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Natural radioactivity measurements and evaluation of radiological hazards in sediment of Oguta Lake, South East Nigeria

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ABSTRACT

The distributions of naturally occurring radionuclides ^{226}Ra, ^{232}Th and ^{40}K in sediments of Oguta Lake, Nigeria were determined using gamma ray spectrometry in order to assess the radiological health hazards and excess lifetime cancer risks associated with the use of the sediments. The mean activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K were found to be 47.89 ± 18.67 Bq kg^{-1}, 55.37 ± 32.74 Bq kg^{-1} and 1023 ± 474 Bq kg^{-1}, respectively. The results of the radiological indices and dose rates obtained in this study were all higher than their worldwide mean values but lower than their maximum recommended limits indicating that the use of the sediments as building materials do not constitute any excessive radiological hazards. The area is known to be subjected to environmental degradations due to oil exploration. Therefore, the results of this study could serve as an important radiometric baseline data upon which future epidemiological studies and environmental monitoring initiatives could be based.

1. Introduction

Living organisms are continuously exposed to a wide range of ionizing radiations from naturally occurring radioactive materials (NORMs) and radionuclides generated from human activities known as artificial radionuclides (El Samad, Baydoun, Nsouli, & Darwish, 2013). Natural radioactivity from NORMs is widely spread in the earth's environment and it exists in various geological formations such as soils, rocks, water, sediment, air and in building materials. Artificial radionuclides are from nuclear weapon tests, nuclear accidents, medical and industrial applications, etc. About 87% of the radiation doses received by humans are from natural radiation sources, which come from the naturally occurring radioactive isotopes of ^{238}U and ^{232}Th and their progeny as well as ^{40}K (Shetty & Narayana, 2010; UNSCEAR, 1993). Other radionuclides of concern are those from the decay of ^{226}Ra and ^{228}Ra. In addition to being a major source of radiation exposure to aquatic biota, sediment acts as a medium of migration for the transfer of radionuclides in the aquatic environment. The sediment deposited at the bottom of rivers and lakes most frequently consist of sand and gravel of different grain sizes, which are very valuable for building constructions. In Nigeria,

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Lakes sediments are used extensively as major mixing materials for building construction. Hence, the needs to determine the activity concentrations of natural radionuclides in sediments in order to accurately assess the radiological health implications to the members of the public utilizing the sediments as building materials.

The contribution of radiation from sediment to human exposure can either be whole body due to external radiation originating directly from primordial radionuclides present in sediment or internal due to inhalation (Jibiri & Okeyode, 2012; Ngachin, Garavaglia, Giovani, Kwato-Njock, & Nourredine, 2007). The internal exposure to radiation, affecting the respiratory track, is due mainly to radon and its decay products which emanate from soil, sediment and building materials (Hameed, Pillai, Satheeshkumar, & Mathiyarasu, 2014). Long-term exposures to radioactivity and inhalation of radionuclides have serious health effects such as chronic lung cancer and leukemia (Qureshi et al., 2014). Data are currently scanty on the natural radioactivity levels in sediments of natural lakes within Nigeria. Oguta Lake is of enormous importance to the local population as a source of utility water, fish, sand for building construction, tourism and also as an outlet for sewages (Wikipedia, 2013). The Lake is located within the oil producing, Niger Delta region of Nigeria, making it susceptible to different types of pollution due to oil exploration activities. The knowledge of the natural radioactivity contents of this lake is thus important. Therefore, activity concentrations of naturally occurring radionuclides (^{226}Ra, ^{232}Th and ^{40}K) in sediment samples collected from different sites within the lake have been determined to evaluate the radiation hazards indices and excess lifetime cancer risk for the local population and tourists visiting the lake.

2. Materials and methods

2.1. *Sample collections*

Oguta Lake is the largest natural lake in South Eastern Nigeria. It covers about 10 km square area and an average depth of about 10–12 m. The communities that surround it are Oguta, Orsu, Nkwesi and Awo. The main feeders of the Lake are Rivers Utu, Awabuna and Njaba. It has a very great economic importance not only to the communities around it, but to the whole country because of its mega-fishing depot and a good source of drinking water. Sediment (sand) from this lake is used extensively by the local population for building construction purposes. The map of the study area is shown in Fig. 1. Sixty sediment samples were collected randomly from various locations along the bank of the Lake. Systematic grid sampling could not be employed due to poor accessibility and lack of necessary equipment. Samples were collected with the help of local fishermen using their fishing boat to transverse the whole length of the Lake. Surface sediments were collected from the depth of 0–5 cm at the floor of the Lake (Jibiri & Okeyode, 2012). The samples were placed in nylon bags and properly labeled at the point of collection.

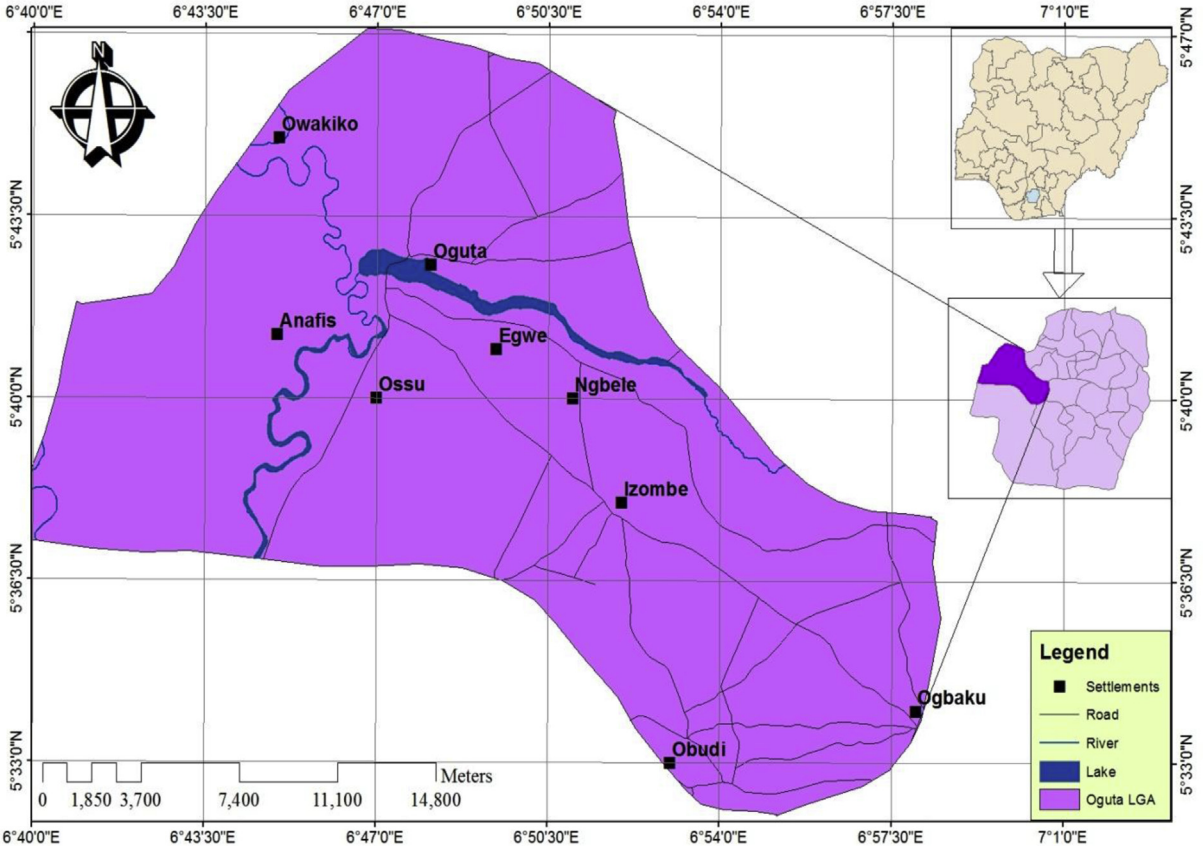

Fig. 1 – Map showing the study area (Oguta Lake) and the adjoining communities.