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Evaluation of Water Sources Situation in Offa Local Government Area of Kwara State, Nigeria

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ABSTRACT

Background: The objective of this study was to investigate the geospatial analysis of underground water resource management and distribution pattern of water supply in Offa, Kwara State, Nigeria. A case study was carried out for the study area.

Methods: Data were collected from two wells in the area. The cumulative values for the variables were collected twice daily for a period of nine months beginning from January to September 2014 for the wells. The data were analyzed by using systematic random sampling technique. The linear regression was used to check the relationship between two variables while the multiple regression analysis was also used as a descriptive analysis tool or as an inferential tool by which the relationship in the total population was evaluated and determined.

Results: The study revealed that despite the government efforts and those of the various agencies, there was still a great reliance especially in the rural areas, on polluted sources of water which make the inhabitants vulnerable to diseases and epidemics which can lead to sudden death if not check-mated.

Conclusion: This research demonstrated that there was a significant reliance, especially in rural areas in the study area, on water sources which make them vulnerable to epidemics.

Key words Water sources, assessment, respondents, Offa, Kwara State.

1. INTRODUCTION

Water resources management is one of the challenges the world faces today. It is difficult to think of a resource more essential to the health of human communities or their economies than water [1]. Human beings cannot live for more than several days without water, shorter than for any source of sustenance other than fresh air. In meeting their demand for water, societies extract vast quantities from rivers, lakes, wetlands, and underground aquifers to supply the requirements of cities, farms, and industries [2]. Besides being an integral part of the ecosystem, water is a social and economic good. Demand for water resources of sufficient quality and quantity for human consumption, sanitation, agricultural irrigation, and manufacturing will continue to intensify as population increases and as global urbanization, industrialization, and commercial development accelerate [3]. Sustainable development is the key to water resource quantity and quality, as well as national security, economic health, and societal well-being. The word sustainability implies the ability to support life, to comfort, and to nourish. For all of human history, the Earth has sustained human beings by providing food, water, air, and shelter. Sustainable also means continuing without lessening [4]. Development means improving or bringing to a more advanced state, such as in our economy. Thus, sustainable development can mean working to improve human's productive power without damaging or undermining society or the environment—that is, progressive socio-economic betterment without growing beyond ecological carrying capacity: achieving human well-being without exceeding the Earth's twin capacities for natural resource regeneration and waste absorption [5]. The challenges that need to be overcome in the sustainable development of cities are enormous. As a continent, Africa is experiencing one of the fastest rates of urbanization in the world, with sub-Saharan Africa leading the way. By the year 2030, Africa

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will have 760 million urban residents-more than the entire western hemisphere today [6]. By 2050 that figure is expected to reach 1.2 billion and with more people moving to cities, the demand is increasing for sustainable development projects in energy, transportation, water as well as in health care [7]. With its comprehensive environmental portfolio, United Nations is a global leader in sustainable urban development most especially in water consumption and discharge projects. United Nations longstanding expertise and ongoing studies conducted with renowned regional partners have resulted in innovative infrastructure concepts and sustainable solutions for green buildings, renewable resources, water purification, green cars, safety and healthcare [8]. Offa Local Government Area of Kwara State was created in 1991 out of the defunct Oyun Local Government Area by the regime of President Ibrahim Babangida. The Offa local Government metropolitan area is about 60 km from the State headquarters, Ilorin at an elevation of 201 meters above sea level. It is boarded in the North by Ilorin, the capital of Kwara State and in the east by Irepodun and in the south by Igbomina. The west is boarded by Osun State. The area is blessed naturally with humus, fertile soils useful for agricultural practices for export trade [9]. Offa Local Government Area has a population of about half a million as of the 2006 census figure. The area has been blessed with a good, conducive, serene environment. Blessed with modern infrastructural facilities, sound education privilege and stable weather conditions. Offa Local Government Area would soon need technological advancement in the expansion of water resource management for her sustainable development to cope with the mass pressure on land and other available natural resources. The climate of Offa favours the location of the headquarters. Offa Local Government Area lies between the equatorial belt and proximity to the Atlantic Ocean which influences the diurnal rainfall pattern and of course, the vegetation pattern of deciduous forest. Offa Local Government Area lies on latitude 80 261 and 80 671 N and longitude 80 261 and 80 901 E [9].

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Sources

The data required for this project was obtained from two major sources, namely; primary and secondary sources. Direct observation and field measurements for the first group of data was carried out, while Questionnaire administration was carried out later to augment the relevant data sources. Use of secondary sources of data is hence necessary to complement the other primary data sources. These include the use of journals, monographs, statistical records, books from libraries, maps, tracts, internets, and the use of other pictorial elements. The success of any research work depends largely among other considerations on the type of data collected for the study and so extra care was always been taken in determining the type of data that was used. In this study, data used was categorized into two groups. In the first category was the data relating to the source of water, types of water source, and characteristics of the wells such as the followings;

i. Depth to water.
ii. Total well depth
iii. Depth of water
iv. Diameter of well
v. Volume of water in the well and
vi. The nature and source of water.

The data and information on the sources of water, usage and problems of water supply in the study area constitute the second category of information used. Finally, the survey got the researcher acquainted with the field conditions and to create a rapport with the village dwellers in the area since a study of this nature that will require a stranger going inside peoples' houses and compounds at least twice daily for proper measurement needs to be approached with viable interaction, understanding and maximum cooperation.

2.2 Methods

2.2.1 *Site information*:

Information on the activities of each agency was obtained from the respective organization. Prohibited reports and previous works yielded useful information on the amount of daily water consumption per capital in each Local Government unit in the study area. The share of each agency relative to all other agencies per local government area was computed using Isard`s location quotient (LQ), [10].

This is defined as LQ=Si/S Ni/N

Where: Si = the number of water points in a local government

S = total numbers of water points in all the local government (state)

Ni = the population of people in the local government

N =total population in all the local government or state

Since the study is concerned with welfare condition as equitable per capital distribution of social infrastructures and services, population size rather than physical size. The LQ this given in sight on the nature of distribution as contribution of each water agency to the provision of potable water in the state as compared with the alternative underground water supply. "The primary objectives of the government's policy on Water supply are to provide water in adequate supply. Make it available and ensure that the water is always safe, potable, handy and healthy for potential populace for human consumption".

2.2.2 *Sampling Techniques*

The study here was made up of three major districts in Offa Local Government Area. The sample size for the purpose of the administration of the questionnaire was randomly selected for easy distribution of the questionnaire. The systematic random sampling technique was used to analyze the data. Before the administration of the questionnaire, there was the selection of the source of water used for water sample collection from the underground reservoir. The information was sought from the district areas which were later coded as sites A, B, and C for the purpose of data sourcing.

2.2.3 Data Instruments

The instruments which were frequently used in this research work include;

i. A measuring tape
ii. An improvised well depth estimator
iii. Hand-held Geo-positioning System.

The measuring tape is very common and very useful at this stage. The improvised well depth estimator is a 30meter long string graduated in meters with beads and a big padlock attached to one of its ends. The string with the padlock at one end was lowered into the well and measurements been taken by counting the number of beads down it in the water. In case where the measuring point on the string did not coincide with the surface of the well, the number of beads down in the well was counted and the measuring tape was used in reading off the remaining length of the string from the position of the first bead in the well.

2.2.4 Survey of the Study Area and Well Sites

Virtually, it was seen that the three districts making up of Offa Local Government Area take a linear pattern with buildings erected along the roads and water sources. Meanwhile, the linearity made the surveying exercise a little bit easier and water sources were neatly divided into scales and aided by the use of topographic sheet for easy identification.

2.2.3 Method of Data Collection

The depth of water was gotten by lowering the improvised calibrated well depth estimator into the existing well. Its first contact with water in the well was noted and the reading of the depth to water was taken. The cumulative values for the variables were collected twice daily for a period of nine months beginning from January to September 2014 for the wells in the study area. There were daily readings of the depth of water in the study area while the monthly average reading for both the morning and evening periods were recorded. For the Total well depth, the reading was gotten by further lowering the calibrated well depth estimator into the bottom of the well severally. Its first contact with deep well bottom is usually felt and this gives the measurement of total well depth. In all, the readings on the total well depth was used to determine the mean value, standard deviation and mean variation. Also, to determine the depth of water, the difference between the total well depth and the depth to water in each well is derived. The Diameter of well was measured by placing the measuring tape across the circular opening of the well. To ascertain accuracy of the procedure described above, the exercise was usually repeated at two different points on the circular opening of each well and the average were taken as the diameter of the wells.

The volume of well water was hence calculated for each well using the formula;

Volume $= \pi r2h$; Where $\pi = 3.142$

r = the radius of the circular opening of the well and

h = the height of the well, which in this case will be the depth of water

Using the above formula, the average monthly water availability for each well in the study area was calculated in cubic meters.

2.3 Data Analysis

Some statistical techniques were used to analyze the data collected. These are the descriptive statistics, linear correlation and regression analysis, and the sampling theory using the student "t- test.

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According to Ogbeibu [11], if a given area is entirely underlain by a groundwater zone, the probability that a randomly selected site in such an area is underlain by groundwater is 1. The above statement therefore implies that the closer to unity the proportion of an area that is underlain by groundwater; the greater the probability that a randomly selected site in the area is underlain by groundwater. Some statistical techniques were used to analyze the data collected. These are the descriptive statistics, linear correlation and regression analysis, and the sampling theory using the student "t-test.

2.3.1 The Descriptive Statistics

This technique was applied to analyze the raw data collected on the important variables in this investigation as a necessary step before the application of parametric statistical methods. This particular method of data analysis was used for simple distribution called frequency distribution of each variable and to transform most of the data set before applying the next statistical methods. The variables are analyzed by using statistical techniques which also include data on depth to water, total well depth, depth of water, diameter of well and volume of well water as they were taken twice daily for at least a total period of nine months.

2.3.2. The Alternative Technique

This represents another statistical technique being employed,

i. The Sample Site was randomly selected

ii. The number of sample sites sampled was reasonably large in comparison with the size of the area under investigation.

iii. The sample sites were widely distributed over the area under study.

The value of probability (P) of success can be obtained for this purpose by adopting the relative frequency definition of probability as coined by [12]. This was achieved by dividing the number of sites underlain by groundwater by the total number of sites in the area under investigation. The greater the value of P, the greater the proportion of the total area that is underlain by groundwater. If the whole area is underlain by groundwater, "P" will be equal to 1. This technique was applied to analyze the raw data collected on the important variables in this investigation as a necessary step before the application of parametric statistical methods. This particular method of data analysis was used for simple distribution called frequency distribution of each variable and to transform most of the data set before applying the next statistical methods. The variable analyzed is by using statistical techniques which also include data on depth to water, total well depth, depth of water, diameter of well and volume of well water as they were taken twice daily for at least a total period of nine months.

2.3.3. Regression Analysis

Regression analysis is the general statistical technique through which one can either analyze the relationship between two variables on one hand (i.e. linear relationship) and between one variable and a set of independent variables (multiple regression analysis). The linear regression was used as a descriptive tool to check the relationship between two variables while the multiple regression analysis was also used as a descriptive analysis tool or as an inferential tool by which the relationship in the total population is evaluated and determined.
The linear regression equation applied is;

$$'Y' = a + bx,$$

Where: 'Y' is the dependent variable
'a' is the graph intercept and
'b' is the graph slope
The multiple regression analysis is as follows;

$$Y = a + bx1 + bx2 + bx3 + bx4 \ldots\ldots\ldots\ldots\ldots + E$$

Where: Y = the dependent variable, a = the intercept of the graph
b = the slope of the graph x1- xn = the values of the independent variables,
E = remain constant value

3. RESULTS

These population structures are expected since the questionnaire was purely administered on the heads of households. The age range between 31-40 and 41-50 had the highest while below 21 and above 60 years were the lowest (Table 1).

Table 1: Age Distribution of the respondents

Age years	Number of Respondent	Percentage of Respondent
Below 21	3	0
21-30	23	4.5
31-40	38	31.3
41 - 50	43	38.8
51 - 60	32	22.4
Above 60	19	3.0
	150	100.0

Educational qualification has been identified as one of the major factors affecting the socio- economic characteristics of any population. This factor influenced to a great extent, both the attitude and behavior of the people in relation to their water use. Table 2 shows that more than half of the respondents (55.2%) had no formal education, with a substantial percentage completing their primary education in Quranic schools. This high illiteracy level, apart from affecting the water consumption pattern of the people, go a long way in compounding their problems in the sense that, very little are knowledgeable about the basic methods of treating their drinking water before use (Table 2).

Table 2: Educational Qualification of Respondents

Educational Level	Number of Respondent	Percentage of Respondent
No. of formal education	60	55.2
Primary	33	19.2
Secondary	28	11.9
OND/NCE	29	13.4
HND/Graduate	0	0.0
Total	150	100.0

This occupation distribution influenced greatly the income level of the people. As characterized by most rural areas. In Nigeria, all farmers in this area practice subsistence farming, growing mainly food crops such as maize, guinea corn, cassava, yams and others which are usually planted on a very small area of land. This makes their average income level to be very low (Table 3).

Table 3: Occupation Distribution of Respondents

Occupational Level	Number of Respondent	Percentage of Respondent
Farming	50	46.3
Professional Occupation	29	16.4
Trading	26	13.4
Civil servant	30	179
others	15	6.0
Total	150	100

The low income level is no doubt one of the major factors that has been preventing the people from embarking on the development of a reasonable water supply project (Table 4).

Table 4: Income Level of Respondents

Monthly Income	Number of Respondent	Percentage of Respondent
Less than N 2000	58	41.8
N 2000 – N 5000	68	46.3
N 5000 – N 10,000	24	11.9
Total	150	100

Substantial percentage of the respondents are married, non is a divorcee, while the widowed and singles account for 4.5 and 10.5%, respectively. The family structure however showed the existence of the polygamous type of marriage, going by the number of children each respondent had. Of all the respondent 64% have 5 to 10 children each. This is not unexpected since the main religion is Islam. Both the marital status and size of the family affect to a great extent the water requirement of the people (Table 5).

Table 5: Marital Status of respondents

Marital Status	Number of Respondent	Percentage of Respondent
Married	122	85.0
Single	20	10.5
Divorced	0	0 0
Widowed	08	4.5
Total	150	100

Respondent's size of household with the highest number of respondents was between the ages of 5-10 while the least number of respondents was recorded by household size with less than 5 children (Table 6).

Table 6: Respondent's Size of Household

Household size	Number of Respondent	Percentage of Respondent
Less than 5 children	20	13
5- 10 children	88	64
11 Children and above	42	23
Total	150	100

4. DISCUSSION

In Offa, Kwara State most especially, prompt and adequate attention is needed by government to checkmate the exploitation of water without plan, causing deterioration and depletion of water source both in quality and quantity, lowering the water level and causing water environmental pollution. In Nigeria, for example, prior to the statutory reforms initiated by the Council of Nigerian Government Water Reform Framework and in conjunction with the Council of Registered Engineers of Nigeria (COREN) and Federal Ministry of Water Resources in the 1990s, many Nigerian states managed groundwater and surface water through separate government agencies, an approach beset by rivalry and poor communication [13]. Underground water supplies are replenished or recharged by rain and run-off percolation, in some areas of the world, people face serious water shortages because underground water is used faster than it is naturally replenished, while in other areas, groundwater is polluted by human activities [1]. Groundwater can be found almost everywhere with the water table either deep or shallow, and may rise or fall depending on many factors. Heavy rains or melting snow may cause the water table to rise, or heavy pumping of groundwater supplies may cause the water table to fall [14]. In most of the areas under study, underground water level decreases, the water flow went down considerably due to unplanned human interference. Some areas have the subsidence of ground, deformation of ground surface, underground water level went down over 10 meters in some wells, and the water flow reduced as half as that at the first-time interval [15]. The action of uncontrolled and overloaded exploiting underground water, in order to satisfy water-consumed demand increasingly the people in the Kwara State including almost everyone who lives in the rural areas, has made flow of water unstable. The largest use of groundwater in Nigeria, most especially in the far North Aquifer are permeable pollutants which can readily sink into underground water supplies [16, 17]. Groundwater can be polluted by landfills, septic tanks, leaky underground gas tanks, and from overuse of fertilizers. Recharge is commonly expressed as the amount of water which falls on an aquifer over a given period of time, and is normally or usually measured in milliliters per year, while discharge represents the outflow of groundwater from underground aquifers [18]. The passive groundwater recharge zone can achieve a thickness of several hundred meters and is underlain by the connate groundwater i.e from groundwater that has not returned to the biosphere for millions of years [19]. Sedimentary rocks like sandstone and limestone have faster groundwater recharge rates. They make the best aquifers because these types of rocks have connected pore spaces [16]. The pit method is most suitable for such alluvial areas, (plains) where permeable strata are not below than 2 to 2.5 meters deeper from the ground surface. This technique is generally considered suitable for the roof having 100sqm areas and it is constructed to recharge shallow aquifers [1, 2]. Most recharge methods estimate groundwater recharge as the product of the water level fluctuation in wells and the specific yield of an aquifer material using water balance/ water budget models [14]. Groundwater is found in two zones; The unsaturated zone, immediately below the land surface, contains water and air in the open spaces, or pores. The saturated zone, a zone in which all the pores and rock fractures are filled with water, underlies the unsaturated zone [20]. In order to implement a groundwater recharge programme on a large scale in an integrated manner and to bring over-exploited/critical blocks into the safe category in a time-bound manner, evaluation of the water quality is envisaged [14, 21]. Again, to effectively implement conjunctive use of surface water and groundwater and to promote efficient methods of water use in the stressed areas, appropriate studies are necessary as stated in this study.

5. CONCLUSION

In recognition of the need to enhance the quality of life of our people through the provision of potable water, successive governments in Nigeria and their agencies as well as international organizations have mounted numerous attempts to improve the coverage and quality of water supplies. Using as a case study the geospatial analysis of underground water resource management and distribution pattern of water supply in Offa, the study revealed that despite the government efforts and that of the various agencies, there is still a great reliance particularly in the rural areas, on polluted sources of water which make the inhabitants vulnerable to diseases and epidemics which can lead to sudden death if not check-mated. It is obvious that water need in any geographical area is determined by the teeming population density and the level of socio-economic development of the area which if not harnessed could be problematic to the implementation of the sustainable development plan of the millennium goal by the government.

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Conflict of Interest

There was no conflict of interest between the two Authors.

Contribution of the Authors

Dr. Abiodun Rasheed Omokanye was fully in charge of the sample evaluation while Dr. Benefit Onu was in charge of data analysis. The Compilation of this paper was organized collectively by the two authors.

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