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By

Suleiman M.T.

Umar F. Y.

Amadi Eugene Chikaike

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The Effect of the Presence of Agrochemical and Leachates in Ground Water on Public Health

[1*]Suleiman, M.T., [2]Busari, A.O. & [3]J. A. Tanko
[1]Department of Civil Engineering, Faculty of Engineering, University of Abuja, Nigeria
[2]Department of Civil Engineering, Federal University of Technology, Minna, Nigeria
[3]Department of Civil Engineering, Federal University of Technology, Yola, Nigeria
[*]Corresponding Author's Email: tankusu54@yahoo.com

Abstract

Purpose: This study assesses the effects of agrochemical and leachates present in and Ground water on public health in Niger state and its environs, to carry out this study four research were raised for the study with four research questions and four research hypotheses.

Methodology: The physicochemical parameters of ground water of four study in four different point area namely Minna, Suleja, Bida and Lapai. The groundwater was collected from the wells located in these study Area during the months of February 2019 to November 2019. The depth of the bore wells ranged from 10-12m in all these stations. Chemical analysis of the water samples was carried out with a view to determine the chemical constituents of the water and the level of pollution in the project area. Thirteen (13) parameters were examined in sixteen water samples collected.

Findings: Physio-chemical parameters present in the various study area were considered to be insignificant hence the results also indicated that groundwater within the range of the study area had less concentration of agrochemical. Except electrical conductivity (EC), in W3 which was found to be lower than the1000 S/cm recommended by the WHO while W1, W2 and W4 were found to be higher than the world health organization standard.

Unique Contribution to Theory, Practice and Policy: This study however recommended that Good Agricultural Practice (GAP), proper timing and application of exact quantity of agrochemicals needed by crops and prevention of spillage during application should continue to be practice.

Keywords: *Agrochemicals, Leachates, Ground Water, Public Health.*

INTRODUCTION

Groundwater quality may be defined as the state of being free from physical, chemical, and biological pollutants. Temperature, turbidity, color, taste, and odor make up the list of physical water quality parameters. Since most ground water is colorless, odorless, and without specific taste, we are typically most concerned with its chemical and biological qualities. Although spring water or ground water products are often referred to “pure” it quality is different from that of pure water Musa, (2013).

Naturally, ground water contains mineral ions. These ions are slowly dissolved from oil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer Nagida, (2015). These are referred to as dissolved solids. Some dissolved solids may have originated in precipitation water or river water that recharges the aquifer. Dissolved solids in any water may be divided into three groups: major constituents, minor constituents, and trace elements.

The total mass of dissolved constituents is referred to as the Total Dissolved Solids (TDS). In water, all the dissolved solids are either positively charged ions (cations) or negatively charged ions (anions). The total negative charged anions are always expected to be equals the total positively charged cations. A higher TDS means that there are more cations and anions in the water

Mande, (2016). With more ions in the water, the water’s electrical conductivity (EC) is also high. By measuring the water’s electrical conductivity, we can indirectly determine its TDS concentration. At a high TDS concentration, water becomes saline Ayoda, (2011). Water with a TDS above 500 mg/l is not recommended for use as drinking water (EPA secondary drinking water guidelines).

Water with a TDS above 1,500 to 2,600 mg/l (EC greater than 2.25 to 4mmho/cm) is generally considered problematic for irrigation use on crops with low or medium salt tolerance. Except for natural organic matter originating from top soils, all of these naturally occurring dissolved solids are in organic constituents: minerals, nutrients, and trace elements, including trace metals. In most cases, trace elements occur in such low concentrations that they are not a threat to human health.

In fact many of the trace elements are considered essential for the human metabolism. High concentrations of trace metals can also be found in ground water near contaminated sources, however it would cause, posing serious health threats. Some trace constituents associated with industrial pollution, such as arsenic and chromium, may also occur in completely pristine ground water at concentrations that are high enough to make that water unsuitable for drinking. Microbial pollutants are also a natural constituent of ground water. Just as microbes are ubiquitous in the environment around us, they are very common in the subsurface, including ground water. Hydro geologists increasingly rely on these, for instance, for sub surface bioremediation of contaminated ground water.

Human activities can alter the natural composition of groundwater through the disposal or dissemination of chemicals and microbial matter at the land surface and into soils, or through injection of wastes directly into ground water. Groundwater pollution (or groundwater contamination) may be defined as the presence of pollutant or undesirable change in groundwater quality resulting from human activities as suggested by Musa, (2013).

Agrochemicals refers to the broad range of pesticides including insecticides, fertilizers, hormones, herbicides, fungicides, and other growth chemicals and concentrates of raw animal manure (cow dung and poultry droppings). Globally, agro-chemicals (agrichemicals) are used for improving soil fertility and crop productivity. These methods of farming have been used in agriculture especially cropping system.

The Study Area

Niger State is a state in Central Nigeria and the largest state in the country fig 1. The state capital is Minna, and other major cities are Bida, Kontagora, and Suleja. It was formed in 1976 when the then North-Western State was bifurcated into Niger State and Sokoto State Yaradua, (2004). The Nupe, Gbagyi, Kamuku, Kambari, Dukawa, Hausa and Koro form the majority of the numerous indigenous tribes of Niger State.

Niger State lies between latitudes 8°15’–11°15’N and longitudes 4°00–7°15’ E. Musa, (2013). It’s borderers in the North is Kaduna and Kebbi States and in the South by Kogi State. It shares boundary in the west with Kwara and Benin Republic and in the east with the Federal Capital Territory and Kaduna state. It is divided into twenty-five local governments with a landmass of about 80,000.00 square kilometers and a population of 3,920,000 (2006, census).

Figure 1: Map of Niger States Showing the Three Senatorial Zone (Yaradua, 2004)

METHODOLOGY

The desk study involved collection of relevant topographic maps, review of literature and assembling of fielder. The topographic map was enhanced to the appropriate scale of 1:25,000 and was gridded to allow for fair capture of the entire area. This is subsequently followed by reconnaissance study, which involves introduction to the local Chief and moving around the village with a local farmer to located probable area for sample collection. This was done in the month of May, 2019

Sample and Sampling Method

Table 1: Site Specifications of Ground Water Samples

S/N	Sample Name	Sample Location	Habitat	Source
01	W1	Minna (m1m2m3m4)	Agricultural area	Well
02	W2	Suleja (s1s2s3s4)	Agricultural area	Well
03	W3	Lapai (l1l2l3l4)	Agricultural area	Well
04	W4	Bida (b1b2b3b4)	Agricultural area	Well

The physicochemical parameters of ground water of four study area namely Minna, suleja, Bida and Lapai. The ground water was collected from the wells at four different point each located in these study Area during the months of February 2019 to November 2019. The depth of the bore wells ranged from

10-12m in all these stations. The sampling locations source and corresponding habitats as well as the source of water are shown in Table 1.

FINDINGS

Table 1 shows the public health impairment associated with agrochemical use in the study area. Diarrhea was indicated by 2%, Cough 2%, Cold 4%, and Chest pain recorded 2% while Skin Diseases 1%. In W1 study area. In addition, 2%, 1%, 2.5%, 5.5%, 1.5%, 4.5% of respondents in W2 locations indicated that they experienced Diarrhea, Cough, Cold, Chest pain, Skin Disease respectively. However, 3.5%, 1.5%, 1.5%, 2%, 0.5% 2% was recorded for Diarrhea, Cough, Cold, Chest pain, Skin Disease respectively in W3 study area.

Furthermore W3 recorded 0.0% for diarrhea, 1% for cough, 5% for cold, 5% for chest pain, 5% for skin disease. This is an indication that there is little connection between the use of agrochemical and health implication in the study area. This study corroborates the findings of Truong et al. (1999), Damalas et al. (2011) and Ye et al. (2016) who reported cough, skin diseases and chest pain as some of the impairments associated with the use of agrochemical. In the overall study large number of respondents has no related health problem in the study area.

This research examined the effect of the presence of Agro chemicals and leachates in ground water on public Health in order to compare the concentration of the examined variable with the WHO as well as Nigerian standard of quality (Nig std). Thirteen (13) parameters were examined in relation to sixteen water samples collected. Electrical conductivity (EC), W3 was lower than the1000 S/cm recommended by the WHO while W1, W2 and W4 were found to be higher than the world health organization standard. Concentration of heavy metals and chemical parameters were not more available in groundwater.

Results also indicated that groundwater within the range of the study area had less concentration of heavy metals.

CONCLUSION AND RECOMMENDATIONS

After evaluating the various researches relating to the effect of the presence of Agro chemicals and leachates in ground water on public Health by various authors, the following conclusions were drawn:

i Groundwater is a universally valuable renewable resource for human life and economic development. Growth and development on the earth surface has rendered surface water of certain areas of the world useless despite its availability in large quantity.

ii The study observes limited migration of agrochemicals into leachate from the base of the irrigation site to be the point source of groundwater. This provide groundwater functions for various purposes (such as domestic, industrial and agriculture). Implication of the groundwater pollution which was found to be insignificant cannot be attributed to different public health related problems.

iii Analysis of water samples collected from various locations revealed that many of the parameters use as measurement comply with WHO standards and Nigerian Standard. Groundwater in some of the study area may not requires precautionary measures before drinking. Concentrations of many variables were not detected in large quantity.

iv Concentration of the examined parameters was analyzed, discussed and explained with relevant statistical tools. Electrical Conductivity (EC) has the highest degree of concentration, that is, concentration of EC in water directly influenced some parameters. Of more important is their reduction in relation to time.

v However, not all public health related impairment could be related to contamination of ground water in the study area owing to the fat that the degree of the contamination by agrochemicals and leaches cannot be link to this ailment.

Emerging Issues and Controversies

Pesticide Residue and Water Contamination: The use of pesticides and herbicides in agriculture is a common practice to protect crops from pests and weeds. However, improper application or excessive use can lead to the runoff of these chemicals into groundwater, contaminating drinking water sources. There is ongoing debate about safe levels of pesticide residues in water and their potential long-term health effects, including links to cancer and other chronic diseases.

Groundwater Depletion: Intensive agriculture often relies on irrigation, which can lead to the excessive depletion of groundwater resources. As water is drawn from aquifers faster than it can be naturally replenished, contaminants from fertilizers and pesticides can become more concentrated, increasing the risk of pollution. This depletion also raises concerns about long-term water availability for both agricultural and domestic use.

Endocrine Disruptors: Some agrochemicals contain endocrine-disrupting chemicals (EDCs) that can interfere with the hormonal systems of humans and wildlife. Even at low concentrations, EDCs can lead to developmental, reproductive, and other health issues. Contaminated groundwater sources can expose communities to these substances, with potential long-term consequences.

Controversies over Regulation: There are ongoing debates about the adequacy of regulatory measures to control agrochemical usage and protect groundwater quality. Some argue that existing regulations might not be stringent enough to prevent contamination, while others highlight the need for balanced policies that consider both agricultural productivity and environmental/health concerns.

Cumulative Effects and Mixtures: Groundwater can be contaminated by a mixture of chemicals, including fertilizers, pesticides, and other pollutants. Assessing the combined effects of these chemicals is complex, as they can interact in unexpected ways. Understanding the synergistic or cumulative effects of various contaminants on public health remains a challenge.

Vulnerable Populations: Certain populations, such as those living in agricultural areas, might face higher risks due to their proximity to potential contamination sources. Low-income communities and marginalized groups could be disproportionately affected by groundwater pollution due to limited access to clean water resources and healthcare.

Research and Data Gaps: There's an ongoing need for comprehensive and up-to-date research to understand the extent of groundwater contamination, the movement of contaminants in aquifers, and their impact on human health. Filling these research gaps is crucial for making informed policy decisions.

Transition to Sustainable Agriculture: The controversy extends to discussions about transitioning to more sustainable agricultural practices that reduce reliance on agrochemicals. While there's growing interest in organic farming and integrated pest management, challenges such as yield sustainability and feeding a growing global population need to be addressed.

Public Awareness and Education: Educating communities about the risks associated with agrochemical contamination in groundwater is essential. Public awareness campaigns can empower individuals to take actions to protect their health and advocate for better environmental practices.

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Study of Influencing Factors of Domestic Solid Waste Management in Federal Capital Territory, Abuja

[1*]Umar, F. Y., [2]Ogwueleka T. C. & [3] Busari A. O.
[1]Department of Civil Engineering, Faculty of Engineering, University of Abuja, Nigeria
[2]Department of Civil Engineering, Federal University of Abuja, FCT, Nigeria
[3]Department of Civil Engineering, Federal University of Technology, Minna, Nigeria
[*]Corresponding Author's Email: umarfaruk645@yahoo.com

Abstract

Purpose: The study is on the influencing factors of domestic solid waste management in Abuja targeted at investigating and studying the factors influencing domestic solid waste management in Abuja, Historically, the amount of wastes generated by human population was insignificant mainly due to the low population densities, coupled with the fact that there was very little exploitation of natural resources. The problem associated with the management of solid waste in most urban cities in Nigeria, like Abuja, does not completely appear to be a problem of absence of legislative framework for solid waste management owing to the fact that at Federal, States, and Local governments levels, there exist some form of sanitation legislations or the other, but some other factors have come to play with the crises experienced in the management of wastes in the Nigerian urban centers.

Methodology: The research procedures involve the following: research design, population of the study, sample and sampling techniques, instrumentation, validation of the instrument, administration of the instrument and data analysis techniques.

Findings: The result of the study to determine the social factor affecting the management of domestic waste: Location have great effect on waste management, not that everyone should leave in that location, but amenities available in that location should be considered in other locations too. There's is inadequate waste bin located across the location of study. To determine the economic factor affecting the management of domestic waste: The key economic factor affecting waste management is the poor economy of the nation. Poor or bad technological concept lack of facilities, insufficient man power and more affect the waste management. To determine the natural factors affecting household waste management in Abuja: Top on the natural factor that affects solid waste management in Abuja is the wind, topography and flooding. Which made the management of this waste difficult by the waste management companies. Rain have a slight stand out as during rainy seasons waste management team don't go into all sessions to extract waste.

Unique Contribution to Theory, Practice and Policy: Further finding solving the research questions shows that the social status of Abuja residence affects the disposal of waste. The lack of finance or poor economic condition result to poor waste management. Some natural element has significance on waste management in Abuja. Some other factor that have significant effect on household waste management, e.g. corruption, bad economy, lack of sensitization and lack of funds. Furthermore, waste reuse will not be out of place hence the territory moves closer to a zero waste level, where all said waste are recycled and reused by the host communities.

Keywords: *Poor Economy, Waste Management, Social Status, Poor Waste Management, Corruption, Bad Economy, Lack of Sensitization, Funds.*

INTRODUCTION

The study is on the influencing factors of domestic solid waste management in Abuja targeted at investigating and studying the factors influencing domestic solid waste management in Abuja, the concept on this chapter is to slate back ground of the study giving a brief knowledge of the study, statement of the research problem a quick touch on the possible challenges in the cause of the study with the positive mind of overcoming them. Statement of the research questions covering possible questions to be addressed by the study, derived from the aim and objectives of the study, also the justification of the study statement for the reason of the study, slating observations and finds resulting to this.

Historically, the amount of wastes generated by human population was insignificant mainly due to the low population densities, coupled with the fact that there was very little exploitation of natural resources. Common wastes produced during the early ages were mainly ashes and human & biodegradable wastes (Biodegradable waste is a type of waste, typically originating from plant or animal sources, which may be broken down by other living-organisms. Waste that cannot be broken down by other living organisms may be called non-biodegradable) and these were released back into the ground locally, with minimal environmental impact.

Recognizing the urgency of this problem, a growing number of countries have taken initial steps to respond to this need. These include the establishment of regulatory frameworks, development of national plans and the demonstration of innovative approaches. However, funding of healthcare waste management remains very inadequate.

The management of solid waste continues to be a major challenge in urban areas throughout the world particularly in the rapidly growing cities of the developing world (Foo, 1997). A high rate of population growth and increasing per capita income have resulted in the generation of an enormous volume of solid waste, which poses a serious threat to environmental quality and human health (Snigdha, 2003). Access to sanitation services and clean adequate water are therefore regarded as crucial to the health and wellbeing of people. It is widely accepted that the management of solid waste is a global problem. This problem is even more pronounced in developing countries such as Nigeria where solid waste management is a major concern. Adeyemi et al, (2001) observed that solid waste constitutes a major problem in most developing countries.

Adeyemi added that waste management is one of the most intractable problems facing city administrators and environmental agencies. Ogwueleka, (2009) reported that solid waste management is by far one of the greatest challenges facing environmental bodies in the country. As a result of the management challenges, Adefemi and Awokunmi, (2009) reported a breakdown of law and order in relation to waste management. They observed that urban centers are experiencing an increased rate of environmental deterioration as a result of indiscriminate dumping of solid waste.

Ogbonna et al., (2007) reported that in response to the enormous challenges pose by municipal solid waste management, the Government is taking steps to address these problems by engaging local contractors to evacuate waste. Ogbonna et al. (2007) observed that cities are divided into sections for the local contractors. However, inefficiency still thrives due to the lack of coordination on the part of the Government and the lack of expertise on waste management issues by the environmental agencies. The reasons behind inefficient waste management practice in Nigeria have been well researched.

For example, Agunwamba, (1998) reported that there is a general lackadaisical attitude on the part of the government towards waste management. In addition, Adeyemi et al, (2001) observed that in Nigeria the management of municipal solid waste revolves mainly around open burning, open dumps, landfilling, reuse/recycling and waste conversion.

Figure 1: Municipal Solid Waste Quantities (Hoornweg and Bhada-Tata, 2012)

The total amount of MSW generated globally is estimated at about1, 300 million tonnes per area, and it is expected to increase to approximately2, 200 million tonnes by 2025 as shown in Figure 1 (Hoornweg and Bhada-Tata, 2012). The major sources of MSW are the residential and commercial sectors (Figure 2; Mihelcic and Zimmerman, 2010). The quantities of food wastes, garden wastes, paper, plastic and glass generated from both sectors contribute most to solid waste over all. Then the waste quantities vary among the remaining sectors, with construction and demolition having the highest contribution percentage after the residential and commercial sectors. This is due to the generation of concrete, metal, wood, asphalt, wallboard and dirt-predominant wastes.

Figure 2: Municipal Solid Waste Source (Mihelcic and Zimmerman, 2010)

Aims and Objectives of Study

This work is aimed at investigating the factors influencing domestic solid waste management in Abuja and possible ways of enhancing the waste management service in Abuja Federal Capital of Nigeria. In order to achieve these goals, the following objectives set out for the study are to: -

i To determine the social factor affecting the management of domestic solid waste.

ii To determine the economic factor affecting the management of domestic solid waste.

iii To determine the natural factor affecting household solid waste management in Abuja.

iv To determine other factor affecting household solid waste management in Abuja.

The Study Area

Abuja is the capital city of Nigeria. It is located in the center of Nigeria, within the Federal Capital Territory. It falls within latitude 8.28° and 9.20° North of the Equator and longitude 6.45° and 7.39° East of the Greenwich Meridian. It occupies an area of about $250km^2$ within the Gwagwa Plains in the northeast quadrant of the FCT. At the 2006 census, the city of Abuja had a population of 776,298 (NBS Census, 2006), making it one of the top ten most populous cities in Nigeria. The FCT is bounded on the north by Kaduna State, on the west by Niger State, on the east and south-east by Nassarawa State, and on the south-west by Kogi State.

The physical development of Abuja is planned to progress in four operational phases. It is being developed in phases (four phases in all) over an area of 250 square kilometres. Each of the phases is divided into districts and each district is further subdivided into neighborhoods for planning and development purposes. The physical development of Abuja is planned to progress in four operational phases. Phase 1 consists of seven districts: The Central Area, Garki I, Garki II, Wuse I, Wuse II, Asokoro, and Maitama.

Phase II consists of 14 residential districts and four sector center. Phase III consists of eleven districts. The spiraling economic and sociopolitical activities, with the attendant strains on housing and living conditions, contributed largely to the upsurge of squatter settlements in the territory. These settlements (with the exception of Garki Village within Garki II District of the city) are predominantly situated in the city suburbs, otherwise known as satellite towns. These suburban areas generally are densely populated and lack good infrastructure, basic social services and amenities. Poor unemployed persons and lowincome workers who live in shanty and poor accommodation structures mainly constitute the suburban population.

Justification

Social factors affecting the management of domestic waste, which covers from domestic waste in terms of sources, these social factors are; class of employment wherein the head of an household is working in a well-paid organization it will be easier for such to pay the bills attached to waste disposal or even hire or subscribe to a waste management agency to help ensure proper management of their household waste, this might not be possible for someone whose monthly take home does not even pay his family meals, light bills or water bills. The family size is another key player in the increase of waste and management of it, at single it may be easier to control waste, when married waste generation increases and as the family increase their is an increase in the quantity of waste generated therefore managing such maybe become difficult or unaffordable.

The level of awareness may stand as a social factor in affecting the management of these waste as residents may have poor knowledge on how to manage these waste even by themselves or even know that there is an agency for waste management, information may be limited reaching them, the knowledge of the policies guiding domestic waste might be out of their knowing, A sought of knowledge gap.

METHODOLOGY

This chapter is designed to describe the procedures adopted in this research. The procedures involve the following: research design, population of the study, sample and sampling techniques, instrumentation, validation of the instrument, administration of the instrument and data analysis techniques. This research will cover the study of solid waste management in the Federal Capital Territory municipalities using ISWM (integrated solid waste management) as an assessment tool.

The area of this study is confined to the five area councils and one municipal area council that makes up Abuja. The focus of the survey aspect of the research will include all residents residing within these areas. Primary data were collected through questionnaires using random sampling for the residential questionnaire. The field survey will be inclusive of all areas within research scope. The research boundaries of the study include the system elements of the integrated solid waste management system.

In the sampling, since the researcher choose to undergo a quantitative research, a probability sampling technique is adopted under which a simple random technique is considered suitable for the study. The Yaro Yamane formula below will be used to determine sample size to be used at 0.05 confidence level (level of significance): The sample size will be obtained using formula

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = expected questionnaire, N = Target population, 1 = Constant, e = level of significant

Now having n =? 1 = constant, N = 2,440,000, and e = 0.05

Using: $n = \frac{2,440,000}{1+2,440,000(0.05)^2}$; $n = \frac{2,440,000}{6101}$

Therefore, n=399.93

Approximately 400 questionnaires are admitted to the metropolitan city at random order. In other to have equal distribution the researcher will use the calculation to get the expected questionnaire per area, as the metropolitan city is divided into 6 areas. In order to avoid insufficiency in quantity or questionnaire 50 more questionnaire were added to the calculated 400 questionnaires making it a total of 450 questionnaire distributed.

$$expected\ number\ of\ questioniare = \frac{calculated\ number\ of\ questioniare}{number\ of\ areas}$$

$$expected\ number\ of\ questioniare = \frac{450}{6} = 75$$

Having the above result, the expected number of questionnaire distributed is 75 questionnaires to six areas of the metropolis.

FINDINGS

Considering the short coming in domestic waste management as observed people are reserved in this case, as a hopping sum of 282 have no comment on any short coming from the government or society or anyone. Though the next high sum of 43 stood bold that corruption is a major challenge to waste management in the area, where 25 of the participant said its lack of fund as if fund is made available then the management would easier, a percentage of 2.8(11) respondent said its poor technology that result to poor management, maybe drawing light from the overwhelming nature of the job, bad economy was not left out in this case of short coming of the present system of waste management in the area, as 20 respondent among others slated. When sensitization came up from a few of 10 participants out of 391.

Perceived all of the above in table 28 above. 62 % indicated that segregation should be done at the source, as against 24.67 % who indicated otherwise.

There was satisfactory knowledge of colour coding of wastes which is an essential factor for proper segregation of waste.

A correlation analysis was done to check for the effect of one potential variable on another, this is to enable detection of the relationship and the intensity of such relationship between variables.

FINDINGS

The study made the following findings based on the responses of the respondents that:

To determine the social factor affecting the management of domestic waste.

- Location have great effect on waste management, not that everyone should leave in that location, but amenities available in that location should be considered in other locations too.
- There's is inadequate waste bin located across the location of study.
- There should be corporate social responsibility among residence as not all within our environment should be left to government (AEPB).
- There should be sensitization, to avoid waste been full before disposal.

To determine the economic factor affecting the management of domestic waste.

- The key economic factor affecting waste management is the poor economy of the nation.
- Poor or bad technological concept lack of facilities, insufficient man power and more affect the waste management.
- The residence has poor attitude to waste management, this must be due to poor awareness, sensitization, and bad economy.
- Unavailability of sufficient recycling company in the land, hence the residence has no economic importance of waste.

To determine the natural factors affecting household waste management in Abuja.

- Top on the natural factor that affects waste management in Abuja is the wind, topography and flooding. Which made the management of this waste difficult by the waste management companies.

- Rain have a slight stand out as during rainy seasons waste management team don't go into all sessions to extract waste.

To determine other factor affecting household waste management in Abuja.

This deals with the preventions of negative management, hence:

- A domesticated recycler should be made available to residence.
- Continuous training and awareness should be carried out via publicity arm of the society.
- More waste collector should be strategically placed, to avoid wrong placement of waste by residence or passer-by.
- Incorporation of waste management into basic school curriculum

CONCLUSION AND RECOMMENDATIONS

Conclusion

In conclusion it is expedient that the case of waste management should be taking more seriously as to help in limiting pandemics, epidemics and their likes. Keeping the environment hygienic enough is the call to everyone, not just a call to the government, the indigenes, citizen's foreigners should be intimated on proper waste management concept with the made available facilities from government and her partners to help cub the complications attached to the waste management. A better management technology should be introduced like the domesticated waste management cabinet and the domesticated waste recycler machine.

Recommendation

The study recommends that:

i Further study should be done on domesticated waste carbine as it will help reduce the quantity of waste generated in the community, and it will help simplify the management of waste by the waste management team and recycling companies.

ii The domesticated waste machine or chamber should be further studied as it will be of interest to the economic growth of the nation, reduce social irresponsibility, and improved hygiene.

Emerging Issues and Controversies

Rapid Urbanization and Population Growth: Urbanization and population growth can lead to increased waste generation. The FCT, being the capital city of Nigeria, has experienced significant population growth and urban expansion. The study might explore how these factors impact waste management infrastructure and services.

Inadequate Infrastructure: The development and maintenance of waste management infrastructure, such as collection systems, recycling facilities, and disposal sites, might struggle to keep up with the pace of urbanization. Controversies could arise regarding the allocation of resources and investments in waste management infrastructure.

Behavioral Patterns: Consumer behavior and public awareness play a crucial role in waste generation and disposal. The study might investigate how cultural norms, consumer choices, and education programs influence waste management practices. Controversies could arise around finding effective ways to encourage responsible waste disposal behaviors.

Informal Waste Sector: In many urban areas, including the FCT, there's a significant informal waste sector involving waste pickers and recyclers. The study might explore the challenges and opportunities presented by this informal sector, including issues related to health and safety, recognition, and integration into formal waste management systems.

Waste Segregation and Recycling: Effective waste management often involves waste segregation at source and recycling. The study might delve into barriers to proper waste segregation, challenges in establishing recycling programs, and controversies related to waste export and recycling technologies.

Waste Collection and Transportation: Efficient waste collection and transportation systems are critical for preventing littering and illegal dumping. The study might discuss issues related to collection frequency, vehicle maintenance, and route optimization, as well as controversies surrounding the privatization or public management of waste services.

Waste Disposal Sites and Environmental Impact: The study could examine the siting and management of waste disposal sites, such as landfills, and their potential environmental and health impacts on nearby communities.

Waste-to-Energy and Circular Economy Approaches: Some regions explore waste-to-energy technologies and circular economy concepts to manage waste sustainably. Controversies might revolve around the environmental and economic implications of these approaches, as well as concerns about potential negative impacts on marginalized communities.

Government Policies and Regulations: The study could analyze existing waste management policies, regulations, and their enforcement. Controversies might involve debates about policy effectiveness, stakeholder engagement, and the need for stricter regulations to address waste management challenges.

Equity and Social Justice: Waste management practices can disproportionately affect certain communities, particularly low-income and marginalized groups. The study might explore issues related to environmental justice, fair access to waste services, and strategies to mitigate inequities.

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Determination of Terrestrial Radiation Level of Obite, Rivers State

[1*]Amadi Eugene Chikaike, [2]Dr. M.A. Briggs-Kamara & [3]Dr I. Tamunobereton-Ari
Department of Physics, Faculty of Science, Rivers State University, Port Harcourt, Rivers State
[*]Corresponding Author's Email: amadieugene2@gmail.com

Abstract

Purpose: The perceived implication of increase in background radiation level of Obite Community due to inputs of hydrocarbon leakages and its emissions, lead to this research work, which investigated the background ionizing radiation levels of the area.

Methodology: An in-situ background ionizing radiation measurement was carried out using radiation meter (Digilert 200) at an elevation of 1.0m above ground level with a Global Positioning System (G.P.S) for geographical location.

Findings: The background ionizing radiation (BIR) results obtained, varies from 0.007 to 0.024 (mR/hr) with a mean value of 0.013 (mR/hr). The values of Absorbed Dose Rate ranges from 60.9 to 208.0 nGy/hr with a mean value of 115.10±0.003 nGy/hr, which is higher than the recommended safe limit of 84.0 nGy/hr (UNCEAR, 2018). The Annual Effective Dose Equivalent (AEDE) varies from 0.009 to 0.38 mSv/yr with mean of 0.198 mSv/yr, is lower than the safe limit of 1.0 mSv/yr stipulated by ICRP (2003) and WHO (2008). The Excess Lifetime Cancer Risk (ELCR) values ranges from 0.32 to 0.09 x 10^{1} with a mean of 0.062 x 10^{-1}, is higher than the ICRP standard of 0.29 x 10^{-3} (ICRP, 2003).

Unique Contribution to Theory, Practice and Policy: These results indicate an increase in cancer risk for individuals within the study area. The results were also summarized using the contour map to show various areas of high radiation distributions with interpretation of variability in concentration, in relation to geographical locations within the study area.

Keywords: *Ranuclides, Background Radiation Level, Absorbed Dose, Effective Dose, Obite Community*

INTRODUCTION

Background radiation is part of the natural environment as such, humans and other living organisms are continuously exposed to it. This has increased on daily bases due to anthropogenic activities with great concerns putting into considerations its effects when exposed to high doses. The human exposure to background ionizing radiation of a particular environment is affected by various factors such as altitude and latitude (Chad-Umoren and Briggs-Kamara, 2010).

Most exposures to radiation sources are modified by anthropogenic activities like the radio nuclides released to the environment during mineral processing (UNSCEAR, 2010). The exposure to high level of gamma radiation has a number of harmful effects, such as mutation and cancer of various types (Aziz et al., 2014).

According to Jibiri et al. (1993), radionuclides are unstable elements, which in the process of attaining stability, spontaneously disintegrates, giving out dangerous ionizing radiation to the environment. However, the background radiation level of a particular place, is linearly propotional to the ecological formation of such area (Jibiri et al; 1993). The inheritance of radiological consequences posed by oil and gas exploration, exploitation, mining and processing of petroleum activities across the Niger Delta, has been heavy for the past forty (40) years (Ononugbo et al, 2011). These activities have altered the natural ionizing radiation exposure level to both workers and the members of the general public. ICRP report, (1990) states, that radiation dose of about 80% to man emanates from natural sources of which radon contributes about 55%.

Radiation doses received by individuals at higher level, puts those individuals at a greater risk of developing cancer, considering their exposure time. The impact of low radiation dose may not manifest immediately, until many years after exposure and no level of radiation exposure despite how low, for which it does not pose a risk to life (Avwiri et al, 2010). The external radiations mainly emanate from radionuclides in soil and are emitted within 15-30cm of the top soil in the earth surface (Farai and Vincent, 2006).

Sigalo and Briggs-Kamara (2004) carried out a study on the background radiation levels within twelve riverine communities of the Niger Delta. This was to investigate whether or not the onshore oil activities, has increased the level of background radiation of the environment. The study showed a result range of 0.57±0.16 to 0.85±0.19 mSv/yr, which are below the set limit in a normal environment of 1mSv/yr by the European Council for Nuclear Research (CERN, 1995).

Also, Osimobi *et al* (2005) investigated the background ionizing radiation level in few solid mining sites in Enugu State, and reported a result of 38.5% elevation above the normal radiation level. Ovuomarie-Kelvine *et al* (2018), reported an average value range of 12.00±0.10 to 22.00±2.10 □Rh^{-1} in the oilfield, while in the communities, the results ranges from 9.00±1.00 to 11.00±0.30 NRh^{-1}, as it studied the terrestrial radiation levels around oil spill sites in Rivers and Bayelsa, which was concluded that the background radiation levels in the area, exceeded normal background levels compared to the world standard.

Ionizing radiations are highly energetic with characteristic high penetrating power. When such radiation penetrates into the biological cell, it causes both excitation and ionization which alters the cells formation (Emelue et al., 2014). Quantities, such as the absorbed dose, effective dose and the equivalent dose, have been introduced to measure the amount of dose received and the level of biological effectiveness of that dose (Akpa, 2010).

Study Area

The study area is Obite Community of Egi Clan in Ogba/Egbema/Ndoni Local Government Area of Rivers State. It lies between the latitude of 5º15'3.06'N and longitude of 6º39'27.81'E, with a fast-growing population of over 5,400 persons (Umunakwe and Aharanwa, 2015). Obite community shares boundary with other communities such as Ogbagi, Ogbogu, Ede, Akabuka, Obuobu and Omoku as their neighbouring town. Obite community hosts Total Exploration and Production Nigeria Limited, the operators of OML 58, as well as different pipelines from Shell Petroleum Development Company of Nigeria (SPDC).

METHODOLOGY

Data Collection

A Global Positioning System (G.P.S) was used to measure the geographical co-ordiantes of the sampling points. Nuclear Radiation Monitor (Digilert 200) was used to measure the background radiation level, which identifies Alpha, Beta, Gamma and X-radiations. The meter was caliberated in terms of its functional quantities. The meter recorded dose rate in milli-roentgen per hour ($mR\ hr^{-1}$), which was converted to absorbed dose rate in Nano gray per hour ($nGhr^{-1}$). The meter was placed about one meter above the ground level for maximum detection, as most stable point was recorded. The measurement was repeated at each measuring point, recording three readings for every point, with an aggregate of thirty (30) readings taken altogether from the research area.

Figure 1: Global Positioning System and Nuclear Radiation Monitor (Digilert 200)

Radiological Health Risk Parameters Absorbed Dose Rate (ADR)

Data obtained for the external exposure rate in mR/hr was converted into absorbed dose rate in nGy/hr using the conversion factor. Absorbed dose is a physical quantity D representing the mean energy conveyed to matter per unit mass by ionizing radiation.

Absorbed Dose = exposure dose rate x 8.7 (nGy/hr)

1μR/hr =8.7 nGy/hr

$$= \frac{8.7 \times 10^{-3} \mu gY}{1/8760} = 76.212 \mu Gyh^{-1} \quad 1.5$$

Equivalent Dose

Equivalent Dose is the product of the average absorbed dose (DTR) of radiation (R) in a tissue and radiation weighting factor (WR). The equivalent dose is use to assess how much biological damage is expected from the absorbed dose of certain type of radiation

$$\text{Equivalent Dose} = 1mR/hr = \frac{0.96 x 24 x 365}{100} \quad (mSv/yr) \quad 1.6$$

Annual Effective Dose Equivalent

Measured absorbed gamma dose rates were used to calculate the annual effective dose equivalent received by the people of the surveyed area. Dose conversion factors of 0.7 Sv/Gy, occupying factor for indoor and outdoor of 0.70 (18/24) and 0.2(6/24) was used to calculate for the annual effective dose equivalent (AEDE).

The annual effective dose (AEDE) is determined using the equation by (Mhuhammad *et al.* 2014), in line with ICRP (2007) guideline.

AEDE (outdoor) (mSv/yr)

= Absorbed dose rate (nGy/h)×8760h × 0.7 Sv/Gy × 0.25 1.7

Excess Lifetime Cancer Risk (ELCR)

Excess lifetime cancer risk deals with the possibility of developing cancer over a lifetime at a given exposure level. The average duration of life is 70 years while the risk factor for public exposure is 0.05 (ICRP 60).

Excess Lifetime Cancer Risk (ELCR) is calculated using the expression;

ELCR **=** AEDE × Average Duration of Life (DL) × Risk Factor (RF)   1.8

Contour Mapping

Contour maps were created by the view of locating area of high radiation distribution of the measured background ionizing radiation, outdoor radiation level. The locations coordinates measured with geographical positioning system (GPS) and the result obtained were used to plot the contour map with the aid of software (Surfer8 software). In this study, the map represents the sampling locations and it summarizes the radiation level of the study area. The maps are helpful in interpretation of the variability in concentration in relation of the geographical location within the study location.

FINDINGS

***In-Situ* Measurement Results**

The results of the *in-situ* measurement of the background ionizing radiation (BIR) levels outdoor of the study area and their respective geographical coordinate are presented in Tables 1 and Table 2 below, Figure 1 show the Comparison of Exposure Dose Rate (mR/hr) with Standard, Figure 2 Show the comparison of Absorbed Dose Rate (nGy/hr) with Standard, Figure 3 shows Comparison of Annual Effective Dose Equivalent (AEDE), Figure 4 show the Comparison of Excess Life Cancer Risk with ICRP Standard (2007) and Figure 5 show the contour map of the study area.

Table 1: Background Ionizing Radiation Measurement of the Study Area

Sampling Points	Code	GPS Reading	Exposure Dose Rate ($mRhr^{-1}$)			Exposure Dose Rate Mean ($mRhr^{-1}$)
			1st Reading	2nd Reading	3rd Reading	
Civic Centre	$OBRM_1$	NO5^{0}15.274' E006^0 39.383'	0.007	0.019	0.006	0.011±0.003
Church of God	$OBRM_2$	N05^0 15.284' E006^{03}9.435'	0.013	0.009	0.009	0.010±0.001
Best Man Layout Point 1	$OBRM_3$	N05^{0}15.237' E006^0 39.472'	0.007	0.013	0.007	0.009±0.001
Best Man Layout Point 2	$OBRM_4$	N05^{0}15.227' E006^0 39.497'	0.013	0.006	0.015	0.011±0.000
Best Man Layout Junction	$OBRM_5$	N05^{0}15.176' E006^{0}39.500'	0.009	0.006	0.015	0.010±0.002
Faith Maternity	$OBRM_6$	N05^{0}15.134' E006^{0}39.573'	0.007	0.017	0.017	0.014±0.002
Farmland by Best man	$OBRM_7$	N05^{0}15.067' E006^{0}39.581'	0.009	0.007	0.015	0.010±0.001
Oil Location Junction	$OBRM_8$	N05^{0}15.046' E006^{0}39.584'	0.009	0.013	0.019	0.014±0.002
Oil Location Road	$OBRM_9$	N05^{0}15'036' E006^{0}39.569'	0.011	0.007	0.011	0.010±0.002
Titi-Ikpe Resort	$OBRM_{10}$	N05^{0}15.049' E006^{0}39.597'	0.011	0.007	0.009	0.009±0.002
Titi Ikpe Transformer	$OBRM_{11}$	NO5^{0}15.038' E006^{0}39.609'	0.013	0.007	0.011	0.010±0.002
Water Project Point	$OBRM_{12}$	N05^{0}15.010' E006^{0}39.665'	0.026	0.020	0.017	0.021±0.001
Egita Road Obite	$OBRM_{13}$	NO5^{0}14.992' E006^{0}39.690'	0.015	0.015	0.011	0.014±0.002
Greater Evangelism Church	$OBRM_{14}$	N05^{0}14.998' E006^{0}39.697'	0.015	0.022	0.022	0.020±0.002
Living Faith Church	$OBRM_{15}$	N05^{0}14.990' E006^{0}39.719	0.021	0.017	0.013	0.017±0.002
Total Guest House Obite	$OBRM_{16}$	N05^{0}14.981' E006^{0}39.806'	0.024	0.019	0.017	0.020±0.003
Assembly of God Church	$OBRM_{17}$	N05^{0}15.986' E006^{0}39.467'	0.020	0.021	0.022	0.021±0.001
Church of God Jerusalem	$OBRM_{18}$	NO5^{0}15.015' E006^{0}39.516'	0.011	0.036	0.026	0.024±0.002
Egita Road By Market Obite	$OBRM_{19}$	NO5^{0}15.003' E006^{0}39.487'	0.007	0.013	0.013	0.011±0.002

Table 1: Background Ionizing Radiation Measurement of the Study Area

Obite First Market Junction	OBRM$_{20}$	N05^{0}15.015’ E006^{0}39.437’	0.019	0.022	0.019	0.020±0.003
Obite Second Market Junction	OBRM$_{21}$	NO5^{0}15.018’ E006^{0}39.418’	0.009	0.011	0.015	0.012±0.002
Market Point	OBRM$_{22}$	N05^{0}15.018’ E006^{0}39.389’	0.010	0.009	0.013	0.010±0.000
Obite Market Roundabout	OBRM$_{23}$	N05^{0}15.017’ E006^{0}39.362’	0.011	0.009	0.011	0.010±0.001
Obite Playground Road	OBRM$_{24}$	N05^{0}15.019’ E006^{0}39.338’	0.007	0.013	0.009	0.010±0.002
Obite Town Hall	OBRM$_{25}$	N05^{0}15.033’ E006^{0}39.331’	0.007	0.008	0.006	0.007±0.001
Obite Play Ground	OBRM$_{26}$	N05^{0}15.032’ E006^{0}39.326’	0.009	0.010	0.011	0.010±0.002
Govt. Comp. Sec. Sch. Obite	OBRM$_{27}$	N05^{0}15.059’ E006^{0}39.276’	0.022	0.021	0.013	0.019±0.001
Gov. Comp. Sec. Sch. Class block	OBRM$_{28}$	N05^{0}15.035’ E006^{0}39.272’	0.013	0.015	0.007	0.012±0.002
Administrati ve block	OBRM$_{29}$	N05^{0}15.058’ E006^{0}39.232’	0.011	0.015	0.011	0.012±0.003
Corpers Lodge.	OBRM$_{30}$	N05^{0}15.022’ E006^{0}39.235’	0.006	0.009	0.011	0.009±0.001

Table 2: Radiological Parameters

Sampling Points	Code	Exposure dose rate (mRhr^{-1})	Equivalent Dose (mSv/yr)	Absorbed Dose (nGy/hr)	AEDE Outdoor (mSv/yr)	ELCR × 10^{-3}
Civic Centre	$OBRM_1$	0.011±0.0 03	0.925	95.7	0.15	0.51
Church of God	$OBRM_2$	0.010±0.0 01	0.841	87.0	0.14	0.49
Best Man Layout Point 1	$OBRM_3$	0.009±0.0 01	0.757	78.3	0.12	0.42
Best Man Layout Point 2	$OBRM_4$	0.011±0.0 00	0.925	95.7	0.15	0.51
Best Man Layout Junction	$OBRM_5$	0.010±0.0 02	0.841	87.0	0.14	0.49
Faith Maternity	$OBRM_6$	0.014±0.0 02	1.177	121.8	0.20	0.70
Farmland By Best man	$OBRM_7$	0.010±0.0 01	0.841	87.0	0.14	0.49
Oil Location Junction	$OBRM_8$	0.014±0.0 02	1.177	121.8	0.20	0.70
Oil Location Road	$OBRM_9$	0.010±0.0 02	0.841	87.0	0.14	0.49
Titi-Ikpe Resort	$OBRM_{10}$	0.009±0.0 02	0.757	78.3	0.12	0.42
Titi Ikpe Transformer	$OBRM_{11}$	0.010±0.0 02	0.841	87.0	0.14	0.49
Water Project Point	$OBRM_{12}$	0.021±0.0 01	1.766	182.7	0.35	0.94
Egita Road Obite	$OBRM_{13}$	0.014±0.0 02	1.177	121.8	0.20	0.70
Greater Evangelism Church	$OBRM_{14}$	0.020±0.0 02	1.682	174.0	0.33	0.89
Living Faith Church	$OBRM_{15}$	0.017±0.0 02	1.429	147.9	0.23	0.81
Total Guest House Obite	$OBRM_{16}$	0.020±0.0 03	1.682	174.0	0.33	0.89
Assembly of God Church	$OBRM_{17}$	0.021±0.0 01	1.766	182.7	0.35	0.94
Church of God Jerusalem	$OBRM_{18}$	0.024±0.0 02	2.018	208.0	0.39	1.09
Egita Road by Market Obite	$OBRM_{19}$	0.011±0.0 02	0.925	95.7	0.15	0.51
Obite First Market Junction	$OBRM_{20}$	0.020±0.0 03	1.682	174.0	0.33	0.89
Obite Second Market Junction	$OBRM_{21}$	0.012±0.0 02	1.009	104.4	0.17	0.60
Market Point	$OBRM_{22}$	0.010±0.0 00	0.841	87.0	0.14	0.49
Obite Market Roundabout	$OBRM_{23}$	0.010±0.0 01	0.841	87.0	0.14	0.49
ObitePlayground Road	$OBRM_{24}$	0.010±0.0 02	0.841	87.0	0.14	0.49
Obite Town Hall	$OBRM_{25}$	0.007±0.0 01	0.588	60.9	0.09	0.32
Obite Play Ground	$OBRM_{26}$	0.010±0.0 02	0.841	87.0	0.14	0.49
Govt.Comp.Sec. Sch. Obite	$OBRM_{27}$	0.019±0.0 01	1.598	165.3	0.27	0.85
Gov. Comp. Sec. Sch. Class block	$OBRM_{28}$	0.012±0.0 02	1.009	104.4	0.17	0.60
Administrative block	$OBRM_{29}$	0.012±0.0 03	1.009	104.4	0.17	0.60
Corpers Lodge.	$OBRM_{30}$	0.009±0.0 01	0.757	78.3	0.12	0.42
Mean		**0.013±0.0 02**	**1.113±0. 001**	**115.10±0. 003**	**0.195±0. 001**	**0.624±0. 002**

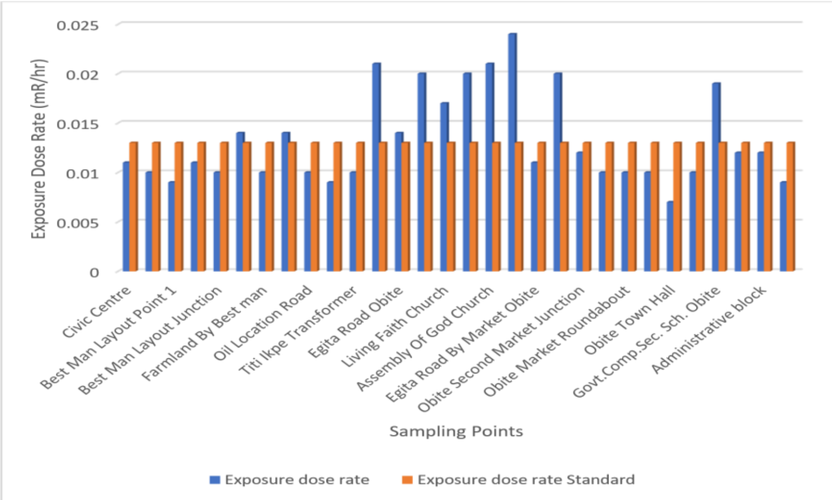

Figure 1: Show the Comparison of Exposure Dose Rate (BIR) mR/hr with Standard

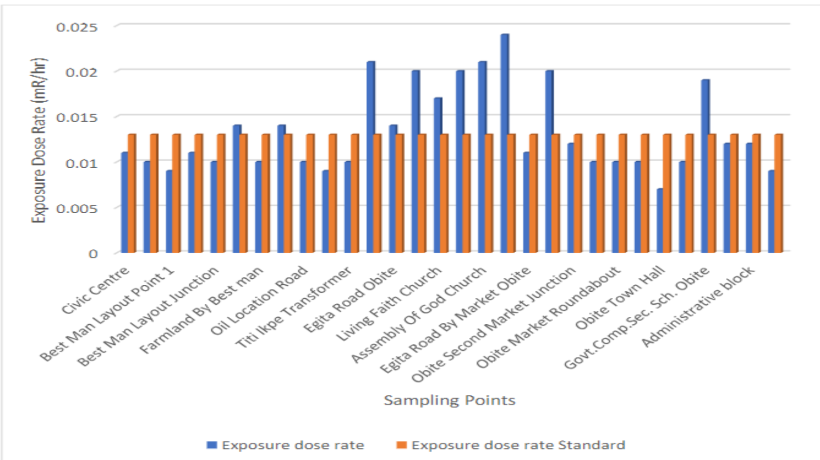

Figure 2: Show the Comparison of Absorbed Dose Rate (nGy/hr) with Standard

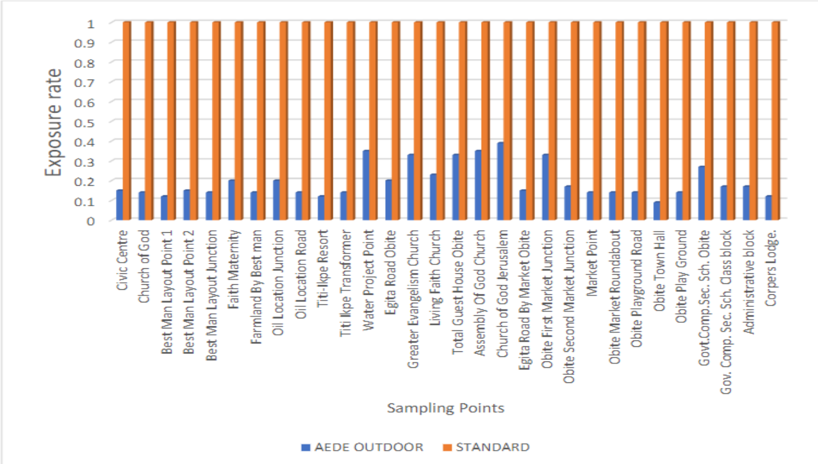

Figure 3: Show the Comparison of AEDE with Standard

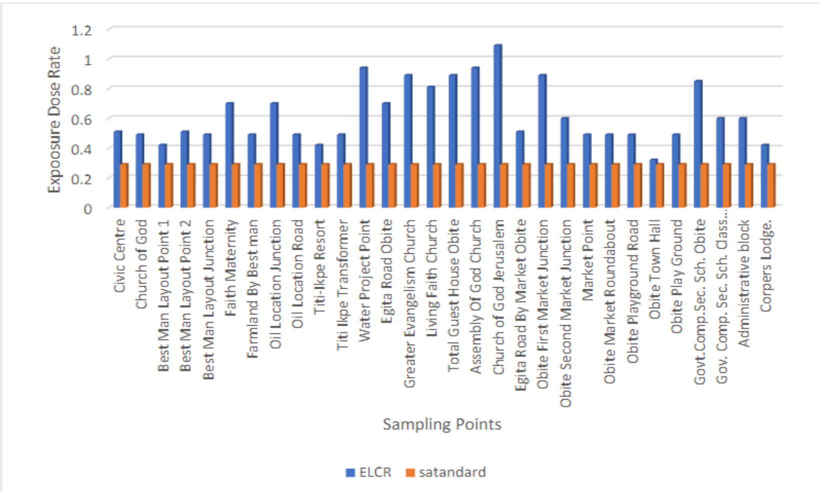

Figure 4: Show the Comparison of Excess Life Cancer Risk with Standard

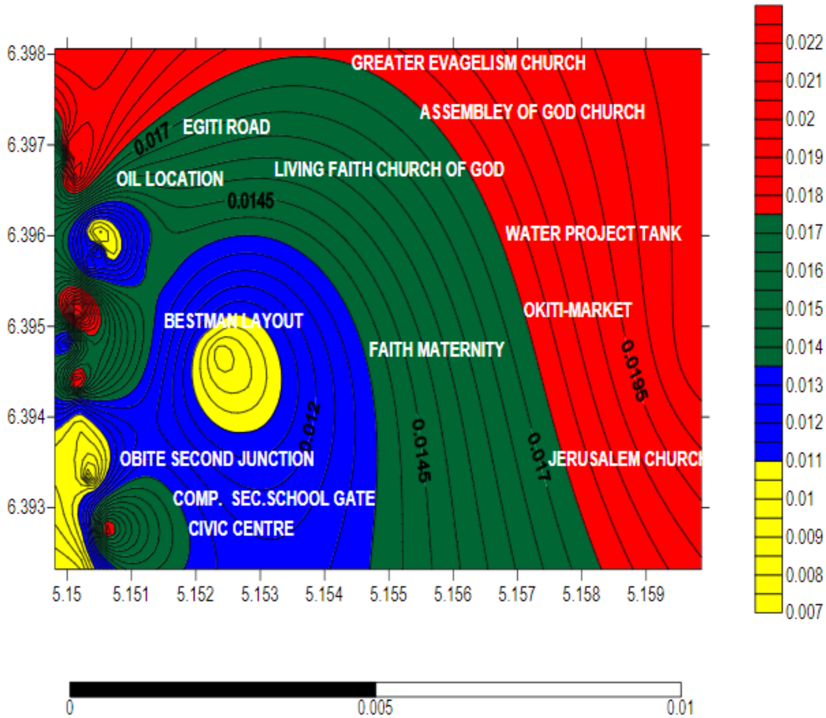

Figure 5: Show the Contour Map of the Study Area

Discussion

The result of the In-situ measurement of the background ionizing radiation exposure are presented in Table 1 and 2, with their respective coordinate. Figure 1 show the comparison of the exposure dose rate (BIR) of the study area as figure 2 shows the comparison of Absorbed Dose rate in $nGhr^{-1}$, with standard. Figure 2 shows the comparison of Annual Effective Dose Equivalent (AEDE) with ICRP standards while figure 4 shows the comparison of Excess Lifetime Cancer Risk (ELCR) with ICRP standard. Figure 5 shows the contour map of the study area. From Table 1, the results showed high values within the areas were industrial activities are carried out on daily bases. The high mean values of 0.024, 0.021, 0.021, 0.020, 0.020, 0.020 and 0.017, obtained in these areas, indicates that the activities of the companies within the areas may have raised the background radiation level in the environment.

The concentration variations was also analysed using a contour map to give a clearer understanding. The red colour areas in the contour map; represents areas of high concentrations with high values that are higher than the ICRP recommended value. These areas are also the major operational regions of the companies with activities that may have raised the background radiation level. The green colour areas in the map, are regions that have slightly higher values than the ICRP recommended values. The purple colour areas, are the regions within the recommended values of the ICRP 2003 while the regions with the yellow colours, have values lower than the ICRP recommended standards.

The background ionizing radiation (BIR) result varies from 0.007 to 0.24 (mR/hr) with a mean value of 0.013(mR/hr). The highest mean of 0.24 (mR/hr) was obtained at church of Jerusalem and the lowest value of 0.007(mR/hr) was obtained at Obite Town Hall. Figure 1 shows the comparison of the exposure dose rate with the standard value of 0.013(mR/hr).

The BIR results were slightly higher than the ICRP standard value but slightly lower compared with the work carried out by Avwiri G.O *et al* (2017) on radiological health risk due to gamma dose rates around Okposi Okwu and uburu salt lakes, Ebonyi State. The values when compared with results obtained by Sigalo and Briggs-Kamara (2004), were higher but are still within the global standards. The high values recorded within the study area are in locations close to the oil producing company within the study area which shows that the community members that are living or doing business transaction within these locations are likely exposed to high radiation due to the activities of the company.

The value of Absorbed Dose Rate varies from 60.9 to 208.0 nGy/hr with mean value of 115.10±0.003 nGy/hr, the obtained mean is lower than the value reported by Ugbede and Benson *(*2018) but higher than the recommended safe limit of 84.0 nGy/hr (UNCEAR 2008). The high value obtained may be due to the presence of radionuclide within the environment or due to the leakage of oil company facility within the study area.

The Annual Effective Dose Equivalent (AEDE) varies from 0.009 to 0.35mSv/yr with mean of 0.195 mSv/yr which is lower than the safe limit of 1.0 mSv/yr stipulated by ICRP (2003) and WHO (2008) for the general public. The results of the Annual Effective Dose Equivalent (AEDE) is lower than the work carried out by Oladele., *et al* (2018) on Indoor and outdoor gamma radiation exposure levels showing average annual effective dose of 1.56 ± 0.33 mSv, which is higher than the world average value (1.0 mSv).

The Excess Lifetime Cancer Risk (ELCR) varies from 0.32 to $1.09x10^{-1}$ showing lower value at Obite Town Hall and a higher value at Egita road by Obite market with mean of $0.62x10^{-1}$ which is higher than the ICRP standard of $0.29x10^{-3}$ and the work of Taskin *et al.,* (2009). The variation of ELCR may be due to pipe leakage of the oil company present in the community or due to the concentration of radionuclide in building materials. The ELCR values of the study area exceeded the worldwide average value of 0.29 x 10^{-3} which imply that the dwellers within the selected study area may develop cancer over a lifetime considering seventy (70) years as the average lifespan of humans within the environment.

CONCLUSION AND RECOMMENDATIONS

This study assessed the background ionizing radiation level of Obite Community, using a nuclear radiation monitor (Digilert 200) and a Global Positioning System (G.P.S). Radiological health risk such as Exposure Dose Rate, Absorbed Dose Rate, Annual Effective Dose Equivalent and the Excess Lifetime Cancer Risk were assessed from the measured background ionizing radiation. The study revealed that the results when compared with the recommended background ionizing radiation standard, exceeded the safe limits stipulated by UNCEAR (2008) and ICRP (2003). The high values of background ionizing radiation recorded, implies that the dwellers within the selected study area may develop cancer over a lifetime, considering seventy (70) years as the average lifespan of humans within the environment. It is therefore important that an urgent enlightenment and strict monitoring by both government and private agencies be carried out to avert an outbreak of disease in the near future.

Emerging Issues and Controversies

Health Concerns: One of the primary concerns related to terrestrial radiation is its potential impact on human health. Controversies might arise around establishing safe radiation exposure levels for residents of Obite and determining whether radiation levels pose any health risks, including an increased risk of cancer or other health issues.

Baseline Data: Establishing accurate baseline data for natural background radiation levels in Obite is crucial. Controversies might revolve around the methods used for measuring radiation, the consistency of data across different measurement techniques, and the reliability of historical data.

Radiation Sources: Identifying the sources of terrestrial radiation in Obite is important for understanding the factors contributing to radiation levels. Controversies could arise over whether radiation is primarily due to naturally occurring radioactive elements (such as uranium, thorium, and radon) or if there are contributions from human activities.

Radon Gas: Radon gas, a radioactive byproduct of uranium decay, can accumulate in indoor spaces and pose a health risk when inhaled. Controversies might involve discussions about the presence of radon in residential and commercial buildings in Obite, as well as debates over mitigation strategies.

Geological Variability: The geological composition of the region can significantly affect radiation levels. Controversies could arise regarding the influence of specific geological formations on radiation readings and whether certain areas exhibit higher or lower radiation levels due to their geology.

Regulation and Guidelines: There might be ongoing debates about the adequacy of radiation protection regulations and guidelines in Nigeria. Stakeholders might discuss whether current regulations are sufficiently protective of public health and whether updates or amendments are needed.

Communication and Public Perception: Effectively communicating radiation data and its implications to the public is essential. Controversies might involve differing perceptions of risk and the challenge of conveying scientific information to the public in a clear and understandable manner.

Land Use and Zoning: Radiation levels might influence land use decisions and urban planning. Controversies could arise around zoning regulations for areas with elevated radiation levels and the potential impact on property values and development plans.

Environmental Impact: Terrestrial radiation levels can also affect the environment, including soil quality, plant growth, and water quality. Controversies might involve discussions about the potential ecological consequences of elevated radiation levels in Obite.

Research Methodologies: Different methods can be used to measure terrestrial radiation levels, including ground-based surveys and remote sensing techniques. Controversies might center on the accuracy, reliability, and comparability of different measurement methods and their potential limitations.

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