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Effect of Gross Alpha and Beta in Groundwater Intake and Estimation of Groundwater Table in Kano University of Science and Technology, Wudil

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Abstract

Groundwater levels in Kano University of Science and Technology (KUST), Wudil were measured in hand-dug wells and boreholes. Water samples were collected in both hand-dug wells and boreholes in the study area, and their radiological quality was measured using an internal proportion counter (model EURISYS MEASURE IN 20) instrument, Results of the measurements shows the gross alpha and beta particles presence. The average depth to water table was 419 m, while the gross alpha activity ranging between 0.022 Bq/l to 0.0005 Bq/l, with an average (mean) of 0.0062 Bq/l, and that of beta activity ranges between 0.345 Bq/l to 0.0080 Bq/l, with an average (mean) of 0.0478 Bq/l. These results reveals that; the groundwater in the study area, is not radioactively contaminated, as the values obtained were all below the World Health Organization (WHO), Environmental Protection Agency (EPA), and Australian Laboratory Services (ALS) drinking water guideline values of 1.0 Bq/l for the gross beta radioactivity, and value of 0.5 Bq/l for gross alpha activity, values of 0.1 Bq/l for both the gross alpha and beta and values of 0.5 Bq/l for both gross alpha and beta activities respectively. Hence, the groundwater of the study area (KUST, Wudil.) is radioactively safe to use.

Keywords: Alpha Particle; Beta Particle; Water Table; Radioactivity; and Global Positioning System (GPS).

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1. Introduction

Water is one of the vital resources useful to mankind, and various studies on water has been documented, nevertheless the subject on its quality still remained very important especially in the tropical world. Early humans probably, learned from the animals how to find water beneath a dry stream bed. A thirsty Coyote in North America or Dingo in Australia will dig a drinking hole in a stream, bed in which ground water lies just beneath the surface. Primitive people learned to do the same thing, and after developing a pastoral economy, they learned to dig wells to supply their flocks [1]. Water that has percolated into the ground from the surface, filling soil pores spaces, fissures, fractures of the lithological formations, among others, is known as groundwater. An impermeable layer of rock prevents it from moving deeper so that the lower levels becomes saturated. The upper limit of saturation is known as water table. Once water enters the zone of saturation and becomes groundwater, it may stay there for a very long time. Even though much of the water supplies for domestic, irrigation and industrial use come from surface streams, boreholes, lakes and wells, a large part of the world still depends on groundwater on wells and springs [2]. In Nigeria and other countries, must rural and many sub-urban areas depend on hand dug wells for their water supply. The presence of radionuclides such as alpha and beta particles in drinking water present a number of health hazards, especially when these radionuclides are deposited in the human body, through drinking water. However, human activities such as mining, milling, manufacture of fertilizers, drilling, transportation, processing and burning of fossil fuels etc., have raised naturally occurring radioactive material concentrations in the environment and contaminated surface and sub-surface groundwater when found in high concentrations [3]. No one knows precisely how much groundwater exists in the world, an estimate indicates that probably at least 200 times the volume of annual runoff from the world’s rivers is stored as groundwater beneath the land surface [4]. This enormous body of water plays a crucial role in the operation of water cycle where water is stored for longer or shorter periods in the atmosphere, probably a few weeks or months in the soil, and a few days or weeks in rivers, on its way back to the ocean.

2. Description of the Study Area

Kano University of Science and Technology (KUST) Wudil lies along the Wudil-Gaya-Maiduguri road in the Wudil Local Government Area (L.G.A) of Kano state (see Figure 1). The study area lies within the Basement Complex region of northern Nigeria. It is bonded by latitude 11^0 48’N and 11^0 51’N and longitudes 08^0 50’E and 08^0 52’E and covers an area of 27.38 km^2.

2.1 Climate, Geology and Hydrogeology of the Study Area

The study area is located about 34 Km to the East away from Kano metropolis. Its center is Wudil town, the seat of Kano University of Science and Technology. The area belongs to the humid tropics, wet and dry zone coded ‘’AW’’ in the Koppen’s classification. Mean annual rainfall is 850 mm/a, with great temporal variation as no two Consecutive year’s records have the same amount of rain [5]. The peak of rainfall is in August. The average temperature is 26^0C with mean monthly value of range between 21^0C in the coolest month of December with the hottest of 35^0C in the month of April [5].

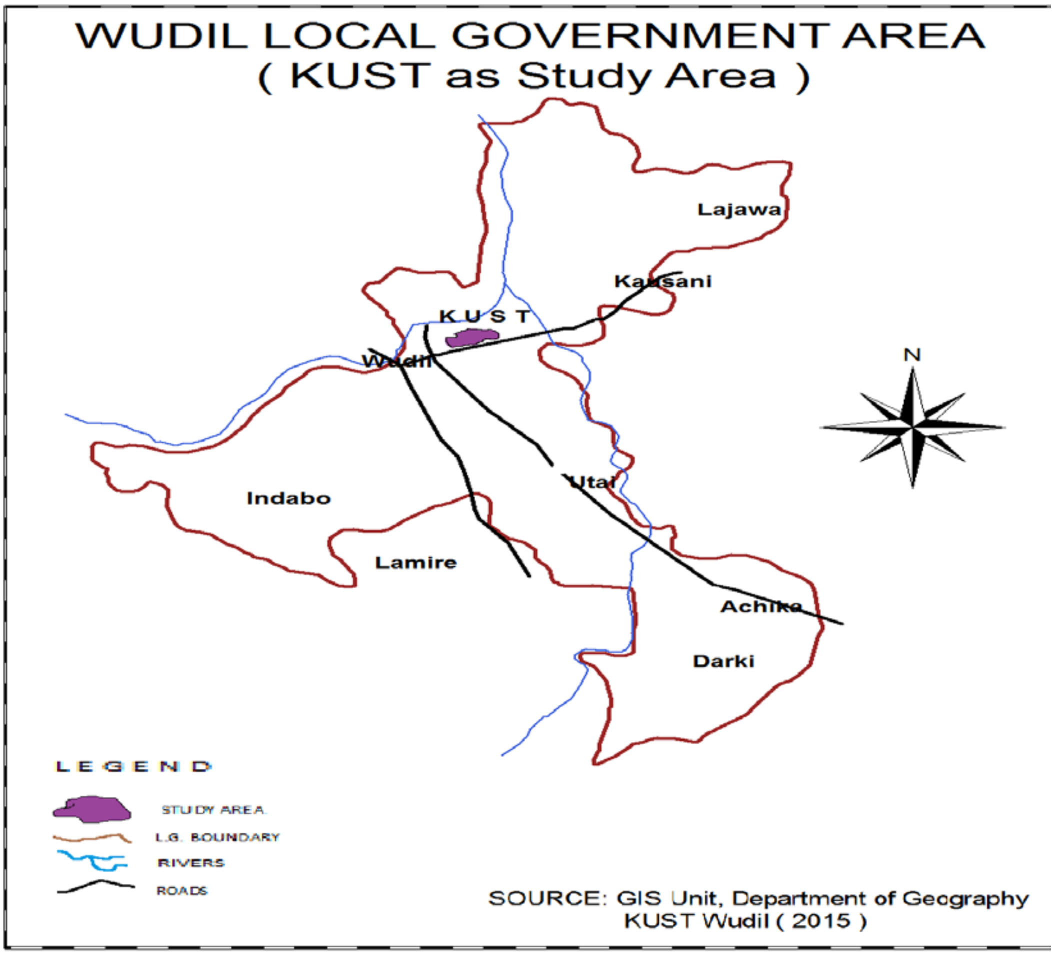

Figure 1: Map of Wudil Local Government Area of Kano State showing the location of the study area.

The Precambrian Basement Complex rocks consisting of Migmatite, gneiss and Pan African granites underlie the area. Commonly mapped rocks includes, Migmatite gneiss, and granite gneiss especially in northern part and granites of the pan African Older Granites mainly outcropping in the southern part of the study area. The older granite was emplaced in the Precambrian times and has given rise to groups of smoothly domed inselbergs in the area. Some Older Granites contain pegmatites that are commonly a locus of tectonic movement that results in the formation of minerals [6]. Major rocks are underlain by a thin mantle of decomposed Kaolinized weathered schist and gneisses which in turn capped by a superficial laterites crust and in some places by thin soil alluvium deposits. The superficial laterites are 2-3 m thick. Migmatites gneisses constitute the largest group of rocks in the area and pockets of undifferentiated Schist's occurring as relics of older metasediments in isolated narrow bodies within the migmatites gneiss complex especially in Wudil town. Major vertical and sub vertical jointing occurs in NE-NW axes and a long an axis slightly east north. Jointing followed better-developed foliations planes. Two type of fractures are found one follows a recognizable horizon, often lithologically controlled, where the rock mass is dislocated possibly as result of consequence stress release. The other is identified as steeply dipping master joint following banded-rich gneiss or pegmatite dykes [6]. The popular Hadejia River passes through Wudil town, which drains up to, the Hadejia- Nguru wetlands. The river was perennial type and has now changed into modern type with continuous flow throughout the year, which is due to discharges from Tiga and Challawa Gorge dams of which the modern river channel now contains migratory sand alluvium.

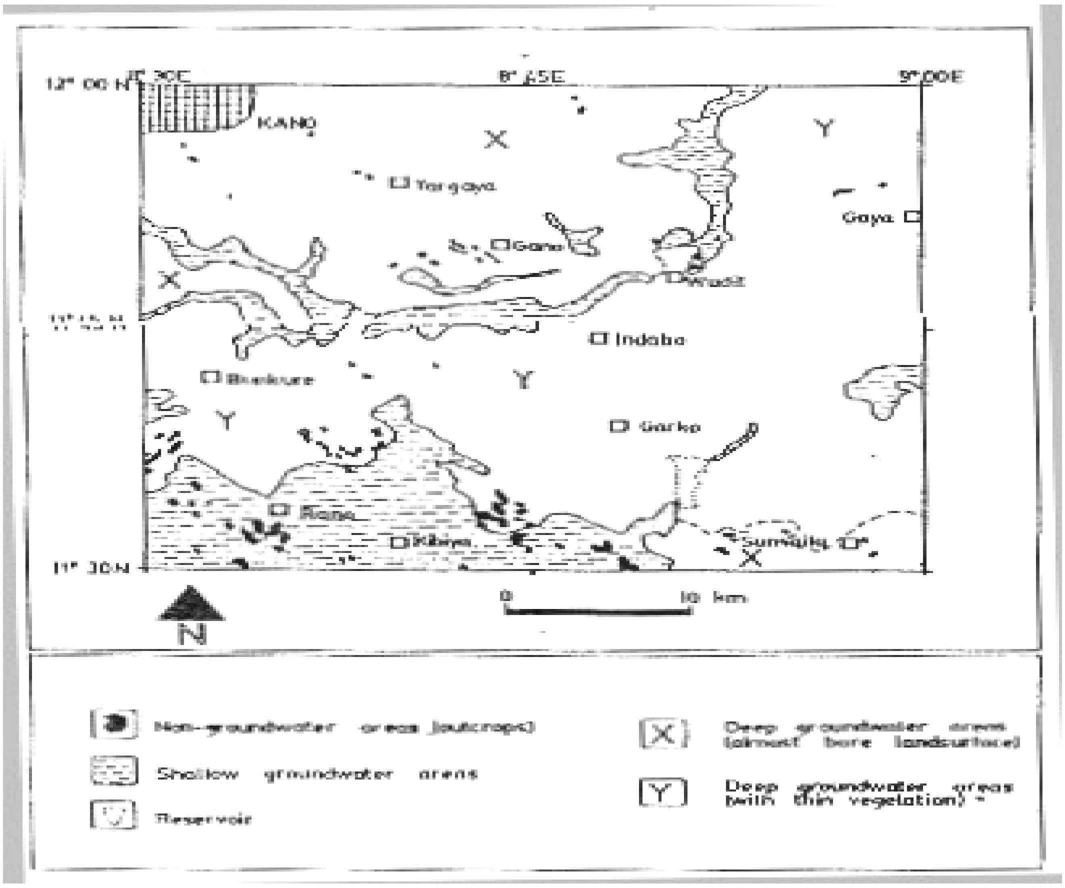

Figure 2: Geological Map of the Study Area, after Bala, 2005 [7]

3. Methodology

A reconnaissance survey was first undertaken in order to study the location of the study area and it was inspected, and the wells for which the water levels measurement were to be measured were located and their locations were obtained using a Global Positioning System (GPS). The two hand-dug wells and the six (6) boreholes were located, and their geographical coordinates were taken using Global Positioning System (GPS). Measurements of depth of water levels in the wells were measured using a measuring tape. During the inspection, a total of ten (10) water samples were collected in a 2 liter plastic bottles that were thoroughly rinsed with the water to be sampled before finally filling the bottles. After pH and total dissolved solids measurements using pH meter, the samples were acidified by adding 20 milliliter (ml) of IN HNO_3 to minimize the lost of radiation to the containers wall. For the determination of gross alpha and gross beta activity, an internal proportional counter (Model EURISYS MEASURE IN 20) was used and the analysis was undertaken at the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria.

4. Results and Discussion

The results obtained are presented in table 1, showing the locations of wells and boreholes that were studied. The coordinates of sampling sites including their altitudes were also taken and shown in table 1. The depth to water table in the two hand-dug wells of the inspected area was measured using meter tape, and the results are presented in the table 2.

Table 1: Locations and Altitude in Boreholes and hand-dug wells

S/N	Samples	Longitude (N)	Latitude (E)	Elevation (ft)	Elevation (m)
1.	B_1	$11^0$48’33’’	$08^0$51’00’’	1434	437
2.	B_2	$11^0$48’30’’	$08^0$51’28’’	1363	416
3.	B_3	$11^0$48’31’’	$08^0$51’51’’	1377	420
4.	B_4	$11^0$48’34’’	$08^0$51’57’’	1373	419
5.	B_5	$11^0$48’29’’	$08^0$51’10’’	1373	419
6.	B_6	$11^0$48’35’’	$08^0$51’25’’	1360	415
7.	W_1	$11^0$48’23’’	$08^0$51’17’’	1384	422
8.	W_2	$11^0$48’05’’	$08^0$51’05’’	1362	415

Note: *Bn = Boreholes, Wn = Hand-dug wells, where n = 1, 2, 3 …

Table 2: Depth to the water table in the two hand-dug wells

S/N	Samples	Longitude (N)	Latitude (E)	Elevation (ft)	Depth to water table (m)
1.	W_1	$11^0$48’05’’	$08^0$51’05’’	1362	415
2.	W_2	$11^0$48’23’’	$08^0$51’17’’	1384	422

Note: Wn = Hand-dug wells, where n = 1, 2, 3 …

From the water well measurements, the depth to the water table ranges from 415 m – 422 m, with an approximate average of 419 m. However, the laboratory results of the gross alpha and gross beta levels determined are shown in the table 3 below;

Table 3: Laboratory results of the gross alpha and gross beta measurements.

S/N	Samples	Gross Alpha (Bq/l)	Gross Beta (Bq/l)
1.	B_1	Nd	0.0080
2.	B_2	0.0005	0.0085
3.	B_3	0.0032	0.0170
4.	B_4	0.0043	0.0165
5.	B_5	Nd	0.0115
6.	B_6	Nd	0.0108
7.	B_7	0.0120	0.0350
8.	B_8	0.0150	0.345
9.	W_1	0.022	0.0125
10.	W_2	0.005	0.0130

Note: Nd; Not determinate, Bq/l; Becquerel per liter, Bn = Boreholes, and Wn = Hand-dug wells, where n = 1, 2…

From the laboratory results of the gross alpha and gross beta activities, indicate the gross alpha activity ranges from 0.022 Bq/l – 0.0005 Bq/l, with an average of 0.0062 Bq/l. The gross beta activity ranges from 0.345 Bq/l – 0.0080 Bq/l, with an average of 0.0478 Bq/l. However, a comparison to the world standard values of the values obtained from the laboratory results for the gross alpha and beta activities are given in table 4 and table 5 respectively.

Table 4: Table of comparison with level obtained and standards of gross Alpha.

S/N	SAMPLES	Gross Alpha (Bq/l)	WHO (Bq/l)	EPA (Bq/l)	ALS (Bq/l)	REMARK
1	B_1	Nd	0.1	0.1	0.5	Not Determine
2	B_2	0.0005	0.1	0.1	0.5	Less than WHO, EPA and ALS standard
3	B_3	0.0032	0.1	0.1	0.5	Less than WHO, EPA and ALS standard
4	B_4	0.0043	0.1	0.1	0.5	Less than WHO, EPA and ALS standard
5	B_5	Nd	0.1	0.1	0.5	Not Determine
6	B_6	Nd	0.1	0.1	0.5	Not Determine
7	B_7	0.0120	0.1	0.1	0.5	Less than WHO, EPA and ALS standard
8	B_8	0.0150	0.1	0.1	0.5	Less than WHO, EPA and ALS standard
9	W_1	0.022	0.1	0.1	0.5	Less than WHO, EPA and ALS standard
10	W_2	0.005	0.1	0.1	0.5	Less than WHO, EPA and ALS standard

Note: Nd; Not determinate, Bq/l; Becquerel per liter, Bn = Boreholes, and Wn = Hand-dug wells, where n = 1, 2…

Table 5: Table of comparison with level obtained and standards of gross beta.

S/N	SAMPLES	Gross Beta (Bq/l)	WHO (Bq/l)	EPA (Bq/l)	ALS (Bq/l)	REMARK
1	B_1	0.0080	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
2	B_2	0.0085	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
3	B_3	0.0170	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
4	B_4	0.0165	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
5	B_5	0.0115	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
6	B_6	0.0108	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
7	B_7	0.0350	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
8	B_8	0.345	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
9	W_1	0.0125	1.0	0.1	0.5	Less than WHO, EPA and ALS standard
10	W_2	0.0130	1.0	0.1	0.5	Less than WHO, EPA and ALS standard

Note: Nd; Not determinate, Bq/l; Becquerel per liter, Bn = Boreholes, and Wn = Hand-dug wells, where n = 1, 2...

The study results reveals that; the groundwater in the study area, is not radioactively contaminated, as the values obtained were all below the World Health Organization (WHO) [10], Environmental Protection Agency (EPA) [11] and Australian Laboratory Services (ALS) [12] drinking water guideline values of 1.0 Bq/l for the gross beta radioactivity, and value of 0.5 Bq/l for gross alpha activity, values of 0.1 Bq/l for both the gross alpha and beta and values of 0.5 Bq/l for both gross alpha and beta activities respectively. Hence, the groundwater of the study area (KUST, Wudil.) is radioactively safe to use.

5. Conclusion and Recommendation

The results obtained from the direct measurements of the water levels from wells in the study area indicated that the water table has an average depth of 419 m. These were compared with the resistivity interpretation by Danbatta and Hotoro, and found that; this range fell in the range of their conductive layers, i.e. the water bearing layers of all their resistivity sounding curves [8, 9]. From the present work, it can be inferred that the ground water samples from the study area have low groundwater radioactivity and all the results measured are below the World Health Organization, Environmental Protection Agency and ALS [10, 11, 12], drinking water guideline values of 1.0 Bq/l for the gross beta radioactivity, and value of 0.5 Bq/l for gross alpha activity, 0.1 Bq/l for both gross alpha and beta activity and 0.5 Bq/l for both gross alpha and beta activities respectively. Hence, the groundwater of the study area (KUST, Wudil.) is not radioactively contaminated, or rather is radioactively safe to use. For future works around the survey area, I would suggest that areas W_1 and W_2 may serve as useful places for groundwater developments because the water there can be reached quicker than the other areas. Also, geophysical survey is still recommended to confirm the otherwise of the water table and the lithological formation within those well sites.

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