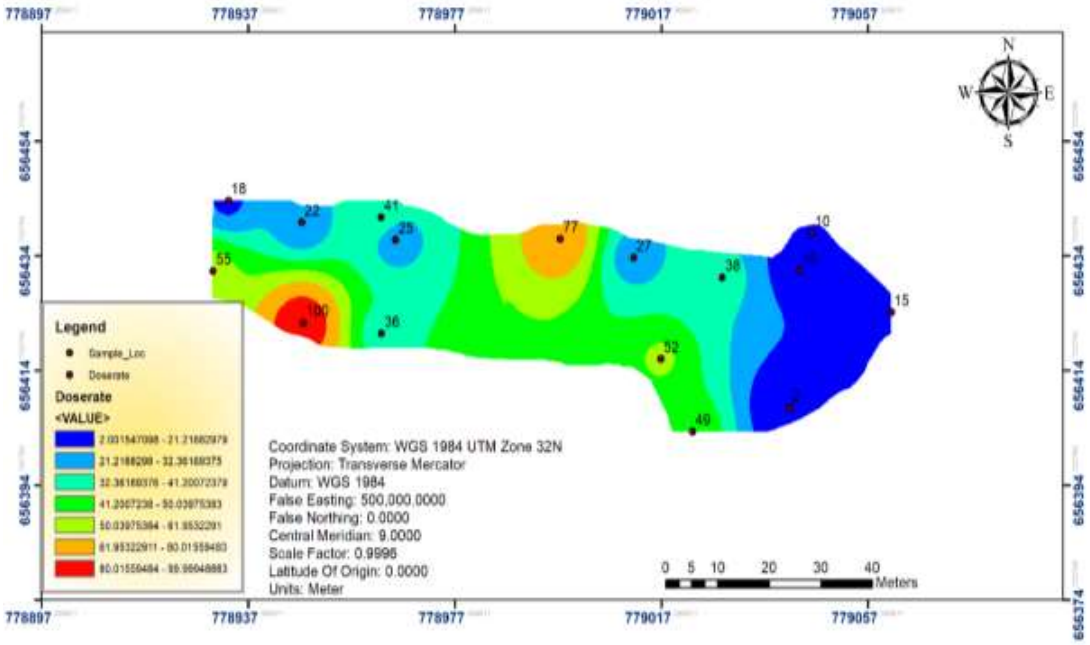

Figure 3. Spatial distribution of gamma dose rates in the coastline area of Unumherin community in Delta State, South-south, Nigeria.

Table 1. The in-situ measured the gamma dose rate (DR)

Points	Lat.(North)	Long.(East)	Elev.(m)	D_{out} ($nGyh^{-1}$)
1	5.933108	5.519315	-19	18
2	5.932997	5.519288	-16	55
3	5.933073	5.519443	-13	22
4	5.932915	5.519445	-14	100
5	5.933045	5.519607	-14	25
6	5.932897	5.519582	-20	36
7	5.93308	5.519582	-15	41
8	5.933045	5.59895	-17	77
9	5.933015	5.520023	-17	27
10	5.932983	5.520178	-18	38
11	5.932855	5.52007	-16	52
12	5.93274	5.520125	-18	49
13	5.932993	5.520312	-26	15
14	5.933052	5.520335	-21	10
15	5.932777	5.520295	-21	2

5. Conclusion

The gamma dose rate in the study area were measured using RS-125 gamma detector to ascertain the potential hazard zones due to background radiation emanating from the coastal environment of Unumherin community in Delta State, South-South, Nigeria. The geospatial analysis from the maps identified the hotspots that indicates the possible vulnerable zones due to distribution of naturally occurring radionuclide in the coastal region of the area. The result revealed the high absorbed dose-rate in location 4 with the value of 100 nGyh^{-1}.This higher value of 100 nGyh^{-1} is far more than the recommended limit of 59.00 nGyh^{-1} provided by UNSCEAR, 2000 by a factor of 1.69.

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